# IAMU AGA 2015

International Association of Maritime Universities

16th

Annual General Assembly

# PROCEEDINGS

IAMU
International Association of Maritime Universities

Hosted by
University of Rijeka
Faculty of Maritime Studies Rijeka

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16th Annual General Assembly

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# PREFACE

Dear Colleagues,

The Faculty of Maritime Studies, the oldest member of the University of Rijeka, has the honour and privilege of hosting the 16th IAMU AGA 2015 Conference and Annual General Assembly. Our Faculty is the oldest and the biggest university institution in south-eastern Europe in the domain of Maritime Studies. We proudly and respectfully highlight that the Faculty of Maritime Studies in Rijeka finds its roots in 1866 when Austro-Hungarian Naval Academy acted in this area that educated navigators and marine engineers, and the Faculty still does it today. Scientific research fellow of the Academy was the world known physicist, prof. Ernst Mach. Prof. Mach, together with prof. Peter Salcher and prof. Sandor Riegler explained and experimentally proved the phenomena of breaking of the sound barrier and formation of "shock waves".

Prof. Mach, prof. Salcher and prof. Riegler presented a paper explaining the formation of the "shock wave" around the projectile moving at supersonic speed in 1886 to the scientific audience of the Department of Mathematics and Natural Sciences of the Imperial Academy of Sciences in Vienna. The Mach-Salcher-Riegler paper was accepted with extraordinary approval by the scientific world of that time. Their successful publication of experimental results on 21st April 1887 opened the way to advanced studies of supersonic aerodynamics.

The IAMU AGA 2015 Conference will be held in Opatija , Croatia from 7th to 10th October 2015. The theme of IAMU AGA 2015 is: Recent Developments in International Maritime Education, Training and Research – Enhancing the Productivity, Safety and Energy Efficiency in Maritime transport. This year the Assembly aims at considering important issues including life-long university education in the field of maritime studies. This book presents the proceedings of the International Association of Maritime Universities (IAMU) AGA 2015 Conference. The book covers the most updated aspects of modern maritime transport, safety and security at sea. Maritime education, energy-efficiency, productivity and reliability at sea and related human activities are the focus through the book. We have 57 presentations, 3 workshops, 4 project reports as well as a strong student program during AGA 2015 and we are confident that this Conference will provide a favourable environment for the world's leading experts to present their most recent achievements, share the results of research projects, and exchange scientific and professional views and experience in maritime education, training and research, thus emphasising the vital role of IAMU in ensuring safe but economically efficient shipping while at the same time making the oceans and seas safer and cleaner.

While attending IAMU AGA 2015 the participants will also have the opportunity to visit the premises of the Faculty of Maritime Studies in Rijeka and two interesting permanent exhibitions: "From the Naval Academy to the Faculty of Maritime Studies" and "Titanic – Carpathia ... 100 years later".

We also trust that the participants will experience excellent accommodation in Opatija, which is the major tourist resort in Croatia, with more than 170 years of touristic tradition.

On behalf of the Faculty of Maritime Studies in Rijeka, its staff and students we look forward to welcoming you to IAMU AGA 2015. I would like to acknowledge and thank all involved in IAMU AGA 2015, speakers, students, participants, the Local Executive Committee, IAMU Secretariat and the Nippon Foundation for their continuing and valuable support.

With 57 papers to be presented at the Conference, and published in the IAMU AGA 2015 Proceedings, we look forward to the presentations and discussions with our international peers and hope that our mutual cooperation will continue for the benefit of IAMU, maritime education, training and research worldwide.

Professor Serdjo Kos, FRIN
Dean of the Faculty of Maritime Studies
University of Rijeka, Croatia
Member of RIN Council, London

# EDITORS' NOTE

The *Proceedings* of the 16th International Association of Maritime Universities (IAMU) Annual General Assembly (AGA) contain papers presented at the Technical Sessions of the IAMU AGA 16 held in Opatija, Croatia, from 7th to 10th October 2015, hosted by the Faculty of Maritime Studies, University of Rijeka.

This year's AGA has received 104 abstract submissions for Technical Sessions. Following full paper submissions and the peer-review process, 57 papers were accepted and scheduled for oral presentations.

On behalf of the IAMU AGA 16 (2015) Program Committee, we would like to thank all authors for their efforts and contributions in development the AGA program. Specially, we would like to thank all reviewers for their valuable time and expertise, and for their helpful assistance in improving the IAMU AGA 16 (2015) program.

Boris Sviličić
Boris Pritchard
*Proceedings* Editors

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# BULGARIAN VESSEL TRAFFIC MANAGEMENT AND INFORMATION SYSTEM AND EDUCATION AND TRAINING OF VTS PERSONNEL IN BULGARIA

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**Abstract.** Based on the requirements of the Directive 2002/59/EC and the Protocol of 1988 relating to the International Convention for the Safety of Life at Sea, 1974 (SOLAS), the Bulgarian Maritime Administration has an obligation to provide appropriate shore-based facilities, such as Coastal Vessel Traffic Services (VTS) and communications in GMDSS Area A1. The financial mechanism of EU Phare program has been used for this purpose. The Phare Project BG0012.01 was completed at the end of October 2004 with building up the 1st phase of a Vessel Traffic Management and Information System (VTMIS), including Operating and Management Center, two Traffic Control Centers, a number of sites equipped with Radars, VHF and AIS Base Stations, Radio Direction Finders, Weather Stations and Telecommunication Backbone. After completing current modernization, financed by the Operational Programme "Transport", Bulgarian VTMIS is expected to be fully operational by the middle of 2015.

For education and training of VTS Personnel two courses have been developed in Nikola Vaptsarov Naval Academy as follows: VTS Operator and On-the-Job Training. The Training of Instructors course has been developed and delivered by the equipment supplier. The subject has been included in the curriculums of some bachelor's and master's degree programs.

This paper presents shortly Bulgarian VTMIS and the experience of Nikola Vaptsarov Naval Academy of providing education and training of VTMIS personnel. Building up a simulator for practical exercises in the Academy's Faculty of Navigation in close cooperation with the German Maritime Simulation Center in Warnemunde and benefits of VTS simulator training are described as well.

**Key words**: traffic monitoring, VTMIS, education and training of VTS personnel

## 1 INTRODUCTION

As the vessel traffic in the European waters increases, so, too, the need to insure safe navigation. The Erika and Prestige accidents proved this need and resulted in a significant strengthening of safety rules and regulations at European level. Directive 2002/59/EC of the European Parliament and of the Council of 27 June 2002 establishing a Community vessel traffic monitoring and information system has been developed as a result of these efforts "with a view to enhancing the safety and efficiency of maritime traffic, improving the response of authorities to incidents, accidents or potentially dangerous situations at sea, including search and rescue operations, and contributing to a better prevention and detection of pollution by ship". According to the Directive "Setting up a Community vessel traffic monitoring and information system should help to prevent accidents and pollution at sea and to minimize their impact on the marine and coastal environment, the economy and the health of local communities" [1].

According to [5, 6] "Vessel Traffic Management or VTM is the set of efforts (measures, provisions, services and related functions) which, within a given area and under specified circumstances, intend to minimize risks for safety and the environment and to maximize the efficiency of waterborne and connecting modes of transport.

Vessel Traffic Management and Information Services, VTMIS intend to respond to public and private demand for facilitating Vessel Traffic Management. Vessel Traffic Management and Information Services include services distributing in given areas (at regional, national or transnational level) the pertinent information to be used both in real time and in retrieval modes by actors involved".

VTMIS can be used for vessel traffic management, port resource management, fleet management and cargo flow management. They deliver a traffic image to be used by for all parties concerned. Parties (authorities, ports and companies involved in shipping, vessels and cargoes) could be divided in two groups – internal and external.

The internal users of the VTMIS are the organizations directly or indirectly involved in dispatching vessels e.g.: VTMIS operators, management and supporting staff as well as vessels in the VTS area.

The external users are all entities directly or indirectly involved in marine transport outside the VTS organization. The most important are:

- Pilot-, tug-, boatman- organizations;
- Berth (terminal) operators;
- Shipping agents;
- Customs services;
- Border Guard Services;
- SAR organizations and Health Department Services;
- Dangerous Goods and Waste Disposal Departments;
- Adjacent VTS, etc.

The Competent Authority is the Authority made responsible, in whole or in part, by the Government for the safety, including environmental safety, and efficiency of vessel traffic and the protection of the environment.

According to [6] Vessel Traffic Management & Information System is a VTM System, which in addition to the VTM tasks has the capability to respond to public and private demand for information to facilitate ship and cargo handling operations, through electronic communication with other VTS, GMDSS at shore based system and Data processing systems in a region. The vessel participates in the system from the moment that its arrival has been announced until the moment it leaves the VTS area on the way to her next port of call.

The shortest possible description would be: "VTMIS are improving vessel traffic information".

## 2 VESSEL TRAFFIC MANAGEMENT AND INFORMATION SYSTEM (VTMIS) OF BULGARA

Bulgarian VTMIS has been built to solve the following tasks [12]:

- Constant monitoring of the sea areas of Republic of Bulgaria;
- Vessel traffic management in the ports, Bay of Varna, Bay of Burgas, anchorages, lakes and connecting fairways;
- Improvement of the efficiency in maritime search and rescue in Bulgarian SAR Area;
- Improvement of the information service for the purpose of environmental protection;
- Collecting and providing the whole necessary information for shipping to the authorities;
- Improvement of the efficiency of the maritime industry.

Development of the system passed through several steps.

The Varna Initial System (VIS) is considered as a first step in the development of the Bulgarian VTMIS. The Project PSO99/BG/3/6 Vessel traffic Management and Efficiency in Bulgaria, has been developed between December 1999 and May 2000 and was co-financed by the Bulgarian and Dutch government.

The VIS had:

- Two radars with 18 feet antennas;
- Two separate daylight displays, both showing a traffic image of the roads, the port approach and the port entrance of Varna, combining radar video and tracks of big and small vessels;
- Human interface and display functionalities;
- Traffic image storage and basis control and monitoring capabilities.

To satisfy the extendibility and flexibility requirements VIS had an open architecture and modular design. Communication between radar sites and traffic center was implemented using standard communication lines providing 64 Kbps.

Varna Initial System contributed to the development of sustainable transport by involving technical assistance, hardware and software provided by the Netherlands. The technical assistance part of the Varna Initial System project comprised assistance in defining the VTMIS development strategy, including feasibility and cost benefit assessment, preparation of the Varna Initial System functional and technical specification and implementation management and evaluation of the performance of a VTS for the Varna port approach, which later on became an integral part of Bulgarian VTMIS.

The next step of the extension from VIS to VTMIS, was to build two VTS centers configured as follows:

- VTS Varna – incorporate the date information from five Radar sensors (two old from VIS Varna plus three new located in Varna Lake;
- VTS Burgas – accept data information from one Radar sensor located at Burgas Traffic Control Tower.

The final step was to build the Vessel Traffic Management and Information System of Bulgaria. Three projects supported by European financial instruments have been developed to achieve this aim.

VTMIS-Phase 1 project was completed at the end of year 2004 [6, 8]. As a result a set of subsystems for Radar tracking, AIS monitoring, Radio Direction Finders, CCTV video observation of biggest ports were installed to provide monitoring of SOLAS vessels and reliable VHF communication between coastal systems and vessel sailing in territorial waters of Bulgaria (GMDSS Area A1 VHF system for distress, safety and public correspondence).

VTMIS-Phase 2 project has been developing for a time period of the next 3 years [7]. During this period an enhancement of the technical structure of the Bulgarian VTMIS has been carried out by installation of new radars, RDFs and other equipment for monitoring, incl. thermo-vision cameras and hydro-meteorological stations. The expansion of the Telecommunication Network has been carried out as well to connect the new equipment to the system.

VTMIS-Phase 3 project will cover a time period of years 2013-2015. This project will extend the coverage of the existing system in the sea areas of Republic of Bulgaria and will integrate all subsystems in a single maritime information system. The telecommunication infrastructure will be upgraded and a new center for electronic documentation in maritime transport in Republic of Bulgaria will be established to upgrade the scope of information services for maritime industry and to provide an interaction with other information systems of governmental and departmental structures, in accordance with the requirements of European and international legislation.

## 2.1 VTMIS-PHASE 1

The results of the Project Phare BG0012.01 - Vessel Traffic Management and Information System was an up-to-date high-tech automatic system aimed at enhancing the safety and efficiency of navigation, safety of human life at sea and environmental protection from the possible adverse effects of shipping in Bulgarian territorial waters. This system provided the user with various navigational information in the way of the decision making support. The system enabled the ships and other navigational objects to be identified and tracked and vessel traffic to be planned.

The objectives of the VTMIS project were:

- Promotion of marine safety in the Bulgarian territorial waters;
- Promotion of the economic development through improvement of maritime transport in Bulgarian Ports and through industrial development in Bulgaria;
- Promotion of the protection of the environment on Bulgarian territorial waters;
- The VTMIS-Phase 1 Project has built a system consisted of the following integrated sub-systems:
- A Radar Tracking System providing a traffic image of the coastal part of the territorial waters and specifically the approaches and entrances of Varna and Burgas ports, including the fairway to the Varna West Port;
- An AIS integral system for automatic identification and monitoring of the vessels movements;
- A CCTV Systems in Varna and Burgas ports, providing real time traffic image;
- A Radio Direction Finding System for vessel locating purposes in the Varna and Burgas approaches;

- Two hydro-meteorological stations;
- A Control & Monitoring System, enabling remote control and status management of the technical components;
- A VHF Communication System for communication with vessels, with full coverage of the Bulgarian territorial waters, i.e. GMDSS Area A1 VHF system for distress, safety and public correspondence;
- A Data Processing System for vessel data and vessel voyage data as well as a Data Base for track and references;
- Telecommunications Network which connects and integrates all components systems and subsystems of VTMIS. TN consists of Microwave Carrier Link (MCL) subsystem – the telecommunications backbone of the VTMIS;
- A Data Network for disseminating the traffic information to all parties concerned and capabilities for computer-computer links with external systems;
- Fully equipped Operational Centers.

The information provided by the VTMIS has been used by the Ministry of finance (Customs administration), Ministry of Interior (Border police), Ministry of defense (the Navy), Ministry of environment, Ministry of agriculture (monitoring of the fishing areas) and the entire maritime community of Bulgaria.

After the acceptance tests of the technical system there an institution (directorate) under the Ministry of Transport and communications, was set up for management, operation, and maintenance.

After completion of the 1st phase with building–up the Operating and Management Centers in Varna and Bourgas, 33 equipped sites and Telecommunication Network backbone have been available since the end of October 2004 (see Figure 1).

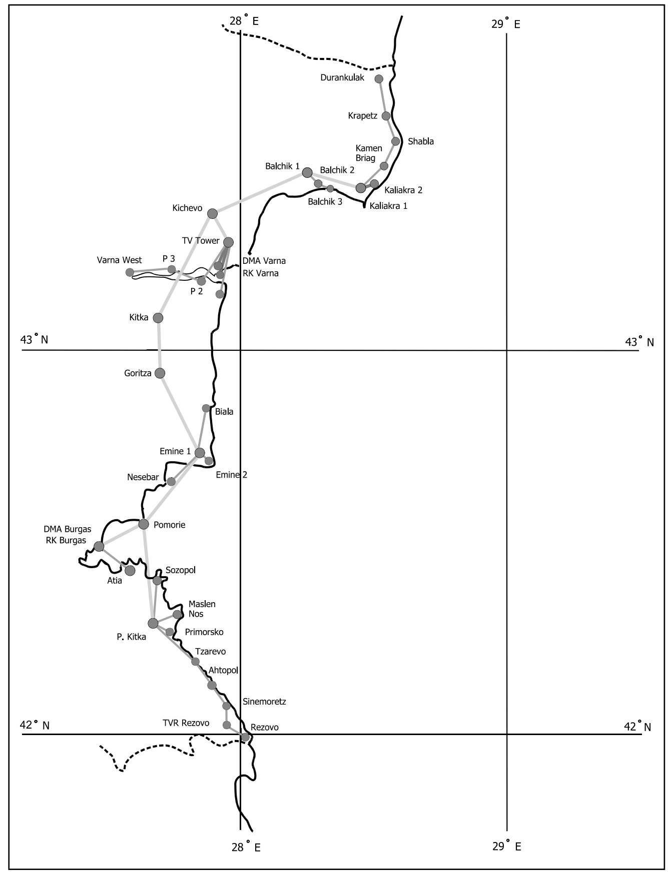


**Figure 1** The site map of Bulgarian VTMIS

## 2.2 VTMIS-PHASE 2

In order to comply with the international standards for the operation of the system as whole completed VTMIS, the 2nd phase of the project – the Project BG 2003/004-937.04.01, under Phare programme was developed during years 2004 – 2007 [7].

Purpose of the VTMIS-Phase 2 project was to enhance the technical structure of the Bulgarian VTMIS as an integrated instrument for full achievement of the objectives stated above and also in line with the EC-Directives and the IMO Resolution A.857 (20), SOLAS 74/78 as amended, ITU-GMDSS, in conformity with the IALA VTS Guide and the IALA AIS Guide.

The VTMIS-Phase 2 project created an enhanced and upgraded system with:

- New radar observation, radar multitracking and multifusion processing subsystem implemented on the base architecture of the telecommunication system laid up in Phase 1. Seven new radars have been installed to improve the subsystem;
- The completion of the RDF coverage with additional three RDF systems to contribute for the coverage of the whole Bulgarian coast. This was a requirement for detection and homing of small (Non-SOLAS) crafts and for providing Search and Rescue operations in Bulgarian SAR Area with locating information;
- The expansion of the Microwave Carrier Link (MCL) of Radio Relay Equipment was for the connection of the radar subsystem with the Telecommunication Network and the possibility for data exchange of communication with the new radar sites;
- The additional video subsystem for coverage of the Bulgarian coast;
- The hardware and the software for the Database subsystem for the management of the traffic data, dissemination and data exchange with the external users. The database platform was very important for the VTMIS structure with the possibility for evaluation and statistical analysis of the system performance and for the support of the system information resources.

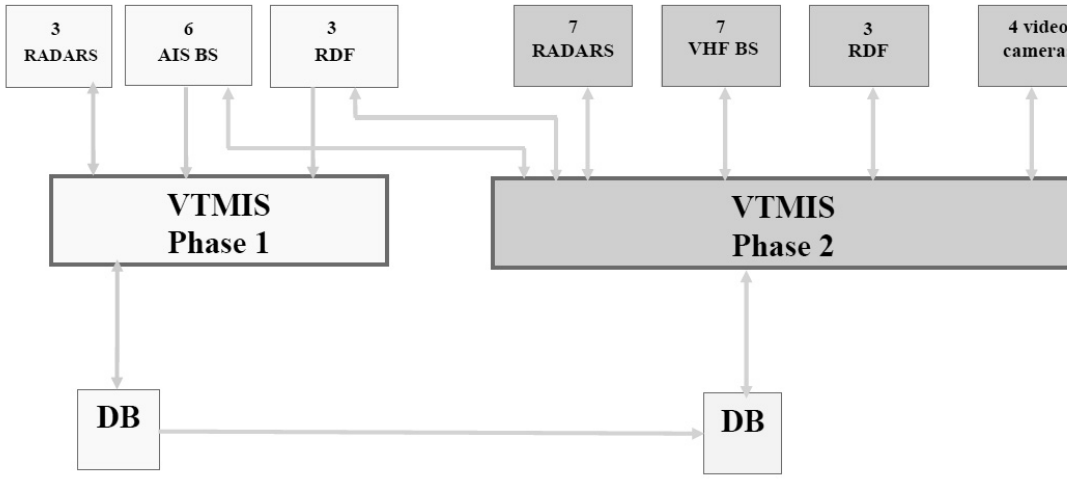


**Figure 2** VTMIS-Phase 1 and Phase 2 integration

Fig. 2 illustrates upgrading the VTMIS of Bulgaria with integration of existing and new equipment.

### 2.3 VTMIS-PHASE 3

VTMIS-Phase 3 Project is included in priority axes IV of Operational Program "Transport" – "Improvement of the maritime and inland-waterways navigation".

The main objectives of the project include installation of the new generation solid-state radars with integration of the existing radars and an upgrade of the Bulgarian coastal GMDSS system. In addition, the overall efficiency of the system will be enhanced with VTS Simulators and 3D visualization VTS software. Installation of new powerful data centres in Varna and Bourgas VTS towers will allow for full integration of all sensors into a single information system.

Purpose of the VTMIS-Phase 3 project is to satisfy the requirements of OP "Transport" as follows:

– Improvement of safety in the area and aquatory of the seaports of Bulgaria by developing and operating a system for monitoring and management of the maritime traffic and information services for the maritime transport (VTMIS) as a part of the EU safety information system SafeSeaNet;

– Establishment and development of the navigational information systems – this will be accomplished by the provided development and upgrade of the VTMIS system under VTMIS-Phase 3 of the project, improving the overall efficiency and scope of the information services for shipping and extending the coverage of the Bulgarian coastline by the system;

– Construction of buildings for the coastal centers for vessel traffic monitoring and management and information services for the maritime transport in Varna and Burgas and establishment of a center for

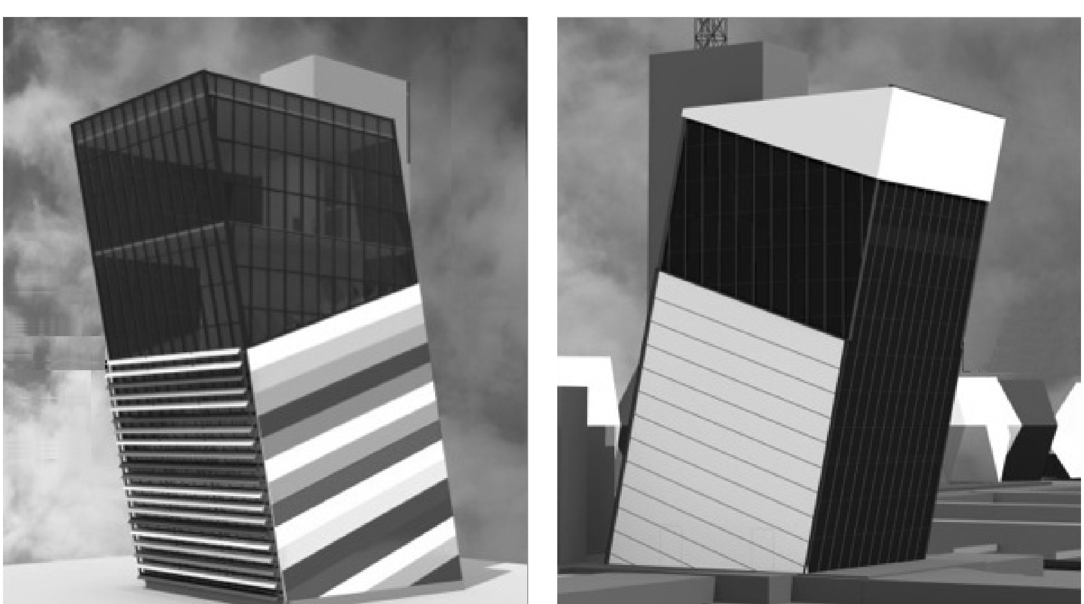

**Figure 3** The new traffic control towers in Varna and Burgas

electronic documentation in maritime transport in Republic of Bulgaria (see fig. 3).

The new project will extend the coverage of the existing system in the sea areas of Republic of Bulgaria and will integrate all subsystems in a single maritime information system, connected to the pan-European structures in accordance with the requirements of European and international legislation. The telecommunication infrastructure will be upgraded, which will provide constant transfer of all data and voice. A new center for electronic documentation in maritime transport in Republic of Bulgaria ("single window") will be established to upgrade the scope of information services for maritime industry and to provide an interaction with other information systems of governmental and departmental structures, involved in maritime transport.

Expected results on completion of the project are to improve safety, to increase the efficiency of shipping and to improve environmental protection. The system will provide information and navigational services, communication with vessels, and will exchange information with competent authorities during disaster and emergency situations. It will optimize the vessel traffic management through constant exchange of information between the participants in sea transport and the Governmental competent authorities for better planning of ship calls and cargo operations. Through constant monitoring of the vessel traffic the system will give opportunities of avoidance of emergencies including spillages. In case of pollution information for all involved parties will be provided and thus the time for reaction will be reduced.

As a part of this modernization Bulgarian VTMIS has already been included in the IALA World VTS Guide [9].

## 2.4 THE SIMULATOR

A VTS simulator has been built as an activity under the above mentioned BG0012.01 Phare project at the end of August 2004. Based on the existing Simulator and with a view to the prospect of development of Bulgarian VTMIS, a project for enlargement and modernization of the Laboratory on Vessel Traffic Management Solutions (VTMS Lab) has been included into the Plan for Enhancement of the Nikola Vaptsarov Academy's Set of Simulators in 2012.

The renewed VTMS Lab provides better conditions for education and training of future specialists in the area of shipping – navigators, ships and port operations managers, electronics engineers and maintainers, etc.

VTMS Lab consists of two pair of VTS simulators with two Instructors workplaces. The first one has two Trainee VTS Operators workplaces and a virtual ship in addition. The second one includes three VTS Operators workplaces (See Figures 4 – 7).

This configuration allows some more flexibility in organizing different types of exercises. In addition there are some computers in the Lab, connected to high speed Internet for online vessel traffic monitoring. Appropriate software provides access to Bulgarian River information system BULRIS as well as EMSA projects SafeSeaNet and EU LRIT DC.

The instructor workplace is based on Transas Navi-Trainer NTPro 5000 navigational simulator. Instructor program is intended for:

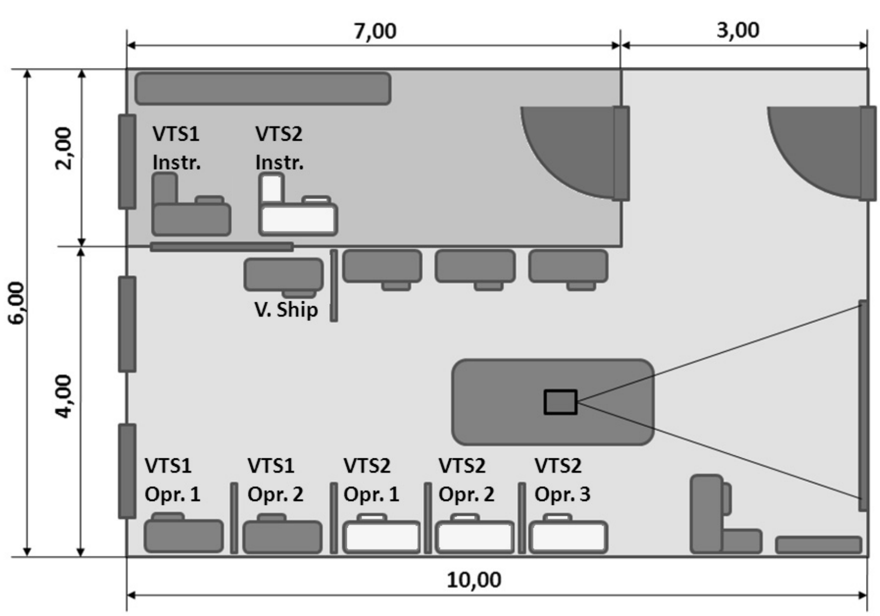


**Figure 4** N. Vaptsarov Naval Academy's VTMS Simulator

- generation and editing of exercise scenarios;
- running of exercises on the operators workplaces;
- monitoring of the exercise performance;
- correction of scenarios in the process of an exercise.

Exercise scenario is a description of location and motion of objects within the scene space. Exercise objects include:

- ships, tugboats and barges;
- mooring objects;
- rescue operation objects;
- VTS surveillance equipment.

In addition, some special objects setting hydro-meteorological conditions and bathymetric characteristics for a certain part of the screen can be introduced in the exercise.

Exercise scene is a model or actual geographic area. The scene is an aggregate of:

- the terrain spatial model (submerged and surface part);
- spatial models of coastal structures (buildings. bridges, berths, etc.);
- spatial models of aids to navigation (lighthouses, buoys, etc.).

Scenes of two geographic areas – Varna and Burgas are supplied together with the Simulator. The exercise scenario generation procedure includes the following steps:

- selection of a geographic area;
- setting of the initial object positions;
- setting of the objects' speed and routes;
- setting of characteristics of the navigational equipment and ship gear for the virtual ships and target ships;
- setting of weather conditions and their changes in time;
- modification of the scene bathymetric conditions;
- setting of the exercise start date and time.

Training and certification of instructors (Training of the Trainers) was provided by the supplier of simulator's equipment.

Trainee VTS station Transas Navi Harbour, developed for training of VTS operators provides the benefit of interaction with active targets, controlled by the program or instructor. Trainee VTS station has the following main features:

- provides imitation of Navi Harbour Operator Display Unit (ODU) operations and objects (real radar signal processing is substituted with simulation software);
- interface with operator identical to that of real Navi Harbour ODU;
- easy adapting to particular operational area and environment for any real VTS.
- imitation of targets' motion based on data, received from Instructor VTS station.

**Figure 5** Instructor's workplace

**Figure 6** Trainee VTS Operators workplaces

**Figure 7** Virtual Ship's workplace

## 3 EDUCATION AND TRAINING OF VTS PERSONNEL

In every implementation program for every stage of building of the Bulgarian VTMIS, described above, a training of operational and technical personnel has been included. According to the requirements of IALA described in VTS Manual [12] simulation should be used in practical training of VTS Operators because of the appropriate environment that simulators offer for acquirement and assessment of the skills and competencies required. In the training program of VTS Operators in Bulgaria the simulator of N. Vaptsarov Naval Academy has been used [10]. Programs for VTS operators and for On-the-Job Training have been developed in close cooperation with the German VTS Training Center in Maritime Simulation Centre Warnemünde (MSCW) and approved by the Bulgarian Maritime Administration. Training scenarios have been created together with senior staff of VTMIS and included not only everyday situations but also critical and emergency situations. The benefits of using simulator in VTS training are well known [11] – good realism but with no real danger and no real consequences, traffic is under control according to training objectives and scenarios, etc. Realism in the Academy's simulator is achieved by using the same software and hardware interface as in real operator's workplace and very good software models of real sensors and VTS objects.

In addition the subject of VTMIS is included now in most of the programs of Nikola Vaptsarov Naval Academy, provided by Faculty of Navigation. The course syllabuses are focused on different aspects of the subject. In Bachelor and Master degrees programs of Navigation the focus is set on interaction of ships with VTS operators, pilots, search and rescue authorities, etc., as well as on ship reporting systems, according to Manila amendments of the STCW 2010 convention; In Radio and electronics program – on all technical aspects of the system and maintenance of the equipment, while in Fleet management and Port operations programs – on the abilities of VTMIS to provide information that helps traffic and cargo flows analysis, port activities, environment protection and security, etc.

## 4 CONCLUSIONS

Bulgarian VTMIS is an up-to-date high-tech system for enhancing the safety and efficiency of navigation, safety of life at sea and environmental protection. It has been developing over the last decade by using support of European financial instruments.

To support education and training of VTMIS personnel, both technical and operational, Nikola Vaptsarov Naval Academy has established educational programs and specialized training facilities. Carrying out a project aimed to establish a new VTMIS Lab the Academy affords better opportunities for research in a relatively new area for applications of information technologies with great expectations towards improvement of safety at sea and coastal safety, including critical infrastructures and environment protection as well as improvement of conditions for economic growth based on activities, closely connected with shipping. And last but not least, it is expected that the new lab would give assistance to the Academy in strengthening its position as a center of marine science and technologies in Bulgaria and regional leader in the area of Vessel Traffic Management and Information Systems as well as in establishment of new contacts with National, European and International Scientific Centers and Universities for further co-operation.

**Aknowlegements**

Author would like to thank VTMIS staff of Bulgarian Ports Infrastructure Company and Translink Consortium for their support and fruitful cooperation and for the permission to use all projects documentations in this work.

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# THE INVESTIGATION OF MARITIME SECTOR LABOUR MARKET NEEDS AS BASE FOR CONCEPTION OF MET IN ESTONIA

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**Abstract.** The political solutions and attitudes of authorities in some European countries are not always in favour of the marine industries and main actors on shipping market. That may lead to ships "escaping" from under flags of these countries and to imbalance between economic and social needs and opportunities or, in other words, between objective and subjective demands on maritime sector labour market. Estonian maritime sector during long time was not the best sample in this sense and undoubtedly needs taking the effective measures for solution of these problems.

One of the main goals designated in "Estonian Marine Policy 2012-2020" is to bring positive trends to developments in maritime sector of economy. Working out the strategy for development of maritime education and training in Estonia for at least next 10 years is significant objective of that. The comprehensive investigation of maritime sector labour market needs was carried out amongst the Estonian enterprises and other subjects of maritime sector (e.g. governmental bodies, craft unions) in 2015. The results of this study work should be the main sources and to give the basic data for working out of abovementioned strategy in MET.

The final result of this activity shall be the conception of maritime education and training in Estonia. The main features of it must be complexity and credibility. That may be achieved by taking into account the impact of all the main factors of both internal and external maritime labour markets as well as subjective and objective demand for maritime education during next 10 years. Not only enterprises and other institutions are subjects to investigation for forming the strategy of MET but very important to involve the alumni and even school youngsters as well. One of main goals is to range the impacting factors by the importance of them for stabile development of national MET and to work out the effective measures for focus on them.

One of well-known and disturbing trends in seafaring during last few decades is the sustained drop-off of MET attractiveness mainly in so-called "old Europe countries" that undoubtedly is one of the most significant reasons for chronic lack of ship officers on management level for EU merchant and passenger fleets. In authors' opinion, in spite of local character of Estonian MET conception the problems and trends focused in that mostly are typical for EU in whole and may give a good opportunity for using the "Estonian lessons" more widely.

**Key words**: labour market needs, objective demand, subjective demand, MET conception, complexity

## 1 INTRODUCTION

The merchant shipping with its transnational nature and high level of globalization is a field of strong competition amongst not only shipping companies around world. Today actually maritime countries themselves are competitors on marine transportation markets [1]. It is why the governments and societies of maritime nations are bound to apply a number of various measures for providing the better conditions for companies and other maritime sector players in own country so that they are able to be competitive on worldwide shipping market. The main features of improvement of situation are ships' "coming back" under flag of country and the stabile positive demand on labour market of maritime sector.

Speaking about attitude of Estonian governmental and political establishment in last decade of XX and most part of first decade of XXI century Estonia might be defined as the "sleeping" maritime nation [1]. Fortunately, some important documents came into force during last 5-7 years and hopefully situation in maritime sector will have trend for improving in current and next decades. One of the most important documents in this field is the "Estonian Marine Policy 2012-2020" (EMP) [2] the main goal of that is stopping the negative trends in Estonian maritime sector, especially in shipping and to achieve a positive breakthrough in the developments during going decade.

According to EMP vision the maritime sector in Estonia must be attractive and sustainable sector of Estonian economics and shall create the high quality surplus value. For achieving of this goal five priorities were formulated whereby the forth priority states: the Estonian maritime education and research and development activity are on up to day level. In frame of this priority achieving of two goals is envisaged: 1) the maritime education giving in Estonia ensures up-to-day education in balanced capacity for specialists in all fields of maritime sector as necessary; 2) the quantity and quality of research works in Estonian maritime sector are growing up [2]. According to plan of activities 2014-2016 the conception of maritime education shall be worked out and planning of maritime education should be guided by it during at least next 10 years. It means in turn that the comprehensive investigation of labour market needs in Estonian maritime sector should be conducted; the results of that are the absolutely necessary input for abovementioned conception.

## 2 LABOUR MARKET NEEDS IN ESTONIAN MARITIME SECTOR

In simple words the main goal of this work was to estimate how many people with maritime education Estonian maritime sector needs during next 10 years.

For obtaining of creditable results two main principles were put in basis of methodology when planning the study work: first one is the principle of objectivity what was provided by conducting of research by independent research worker found by tender; secondly, the principle of scientific methodological approach was applied, i.e. figuratively speaking everyone independent researcher who wants to repeat this research work using the same methodology and the same initial input should have inevitably more or less the same results. One necessary presuppose for that the objectivity of initial data that must be obtained only from official and widely recognised sources.

### 2.1 The Methodological Approach

There are a lot of several methods in use for making prognoses for labour market's needs. In very general they may be divided to quantitative, semi-quantitative and qualitative methods ore some combinations of them. In lots EU countries the enquiries amongst employers are used frequently because usually there are no the creditable statistical data about proposed or vacant job places. Actually such enquiries are oft the object for critique because they may be sometimes not very representative and give as rule the static picture of momentary situation, besides they may not reflect the situation objectively in full because the subjectivity of employers' viewpoints. The biggest value of such enquiries is the qualitative view for finding out the shortages in quality of labour forces (e.g. appraisal of skills) – such information may not be collected using the quantitative methods. [3]

The second frequently using method is the so-called statistical model. By that for example the demand and supply of labour forces may be compared. The strength of such model is in possibility for nationwide applying and in being applicable for more long periods (5 – 10 years). The weaknesses are the relative imprecision and excessive generalization, and some insufficiency of model in whole as well – it's principally impossible to find answers for some questions using this method. [3]

Taking into account all the above mentioned factors the combined methodology was chosen for this investigation work. It is combination of quantitative model that based on statistical approach and of qualitative analytical method based on appraisals of employers giving in course of interviews. So the practical work consisted of two parts: first one was the collection of statistical information about employees from enterprises using the questionnaires, second one was the obtaining of qualitative appraisals about situation in sector by use the face-to-face interviews. By dint of first kind information the structure of labour force in maritime sector as of 2014 was determined and the possible development scenarios in next 10 years were composed and analysed. The employers had given qualitative appraisals to possible future developments in their own fields of activity, i.e. they expressed their opinion about quality, sufficiency and necessary competences of employees in next 10 years.

The prognosis model takes into account two main kind of demand affecting the developments: growth demand and replacement demand. The growth demand may be the positive one as well as the negative one and it depends on economic prognosis for investigating period. Whilst developments in economics are dependent on a lot of circumstances and unpredictable events such prognoses are relatively imprecise so the method of different scenarios is usually being in use; hence the three scenarios were used in this work as well: so named basic, conservative and optimistic scenarios.

The replacement demand is always positive because a number of employees in sector in the long run decreases inevitably by several reasons: mortality, retirement and moving of employees to other working places out of sector. The labour market needs in maritime sector are certainly affected by both growth and replacement demand factors.

The selection of employees' specialities and job positions for investigation purposes was done. The main principle of this selection was that people need maritime education for obtaining of these specialities and working on these workplaces. Selection by specialities and job positions is shown in Table 1 [3].

The selection of enterprises for enquiring and taking the interviews was done as following: using the database of Estonian Commercial Register the enterprises were chosen by main field of activity declared by them as acting in maritime sector during 2008-2013. The activities were determined according to Estonian Statistical Classification of Economic Activities EMTAK 2008 that is the national version of EU classification NACE. [4] Additionally the enterprises having declared maritime sector activity as ancillary one were included to selection as well in case if researcher had information about real acting of this enterprise in maritime sector during named period. In such way formed complete selection consisted of 464 maritime sector enterprises with 9 123 employees in sum.

**Table 1** The specialities and job places handled in study work

| Specialities | Job Places |
|---|---|
| Navigation | Captain |
| | Chief Mate |
| | Second Mate |
| | Third Mate |
| | Deck Cadet |
| | Boatswain |
| | Deck Rating (Sailor) |
| | Pilot |
| | VTS operator |
| Ship Engineering | Chief Engineer |
| | Second Engineer |
| | Third Engineer |
| | Fourth Engineer |
| | Engine Rating (Motorist) |
| Ship Refrigeration | Refrigerating Engineer |
| Ship Electro Mechanics | Electro-Technical Officer |
| Ship Electricity | Electrician |
| Shipbuilding | Ship Building and Repair |
| | Shipbuilding Manager |
| | Shipbuilding Planning and Design |
| Small Craft Building | Small Craft Building and Repair |
| Small Harbour Management | Small Harbour Specialist |
| Port and Shipping Management | Port or Shipping Manager |
| | Ship Agent |
| | Cargo Forwarder |
| | Stevedore |
| | Ship Broker |
| Seaways Operation and Maintenance | Hydrographer |
| Radio Electronics | Radio-Electronic Officer |

## 2.2 The Results Of Study

The answers for questionnaires were received from enterprises that employ in total 3 543 people what is 39% of total selection for study work. For getting of expert opinions regarding to present situation and future trends the semi-structured interviews were carried out within 39 most important and biggest enterprises as well as craft unions and governmental bodies in field; the interviewees were mainly top managers or owners of these enterprises and organisations. The information obtained was analysed and used for giving the appraisal to situation in maritime sector having in mind the quality and sufficiency of labour force today and in future. For better systematisation all the answers were divided to three groups: 1) ship building and repair incl. small craft building and repair, 2) shipping together with crewing, towing and bunkering, 3) ports and port services together with stevedoring and agency.

For drawing up the labour market needs' prognoses three future developments' scenarios were composed on the base of statistical analysis, interviews and experts' assessments. They were basic, conservative and optimistic scenarios. According to that the needs for additional labour forces in maritime sector until year 2025 are shown in table 2 [3]. Under additional labour forces we understand people who need to have maritime education to be employed in maritime sector enterprises, governmental and supervising organisations.

**Table 2** The needs for additional labour forces until 2025 in maritime sector and in governmental and supervising bodies concerned

| Job position | Scenario | | |
|---|---|---|---|
| | **Conservative** | **Basic** | **Optimistic** |
| Captain | 42 | 59 | 71 |
| Chief Mate | 14 | 18 | 25 |
| Second Mate | 8 | 12 | 17 |
| Third Mate | 21 | 24 | 29 |
| Boatswain | 31 | 36 | 44 |
| Pilot | 10 | 12 | 15 |
| Deck Rating (Sailor) | 67 | 87 | 119 |
| Chief Engineer | 57 | 66 | 79 |
| Second Engineer | 13 | 15 | 20 |
| Third or Fourth Engineer | 64 | 73 | 89 |
| Engine Rating (Motorist) | 70 | 72 | 91 |
| Refrigerating Engineer | 8 | 10 | 13 |
| Electro-Technical Officer | 21 | 25 | 30 |
| Radio-Electronic Officer | 11 | 13 | 15 |
| Electrician | 21 | 28 | 36 |
| Ship Electrician | 20 | 22 | 26 |
| Ship Builder | 82 | 91 | 102 |
| General Manager of Shipbuilding | 20 | 23 | 27 |
| Project Manager in Ship Building and Repair | 18 | 22 | 28 |
| Port or Shipping Manager | 40 | 47 | 60 |
| Harbour Specialist | 21 | 23 | 28 |
| Agency, Forwarding, Brokering | 5 | 6 | 8 |
| Other | 4 | 5 | 6 |
| Total | 670 | 788 | 978 |

## 3 THE BASIC PINCIPLES ON CONCEPTION OF MET IN ESTONIA

The results of investigation work carried out are the very important input but not only for working out and coming into force the Conception of MET in Estonia. A lot of other factors and impactors should be taken into account. Actually the study of labour market needs has made to certain extent clear the so-called objective demand only in maritime sector in next 10 years. The first main goal of Conception will be to investigate the supply side as well as the subjective demand coming from community side. The proposals for measures and activities for bringing these maybe contradictory factors into balance are the second very important goal of it.

For example, very significant factors that strongly impact situation on labour market of Estonian seafarers are the international character of shipping and freedom of labour forces moving within EU thanking to that a lot of graduated ship officers find their job places under foreign flags. For Estonia proportion between seafarers-residents of Estonia and Estonian seafarers sailing under foreign flags (mainly flags of convenience) is nowhere near in the favour of Estonian residence. This may be easy explained by fact that number of ships fly Estonian flag is marginal now. The usual question of politicians is: does the country have obligation to waste money and educational potential for preparation of well-educated seafarers who leave country and go to foreign ships? Conception has to give answer to this question amongst other important things.

The labour market needs investigation gives us some imagination about output of maritime education and training institutions that should enter into market every year to satisfy the demand of that. But what is the real proportion between amount of entrances and number of graduates after 5 years in this speciality? In other words, if we want to have for example 10 graduates with definite qualification entering to maritime sector in 5 years, haw many school youngsters have to be enrolled to MET institution on appropriate speciality today? Giving the correct answers for this and other questions is not so easy because of a number of several impactors plus not always clear developments in future plus unstable and not very positive demographic situation in country and more other factors. But of course all these factors and trends shall be taken into account by working out of Conception.

## 4 CONCLUSION

A number of investigations and study works carrying out during last decades was dedicated to developments of MET and labour market problems in several EU countries and in EU in whole. Because the maritime sector, especially shipping is very dynamic sector of economy from one side and has clear an over-border character from other side the results of these jobs need to be regularly revised and renewed. Systematization of existing materials and actuating the new investigation jobs by working groups from different countries are essential and may take place under coordination of IAMU.

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# WILL CHANGED REGULATIONS IN EDUCATION AND TRAINING, MAKE FOR SAFER SHIPS AND SHIP CREWS, A CRITICAL REFLECTION

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**Abstract.** Critical reflection is widely accepted and used by teachers to analyse adult learning application and approach, Brookfield (1995). This paper uses this reflective practice and applies it into the Maritime Education and Training (MET) environment by focusing on the introduction of several significant amendments to key conventions and regulations by the International Maritime Organisations, (IMO) during 2014. Applying the four reflective lenses outlined by Brookfield (1995) to argue the impact these changes will have on the operational safety capability of the ship and whether these changes will result in improved safety of the crew.

Focusing on the Manila amendments 2010, an argument is presented that questions how the Maritime Safety criteria of the IMO, is maintained or improved as a result of the changes to the International Convention on the Standards of Training and Certification for Watchkeeping, (STCW10).

Applying the reflective process the study attempts to identify if the introduction of amendments and regulative change will make for safer ships and ship crew, with a significant focus on emergency response and subsequent emergency management. Therefore, the literature reflection includes authors such as Owen et.al (2014) who has studied emergency management factors in teams and subsequent response outcomes.

Anecdotal evidence has been captured since midyear 2014 at the Australian Maritime College (AMC) through refresher training targeting the requirements stipulated by the STCW amendments. These courses service a significant number of experienced seafarers from varied shipping backgrounds undertaking basic through to advanced refresher training. The paper uses evidence generated from student feedback at the end of each course to provide the basis of the student reflective lense.

The findings looks at what different teaching approach is required for these short duration refresher training, and what additional skills do teachers need in this particular environment requiring high volume quick turn over programs. The reflection process also considers how this training differs from onboard requirements, and provides a comparison as to whether refresher training alone will improve ship board safety or whether this combined with the development of onboard institutional type delivery knowledge and skill will be the better mix. The paper uses these reflective lenses to meet the needs of the various stakeholders.

**Key words:** critical reflection, maritime safety, stakeholders, training

# 1 AUTOBIOGRAPHICAL AND LITERATURE LENSES

As the title of the paper suggests the following argument considers recent changes implemented into key conventions which require seafarers to undergo refresher training in emergency response capability at an approved MET institution. Seeking to challenge, through the use of critical reflection, the somewhat traditional approach to educating maritime students, and look to introduce a contemporary concept of reinvigorated education back at the foundation stage of the students learning. Using this newly underpinned foundation of learning to question if it would provide sufficient future influence and make for safer ships and ships crews. It has been widely accepted in the field of education that good teachers, (teachers who can and do influence their students learning), are those who have developed a practice of reflection. Brookfield (1995) among others, discuss this success coming to those teachers who have become critically reflective about the whole of their teaching. It is recognized that to many, this practice of critical reflection can be confronting as we are asked to challenge our ability and authority in the classroom.

So what does it mean to become a critically reflective teacher? While the paper will not answer all the questions, it will provide an insight to reflective practice in action, achieved through the use of four distinct lenses described in the writings of authors such as Brookfield (1995) and Biggs et.al (2007).

These four lenses are used to reflect on our own teaching practice by identifying with autobiographies of yourself as a learner and teacher, looking at your practice through your student's eyes, through peer reflection by your colleagues and theoretical literature. It is worth noting that genuine teachers will through practice undertake one form or another of these reflections, they just don't link it to a reason or consider how it can improve their teaching.

Teaching practice is changing and Kemmis et.al (2014) suggest that a student needs to be active in their approach to learning, they need to engage in the process and understand it is what they do that they learn, it is not what the teacher does. But it is the teacher's role to engage the student into the learning cycle. This in itself pushes the boundaries, especially in the area of mandatory education and training that has prescribed content; established curriculum, but requires the learner to be adaptive to enter what may be a less than familiar vocational environment. Teachers need to understand their students and the learning needs. Kemmis et.al (2014) further discuss this as developing a learning theory, an understanding about how people learn as the key to developing an approach that will suit the student moving through your class room now. Maritime is an interesting vocation in itself as unlike many other fields of employment those that work within have many roles and responsibilities depending on what stage of development they are at, and what operating department they end up working in.

The reflective journey has commenced and already a challenge to question ourselves as quality teachers. Teachers who can engage the students learning, across all areas of their study including that of emergency response can only be successful if they identify with themselves first then identify with what motivates their students. The journeys end point is the establishment of a conditioning within the student's career long learning cycle; this conditioning is that training no matter how long apart will be just that refresher training re-conditioning of competence.

# 2 SELF REFLECTIVE LENSES

Why do non maritime emergency response agencies generally have success. Success either with the emergency itself, or success within its response team. Is it due to a coordinated approach with a common goal? Is it due to the team functioning as one with a common goal? The answer may well be yes to both of these questions. So what is different in our maritime emergency response where there is a mixture of success and failure? Both response areas are similar in that emergencies are emergencies, unplanned events that cause disruption. It is really only the operating environment that differs. But why do we need five yearly mandatory refresher training on top of our prescribed shipboard emergency drills that must be undertaken. Is it because these drills are not as realistic as they could be. Is it because those conducting the drills are not as experienced in delivering training as they could be? The answer to these questions is yes. When it is questioned as to how realistic we make a drill on board there are mixed reactions that usually reflect the very ordinary ticks the boxes approach to full on well planned and thought out activities. It is not the papers purpose to delve too deeply here other than to say all training exercises have the ability to be a realistic as possible to ensure the response teams are as emergency conditioned as possible. Reflecting on the writings of Owen et.al (2014) a key learning emerges that while emergencies can catch those around them unawares, even with prior warning and regardless of the training the team has been exposed to. The key is how to ensure the individual and or team performance is at its optimum in order to limit the impact of the emergency. Using a shipboard emergency context the initial team responsible for timely key decision making is the command team. But they are only able to effectively function if provided with relevant and up to date information. Anyone who has dealt with emergency response knows that the quality and timing of this information will vary dependent on how the responding first on scene can read the event. This is made all the harder through the lack of situational, conditioning training; training that puts a team into extraordinary nontraditional response.

As maritime education training institutions there is an opportunity to re-condition the seafarer of today and tomorrow for any emergencies that arise. We prepare seafarers for a career at sea. They gain employment and hone their skills and knowledge to what is appropriate to their ships' needs and then gain experience. We very effectively provide them with the knowledge to enable them to move vessels from one port to another, to keep that vessel well maintained and to ensure that loading, unloading and other daily business is conducted as safely as possible. These skills become second nature due to daily ongoing exposure and are backed up with sound procedures, policies and safety management systems. Brooks (2014) discusses human error and the need to understand how and why it occurs within an emergency management environment, especially when there are training systems developed and intended to reduce and manage it. Many recorded instances of ship fires and events have led to abandonment or serious injury and despite much effort to train, qualify and measure seafarer credentials to avoid incidents of this nature they still occur.

The following autobiographical reflection focuses on the refresher training for fire and other emergency response brought about as a result of the Manila amendments of 2010. The Emergency Response Centre at the Australian Maritime College conducts this training as core business. The courses are exclusively short in nature with a maximum length of time being two days. Prescribe learning outcomes are expected and most are heavily weighted towards practical skills such as using a fire extinguisher on a class of fire, entering a life raft or extinguishing a fire using a fire hose whilst wearing breathing apparatus. This raises the question of what is a reasonable expectation of a seafarer to know and be able to do within this available time frames, e.g. is it reasonable to expect that a rating will know how to operate breathing apparatus safely or expect that a deck officer can manage a muster effectively and supervise the work of ratings during a simulated emergency and that everyone will have the ability to launch a life raft.

From the first refresher course mid 2014 it became evident that the expectations, or prescribed refresher outcomes might not necessarily be consistent with all ships' crew members as in many cases the ability or inability to use certain equipment is directly attributed to the role and function of individual. Or in other words different ships have different ways of doing things which includes having rigid predetermined roles and responsibilities for individuals during day to day emergency drills and any real emergency that may arise.We are relatively fortunate in that we get to work with many students who achieved their STCW certification with us sometime in the past which provided us with the opportunity to measure and reflect on the success or otherwise of our original training methods.

The objective of any emergency short courses is to instill the basic knowledge and skills required to avoid an emergency, respond to an emergency and bring an emergency to a best case conclusion. Each course currently delivered is based on model courses directed by the IMO. Overall we meet and in some instances exceed the requirements of the IMO model courses for the Certificate of Safety Training and Certificate of Competency courses as required for STCW certification. We are confident that students leave us having completely fulfilled the requirements, but with the advent of refresher training, it has become apparent with returning students, that a high percentage have lost the underpinning knowledge that is important when responding to an emergency in a time efficient, safe manner. There is a lack of appreciation of the apparent risks and control measures required from an emergency perspective and some of the reasoning behind gathering enough of the right information to make informed decisions and set realistic priorities at all levels of an emergency response. It is apparent then that some facets of our training has not survived the test of time as well as it could. The question that arises out of this is why.

It could be argued that little or no exposure to actual or pseudo emergencies is to blame and that the modern age concern of record keeping, responsibility for welfare and safe systems of work continue to hinder realistic training scenarios on board ships. For example, mustering a full crew at night with little or no lighting and with theatre smoke would provide the realism of an actual emergency but, would it survive past a job safety analysis? In the same way, launching a life raft or setting a fire is impossible to achieve safely or fiscally. Hence the initial need for refresher training in the first place. Mandated refresher training should then, in time, increase the knowledge and skills of seafarers in the aspects of emergency response which cannot be maintained on-board but, should we stop there? Will this alone prepare crew and officers to respond to an actual emergency? Baumann et.al (2011) argue it may not. We may need to explore the dread factor as discussed by Burke et.al (2011) to make training for high risk low volume duties.

While quoting a small amount of literature the previous reflection has taken the teachers or self's view. To build on the argument that more can be done on board a ship to keep the seafarer conditioned to emergency response the following reflection is offered through the eyes of a senior ships officer who has served on a variety of shipping types, and having worked in a variety of roles the last of which was Chief Officer.

## 3 SELF AS STUDENT LENSE

As a deck officer, joining a MET institute provided an opportunity to reflect on the role and function and subsequent influence he and other ships officers have on those embarking on a career at sea during and after their initial training. Traditionally a cadet begins their career with many months of learning at a MET institute followed by periods of time at sea to gain experience and to put the theory of learning into practice to develop the necessary skills of a student's chosen vocation and to refine the knowledge gained from their studies in a real world environment.

The influence of on-board mentoring cannot be underestimated as a key component of a cadet's development and future career direction. Mentors will themselves have been mentored and will often reflect the same qualities as their own mentor as well as the culture of the vessel or of the company.

After becoming a lecturer it became apparent that there is a wide gap between following and exploring the sturdiness of policies and procedures and passing on knowledge of them to new crew members which became one of his duties as his career progressed. While equipped with many years of sea-going experience, there had only ever been informal train the trainer type preparation given to educate the officer as to how to teach and train the ship's crew. Reflecting into his role now and the skill and knowledge learnt matched with the quality of teaching that is required there are questions as to how efficient and effective some of this previous on-board training might have been.

The context of the teaching undertaken today has now evolved to maximize the student's learning in a short course environment. As a survival lecturer there is precious little time to impart the knowledge and hone the skill required by students, where as in contrast, the on-board environment provided a situation where it was possible to continually monitor and teach over a prolonged period of time if required.

Typical onboard training would consist of classroom type emergency training conducted monthly and consists of video, face to face teaching and practical equipment demonstrations. Fire and rescue boat drills are conducted as required and followed up with debriefing to establish any deficiencies and efficiencies. It is suggested that emergency drills are strongly weighted towards testing procedures or equipment and that safety management systems (SMS) are regularly updated to reflect identified improvements.

Reflection is also drawn to comments previously made that actual firefighting or wet survival training occurs very early in a cadet's career, as part of their institutional learning and that until the Manila amendments 2010 were adopted that might be the last exposure to a realistic training environment, which could conceivably span an entire career, evident in comments that 30 years or more has lapsed since a student wore breathing apparatus. Many benefits are to be found in regular refresher training, the heat from an actual fire and learning how best to extinguish it or experiencing again how quickly being in the water can take the heat and strength of anyone required to abandon a vessel is an important lesson to remember but one that is easily forgotten when the day to day business of running a ship is the highest priority. These comments are echoing a common theme with anecdotal feedback from refresher training participants concluding with a statement that no matter how many times you work through the stress of managing a pseudo emergency with perceived sense of urgency attached to it, on-board drills cannot easily replicate the real life MET conditions.

## 4 PEER LENSE

In the preparation of this paper colleagues were invited to review our teaching methods and review our findings and in this regard we found some similarities with other maritime training that appeared to follow a similar pattern, this one is regarding confined space entry, another example of high risk work with too many fatalities.

On the 1st January 2015 the Maritime Safety Committee introduced a resolution that impacted the Safety of Life at Sea Convention, (SOLAS). These changes in particular were to mandate the conduction of enclosed space entry and rescue drills. This certainly was a move in the right direction, but is it enough? Will this alone stem the senseless loss of seafarer lives? These questions are asked because to date Enclosed Space Entry Training is not a mandatory short course. So it has to be asked what benchmarks will underpin the training, procedures and equipment requirements? Are the drills alone actually going to increase awareness, skills and knowledge of the inherent risk associated with working in and around these spaces? Will conducting drills improved the safety of seafarers, or are we going to have substandard knowledge and skills being practiced through drills, coupled with poor procedures and in some cases inappropriate equipment?

The hazards associated with working in and around enclosed spaces have been known for many years; nevertheless seafarers are still dying in and by them. Historical accounts suggest this unnecessary loss of life is likely to continue, unless the global maritime community becomes more proactive in developing, embracing and enforcing; educational, procedural and equipment standards that address the harsh realities of enclosed space work.

While the Manila amendments 2010, and the Maritime Safety Committee's resolution introduced to provide the need for refresher training and conduction of drills in enclosed space rescue, student feedback would suggest that where this is being undertaken, it occurs in idealistic locations and conditions which in turn may impact on the effectiveness of safety and cautionary learning.

Further self-reflection covers the increased need for ships to undertake support and rescue of other ships crews or passengers legal and otherwise. The argument here is that while we undertake training to ensure the safety of crews and individuals in the event of vessel abandonment, nothing is done to prepare crews and officers for the seemingly inevitable responsibility to rescue others when requested. Training of personnel, particularly in emergency response, largely focusses on the seafarer's ability to deal with a grave on-board situation such as a fire or the sinking of their own vessel. Ship abandonment and sea survival have historically been trained with a focus on the way crew should safely abandon their own vessel and the understanding of strategies to ensure their survival while awaiting rescue. Crews however, are not being formally trained to become competent in assisting at the scene of a large scale humanitarian crisis involving many people requiring rescue at sea.

There has been many publications, Alan (2015), International Chamber of Shipping (2014) produced to assist or provide guidance to masters and crew in the event they find themselves in this situation, and while these documents are invaluable resources, there is no requirement to date that mandates training at a shore based maritime training establishment, or to conduct formal drills of a similar nature onboard ship in preparation to undertake a rescue at sea.

According to the International Organisation for Migration (IOM), disasters at sea such as the capsize of a vessel transporting migrants have contributed to the loss of more than 40,000 lives since the year 2000. In 2014, more than 4,000 migrants lost their lives at sea attempting to reach their destination, Brian et.al (2014).

A merchant ship at the scene of such a disaster would almost certainly be overwhelmed by the complexity and scale of a rescue that may involve an unseaworthy vessel with a very high number of passengers on board or already in the water. Some of the problems faced by the assisting merchant ship's master and crew initially include the ship handling and seamanship aspects to best assist the stricken vessel and the safe embarkation of many people of all ages on-board their ship.

Triaging and treatment of the sick and injured would also be a major concern as would the potential for disease and other health issues. Establishing quarantine areas on board would be necessary and procedures would be needed to deal with the deceased. Intermanager and ECSA have argued that rescues cannot be performed by merchant ships on a permanent basis due to the crews not being trained and the ships not designed to look after many additional people often requiring medical attention Shipowners (2015). Prior to a workshop in March 2015 to discuss solutions in dealing with large scale rescues at sea, Intermanager (2015) posted on their website that they believe discussion of crew training for rescue operations is an important subject for consideration where they have an obligation to find training solutions that will provide knowledge and skill to deal with these out of ordinary events.

## 5 CONCLUSION

The above reflections are by no means the end of this journey. What they have undertaken to achieve though is that we simply cannot rely on a five yearly cycle of senior experienced ship crews coming back through MET institutions to ensure the ongoing safety of our ships and crews at sea. It has been discussed that there are areas of training that simply does not exist yet we insist on putting our crews into roles where they are charged with the rescue of other shipboard persons who have had an emergency at sea; the current spate of rescue of sinking ships and the assistance offered. Crews are training to deal with one of their own overboard let alone charged with the rescue of several hundred persons. How does a failure in this area impact on the mental capacity and employability status of an ad hoc rescue team. The high fatality area of confined or enclosed spaces. Not a prescribed mandatory short course, but one built into most curriculum, and one that has a variety of teaching approaches by a variety of educators. Rescue on the other hand has become mandatory from the conducting of a drill perspective. But nothing has been introduced to suggest ways to eliminate the almost daily loss of life undertaking this high risk activity.

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# FOUNDATIONS OF LEADERSHIP DEVELOPMENT: TEACHING PRACTICES THAT INSTILL LEADERSHIP OF THE SELF

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**Abstract**. This paper is the second in a series focused on the development of a pedagogical model and philosophy that integrates the leadership development, academic learning, and practical experience of maritime university cadets into a coherent whole. We focus on three questions relevant to maritime education and training at maritime universities: what can be done in the academic classroom to promote self-leadership development through leader-leader (faculty-student) relationships; how can a cadet-led organization (i.e., Corps of Cadets) be effectively leveraged to support the promotion of self-leadership and leader-leader relationships; what psycho-social development of individual cadets is necessary to support self-leadership development and how might it be best structured? A Leader-Leader relational frames model of leader development is presented and its applications and challenges discussed.

**Key words**: authentic leadership development, self-leadership, classroom instruction, pedagogy, relational frames

# 1 INTRODUCTION

This paper is the second in a series focused on the development of a pedagogical model and philosophy that integrates the leadership development, academic learning, and practical experience of maritime university cadets into a coherent whole. In our initial paper on this topic [1], we discussed the findings of research conducted in two academic classrooms that was focused on the performance of so-called "leader-less" teams. Utilizing several methodologies that are commonly used for the development and support of team leadership competencies (i.e., team social contracting, team performance assessments, team process coaching), our study attempted to demonstrate that the overall quality and effectiveness of academic learning could be significantly improved through the embedding of leadership practices into courses that are not otherwise designed to contain leadership content. Equally, non-positional[1] leadership could be learned and practiced by each student through the act of mastering the course content while working in student groups.

While the study overall proved moderately successful, two problems were identified. First, a single one-semester course offered inadequate time and opportunity to realize sufficient leadership skill development in our students. It was clear that such development must begin early in the student's tenure and must occur across a longitudinal arc of development over the entirety of the undergraduate career. Second, in order to achieve a truly coherent and integrated arc of development within an academic program, cross-functional co-curricular programming must be developed and coordinated to prepare and support cadets for in-class learning.

In this paper, we intend to address these problems by proposing a theoretically grounded approach to developing foundational leadership competencies in the individual student, both in and out of the academic classroom environment. We focus on three questions relevant to maritime education and training at maritime universities: 1) what can be done in the academic classroom to promote self-leadership development through leader-leader (faculty-student) relationships; 2) how can a cadet-led organization (i.e., Corps of Cadets) be effectively leveraged to support the promotion of self-leadership and leader-leader relationships; and 3) what psycho-social development of individual cadets is necessary to support self-leadership development and how might this best be structured?

[1] Non-positional leadership, in this instance, refers to the ability to demonstrate leadership qualities and competencies in a team context, without being the designated leader of the team.

### 1.1 Self-leadership and the "leaderful" model

The premise for this work is simple; one cannot lead a team, or participate effectively in a team, without first developing the skills, even rudimentarily, for *leadership of the self* [2, 3]. This premise is, at all times, leading-focused. *Self-awareness* and *self-regulation*, two of the hallmarks of the construct of *Authentic Leadership* [4], are known to be essential to the practice of healthy effective leadership [2, 3, 5]. A logical corollary to our premise is that no higher-order human system (e.g. group, organization, community, society) can maximize its capacity for effective action without developing the self-leadership competencies of each of its members [5]. Since the middle of the last century, the management literature has progressively shifted its construct of leadership from a focus on *leaders* to one focused on *processes* within contextualized relationships. Thus, skill development of the self in relation to others is a necessary extension of self-leadership; authentic leadership has been construed as encompassing both the personal authenticity of the leader and the leader's relations with followers and associates [4]. Current models of *Authentic Leadership Development* [4, 5] posit that the actions of an authentic leader in relation to a follower – including "positive modeling" – positively foster the development of followers into leaders. We concur, and the model presented in this paper attempts to demonstrate this relational development, however we take exception to the role construct of follower as an antecedent to that of leader.

As in our first paper, we reject the conventional emphasis on first instilling "followership" in our cadets. Equally, we reject the popular assertion that, almost by definition, one is a leader if one has followers. Defining "leading" and "following" in terms of fixed roles (i.e., leader and follower), rather than as the natural actions of any member of a human system, inhibits the capacity development of the individual and system alike. We assert a leader-leader model [6], where everyone understands and executes his or her leadership responsibilities within or without a hierarchical structure of roles. Unlike our first paper, we now abandon the concept of "leaderless" teams, preferring a term more consistent with the above assertion: "leader-full" teams and "leader-full" individuals.

# 2 THEORETICAL FOUNDATIONS OF THE "LEADERFUL" MODEL

As previously mentioned, self-awareness and self-regulation are central to the constructs of self-leadership and authentic leadership [2-5]. Self-awareness can be defined as an introspective process, rather than an end state, through which one develops clarity around who one is (personal and social identities), what one values, and how one makes meaning of one's world [5]. Self-regulation is a form of self-control encompassing a three-fold process of setting internal standards, evaluating variances from these, and identifying actions that might resolve the variances [5], and is nicely captured in the maritime metaphor of "minding one's helm." It follows that clarity in self-awareness supports integrated and internalized self-regulation; when one knows who one is and what one values, the source of regulatory motivation is coherent and found within oneself.

Deci and Ryan [7] have described four types of motivation that progressively obtain to higher levels of integration and internalization, and thus, authentic self-regulation: *external regulation*, where behavior is driven by external consequences (rewards and punishments); *introjected regulation*, whereby internal prompts (oughts and shoulds) derive from the introjection of external regulation; *identified regulation*, in which one complies with a particular behavior expectation because one identifies with the value underlying that behavior; and *integrated regulation*, in which one fully integrates into one's sense of self the identified values and regulations [5].

As stated previously, the positive modeling by leaders who themselves possess higher levels of self-awareness and self-regulation (authentic leaders) fosters similar development in their followers. This is particularly true in positive strengths-based organizational climates that are characterized by transparency, a commitment to learning and human development, and ethical conduct [5]. In short, one who would aspire to develop authentic leaders must likewise be one.

## 3 LEADERFUL EDUCATION AND TRAINING: A NEW RELATIONAL FRAME

At its most fundamental level, our model embodies the counsel of Steven Covey [8] that one must "begin with the end in mind." If it is leaders that we intend to develop at our maritime academies, we should engage with our cadets as leaders, however nascent, from the outset. Certainly they will follow a great deal in their first year or so, but they equally will lead (if only as leaders of self) if supported in doing so and, thus, are not served by being role-bound as followers. As stated before, ours is a leader-leader model, which both recognizes the nascent leader in the new cadet, as well as, the clear disparity in identity development, knowledge, and experience between the cadet and her faculty and staff.

The initial stage of the model (Figure 1) shows the faculty member (F) and cadet (C) with just a slight overlap of role boundaries. Underlying the faculty role and intersecting the cadet role is a dotted line, above

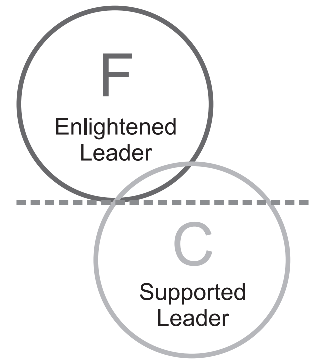


**Figure 1**

which represents the developed practices of authentic leadership. The model originally envisioned this area as representing the five *Student Leadership Practices* [9][2], and this is also appropriate. The premise is that the cadet has some initial level, however slight, of emerging self-identity and values, on the one hand, and some overlap of social identity, values, and interests with the faculty member. It is assumed that each dyadic relationship will differ in levels of development and overlap for each member; it is sufficient to our model that a faculty member should be adequately developed in her own authenticity to be able to "model the way" [9] for her cadet "supported leader".

At the middle stage of the model (Figure 2), the cadet is shown to have risen in leadership and technical development to a point where she can appropriately share in the leadership of the education or training. The faculty member still maintains the primary lead, but the cadet carries more responsibility for the learning.

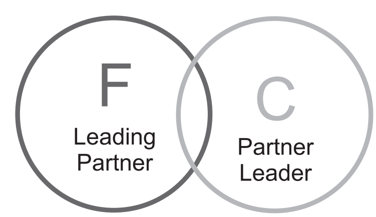


**Figure 2**

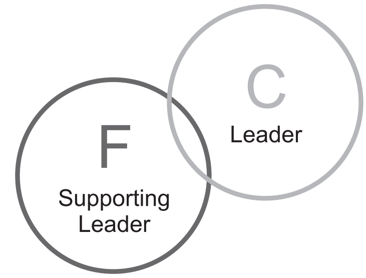


**Figure 3**

[2] The five practices are *Model the Way*, *Inspire a Shared Vision*, *Challenge the Process*, *Enable others to Act*, and *Encourage the Heart.*

In the final stage (Figure 3), the cadet takes a leadership role more commensurate with our end goal. The faculty member still maintains a technical and experiential advantage, but the cadet now takes primary ownership for her learning.

At each of the three stages, we prescribe specific developmental practices that support the shift to the next relational stage.

### 3.1 Leaderful practices in the academic classroom

In the full model (Figure 4) we see the developmental progression begin at the top with the 4th Class cadets (freshmen) and move downward through the 3rd and 2nd Class cadets to the 1st Class cadets. At each relational stage, a primary developmental practice is identified: *Contracting*, *Supported Team Projects/Work*, and *Self-Managed Teams*. A second practice is identified in the third stage in which the 1st Class cadets replicate with underclass cadets the leader-leader relationships they are experiencing with their faculty and staff.

The contracting undertaken in the first stage transpires between the individual cadet and his faculty member. Similar to the team contracting that we discussed in our first paper [1], where the expectations and plans for working together are made explicit by the team stakeholders, this individual contracting fosters in the cadet some initial reflection around his purpose, goals, and support needs in relation to the expectations articulated in a course syllabus. It is an opportunity for the cadet to begin to explicitly take some active ownership of his learning and for the faculty member to partner with the cadet in optimizing the effectiveness of the curriculum; both cadet self-awareness and self-regulation are intentionally and explicitly supported through this process. While the prospect of individually contracting with a class of 40 to 50 cadets might seem daunting, this "front-loaded" approach to advising and coaching has shown in our classes to be effective and efficient in supporting ultimate student success in the classroom. With the benefit of a new level of self-awareness and some experience with self-regulation practices, cadets are ready to move to the practice of the second stage, where group and team assignments are given by the instructor. Individual contracting skills carry over to team contracting, as does an increasing sense of cadet ownership (individual and collective) of the learning undertaken. While the cadet leaders are not yet prepared to take the primary lead on their projects, they are ready to work with their faculty to take on increasing amounts of responsibility.

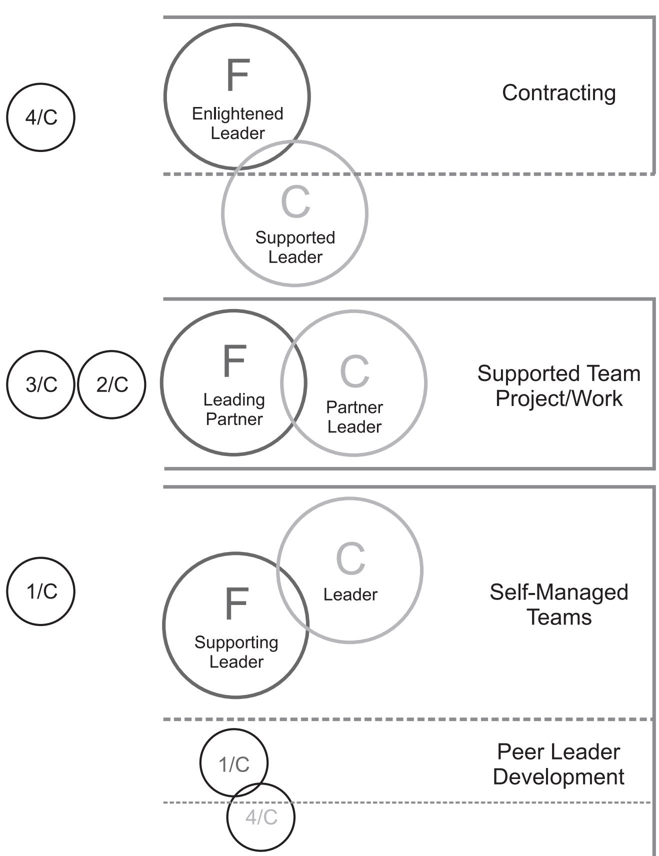


**Figure 4**

In the third stage, we see a pedagogical shift towards self-managed cadet teams (e.g., in courses such as Bridge Team Management, senior capstones, Engineering Management, etc.). This is the work that we attempted and documented in our first paper, which later showed the absence of the development of fundamental self-awareness and self-regulation, as well as team contracting skills; the cadets had not been adequately prepared fully to take ownership of their individual and collective learning and team outcomes. At this stage, the faculty member still possesses the greater technical knowledge and experience, but provides that as a resource to the learning activities led by the cadets. Equally, it is at this stage that the upperclass cadets begin teaching and mentoring the underclass in basic skills (e.g., Deck seniors coaching 3rd class cadets in basic seamanship or the fundamentals of celestial navigation; Engine seniors tutoring their 3rd class in diesels or calculus refreshers).

At every stage of the model, faculty and staff are focused both on technical knowledge transfer and on creating positive ethical learning environments, where they model and support the leadership behaviors they seek to develop in their students.

### 3.2 Self-regulation development in the corps of cadets

A significant advantage with this model that maritime academies and universities possess is the existence of regimented hierarchical cadet-led organizations. These organizations provide both excellent laboratories for the development and practice of leadership skills, as well as the critical elements of collective social identity and ethical conduct standards. Cadet-led organizations tend to espouse strong, clear, collective identities ("we" identity) that in turn can draw individual cadets towards internalizing collective values. The conduct system, if it supports clear, worthy, and consistent standards of conduct rather than mere extrinsic punishment/reward schemes, can effectively move underclass cadets through the more primitive motivational levels of external and introjected regulation towards ultimate integrated regulation. To the extent that these organizations can foster environments that provide clear identity and regulatory cues, underpinned by transparency, a commitment to learning and development, and ethical conduct, cadets will be well supported in their development of leader identities and internalized regulation [5].

### 3.3 Self-awareness development through first-year experience

The use of leader-leader relational frames in the classroom and the promotion of collective identities and values in cadet-led organizations can each and together do much to support the authentic leadership capacities of individual cadets. Nevertheless, neither possesses sufficient time and opportunity to dedicate adequate time to the clarification by cadets of personal identities and values or the development of their self-leadership and leaderful team skills. This was a primary shortcoming identified in our first paper. As the literature clearly demonstrates the need for this personal development [2, 3, 4, 5, 12], additional educational opportunities must be created to support the work and development that occurs in the classroom and in the Corps. One way to achieve this objective is to design and implement a comprehensive First Year Experience program (FYE) that focuses on providing the knowledge, skills, and practices necessary for self-leadership and freshman success. In concert with the efforts made in the classroom and in the Corps, an FYE program can deliver both leadership content and basic skills practice. When this curriculum is explicitly linked bi-directionally with classroom curricula and Corps operations, a coherent and consistent leadership development experience can be achieved for all cadets.

## 4 THE CHALLENGE OF THE LEADERFUL MODEL

We well understand that implementation of the model presented in this paper is fraught with cultural and developmental obstacles. As was demonstrated in the 1980's, when private sector enterprises attempted to "empower" their work forces in an effort to become more competitive, shifting leadership expectations from a relative few positional leaders to whole teams and organizations understandably breeds resistance from many parties. When people who have been designated "followers" have no training or support to take initiative, collaborate, risk making mistakes, or generally assume responsibility for collective outcomes, they will avoid risks and demur [10, 11]. The literature demonstrates that when people possess low levels of self-esteem, self-efficacy, and tolerance for ambiguity, and high risk aversion and conflict avoidance (arguably a fitting profile of young first-year cadets), they will display greater dependence on positional leaders and fail to aspire to self-regulation [5, 12]. This, it could be argued, is a typical leader-follower dynamic – one that was painfully demonstrated in the USS *Greeneville* collision with the *Ehime Maru*, a Japanese fishery high school training ship, in 2001[6]. Despite numerous people in the control room with knowledge that the school ship was too near them and that an emergency ballast blow surfacing maneuver was contraindicated, no one challenged the Captain's order; the resulting tragedy was nine Japanese dead, including four high school students.

Faculty and other designated leaders are equally susceptible to supporting a dysfunctional leadership dynamic. In particular, those who hold advanced terminal degrees (MA, MS, PhD) and/or merchant mariner licenses often in our experience fall victim to self-identities that compel them to always "know best" and have all the right answers. Students and the larger culture readily support this perception. It can easily lead to teaching and mentoring relationships that Kets de Vries [13] characterizes as a *folie à deux* (shared madness), where all parties in the dyad or group collude to maintain a "learned helplessness" [14] on the part of "followers". As with students, when faculty and staff are driven by ego defense motives that cause them to be risk averse and intolerant of ambiguity, self-protection objectives can trump desires for self and student development.

Clearly, the most tenuous stage of our model is the first one, where the expected tendency of cadets would incline towards faculty (leader) dependence and externalized regulation. This tendency of cadets can only be corrected by faculty and staff members' modeling of self-discovery processes [5], supported by FYE programming that encourages skill development in such processes. The most challenging aspect of the implementation of our model is that we who would use it must sufficiently be (in our authenticity) what we would have our cadets become. We must "go within" ourselves and ensure that we have done our own self-leadership development work [12]. "[Our] function is not to teach students the right answer, but to help them develop the ability to find and work with alternative approaches to a problem, and to apply them in ways that make sense to them"[15].

## 5 CONCLUSION

As our model and its applications demonstrates, much can be done to better develop our cadets to effectively and authentically lead the maritime industry well into the current century If we can unbind our cadets from the constraints and limited leadership expectations of “follower” roles, develop their self-leadership skills through FYE programming and Corps behavioral standards, and model these skills and standards in our leadership relationships in the classroom, we can confidently expect to develop our cadets into future senior leaders on whom we can rely and of whom we can be justifiably proud.

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# MODERNIZING AND HARMONIZING MARITIME EDUCATION IN MONTENEGRO AND ALBANIA. MARED PROJECT

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**Abstract**. This paper presents achieved results of the first stage of the TEMPUS project (544257-TEMPUS-1-2013-1-ME-TEMPUS-JPCR) titled Modernizing and Harmonizing Maritime Education in Montenegro and Albania, MArED Project. The main objective of MArED project is to overcome a problem of competent and qualified human resources in maritime sector in Montenegro and Albania. It will be achieved through the modernization and harmonization of educational and training system in accordance to IMO and STCW Convention requirements.

The paper is divided into following sections: First section is an explanation of the background of the MArED project. Secondly, a general overview of the whole project and activities is described. After, a revision of the existing maritime undergraduate study programmes is carried out and taking into account the results obtained from this initial analysis; the development and design of a programme which meets the new requirements of the STCW for the University of Montenegro and Albania (PC)[1] is explained in third section. Fourth section is focused in the identification of the STCW 95/2010 competencies within the nautical and engine degrees (considering Barcelona School of Nautical Studies (FNB) curricula) and which of them can be evaluated by approved simulator training and also (re) training of PC teaching staff is described. Finally, achieved results and conclusions are presented.

**Key words**: Maritime Education and Training (MET), STCW Code, simulation

[1] Partners Countries, id est not part of the EU but with future possibilities to be included.

## 1 BACKGROUND OF MARED PROJECT

The project arose in response to the obligations of Partner Countries (PC) concerning the ratification and implementation of the latest amendments to the International Maritime Organization (IMO) [1] regulations related to education and training of seafarers. All necessary changes and harmonization aim to meet the prescribed international standards to be carried out by 2017, in order to enable the educational and training systems of Partner Countries keep the status of internationally recognized maritime educational and training institutions. The latest IMO requirements refer to the reform of the existing and development of new study programmes, which anticipates the creation of opportunities for both theoretical and practical training of students, through the modernization of laboratories, marine simulators and practical workshops. Furthermore, by introducing certain IMO model courses for seafarers, the educational institution aims to develop a lifelong learning process for providing the seafarers with the possibility of continuous professional training.

The harmonization of the educational programmes with valid international standards, as stipulated by IMOs STCW Convention and its Manila amendments 2010, ensures the survival of maritime educational institutions and their competitiveness in the international market, thus ensuring the competitiveness of the seafarers from Partner Countries, as well.

Both Montenegro and Albania are strategic Adriatic countries with long maritime tradition, sharing the similar problems of derogation of maritime sector caused by transition. Namely, the Montenegrin shipping fleet before 1990's war period consisted of two shipping companies with 50 ocean going merchant ships, employing more than 2,500 Montenegrin seafarers, while rest of 2,500 were employed at international shipping companies. At that time, it was the second largest economic sector in the country. Today, there are only two ocean going merchant ships, and about 100 small vessels of up to 3,000 DWT, employing about 300 Montenegrin seafarers. The rest of 4,000 are employed internationally. Before 1990's, Albanian shipping fleet was organized as a state-owned enterprise with a capacity of about 90,000 DWT. Currently, this fleet is represented by many private owners who have vessels with a capacity of 1,000 – 2,000 DWT. Still, this sector is weak, at both the technical and management level. Currently there are about 2,000 Albanian seafarers.

Such situation significantly affected the maritime education and training process in both countries. The following disadvantages are notable: the curriculum is not harmonized with IMO STCW Convention, which is the precondition for internationally recognized maritime education and training, the teaching process is mainly theoretical due to poor laboratory and marine simulator conditions (or without any), difficulties in involving active and experienced seafarers (masters and chief engineers) for practical training, difficulties in organizing onboard trainings, staff trainings, decreased number of interested students and similar. All this resulted in the deterioration of maritime competencies and therefore difficulties in employment of graduates and seafarers on international maritime market.

The Governments and policy makers in both countries are making efforts to improve the situation and to bring maritime education sector in the focus of development. Montenegrin Government adopted several strategies covering this area: National strategy for transportation sector (2014) [2], National strategy for sustainable development (revised in 2012) [3], while Albanian adopted: Transport Sector Strategy (2008-2013) [4] and Fisheries and aquaculture development strategy (2007-2015). Those national strategies are in accordance with the European Maritime Strategy (2008-2018). [5]

Such intention can be achieved only through developing the synergy of maritime industry and maritime education. With the introduction of IMO model courses [6], as a way of lifelong learning, the seafarers will be provided with the continuous professional training on order to remain competitive at the international labour market. That way, partner countries will be able to keep their status of the countries meeting the strictest IMO requirements.

The project idea itself helps the PCs obtaining a certain status at the international maritime market, and therewith also a step forward towards European and Euro-Atlantic integrations.

The harmonized educational systems in PC and EU countries results in the creation of competitive maritime staff at an international level, which enables the national maritime companies to employ national, but, at the same time, competent and highly educated staff. This way, we would contribute to the economic status of the PCs, and therewith also meet the prerequisites for easier and faster reaching of European standards.

## 2 GENERAL OVERVIEW OF THE PROJECT

The main objective of MArED project is to overcome a problem of competent and qualified human resources in maritime sector in Montenegro and Albania. It will be achieved through the modernization and harmonization of educational and training system in accordance to IMO and STCW Convention requirements.

The project is divided into different stages, which are assigned to the different participating universities and institutions. Next table (Table 1) shows the list of the project partners.

**Table 1** MArED project partners

| Role | Organization name | Country |
|---|---|---|
| Coordinator | University of Montenegro (UoM) | Montenegro |
| Partner | University “Ismail Qemali” of Vlora (UV) | Albania |
| Partner | Shkodra University “Luigj Gurakuqi” (UNISHK) | Albania |
| Partner | University of Ljubljana | Slovenia |
| Partner | Universitat Politècnica de Catalunya | Spain |
| Partner | Constanta Maritime University | Romania |
| Partner | University of Split | Croatia |
| Partner | Karl-Franzens-Universität Graz | Austria |
| Partner | Ministry of Education of Montenegro | Montenegro |
| Partner | Crmogorska Plovidba A.D. Kotor | Montenegro |
| Partner | Institute of transportation | Montenegro |
| Partner | Invar-Ivosevic Ltd. | Montenegro |
| Partner | Montenegrin Association for New Technologies | Montenegro |

The specific objectives of the project are: Revision of undergraduate study programme, 180 ECTS, in Navigation and Marine Engineering at UoM; Development of undergraduate study programme in Marine Electro Technics, 180 ECTS, at UoM; Revision of undergraduate study programmes, 180 ECTS, in Navigation and Naval Engineering at UV; Development of 2 new postgraduate (MSc) courses, 8 ECTS, in field of Marine Financing and Marketing at UNISHK; Development of IMO model courses for LLL based training of seafarers at UoM and UV; (Re)accreditation and implementation of developed undergraduate study programmes and IMO model courses; Update existing and build new teaching and infrastructural resources for maritime education and training in Montenegro and Albania; Training of teaching staff and its mobility within the PCs and EU universities and fostering cooperation between university and maritime sector enterprises.

The project duration is from 01/12/2013 to 30/11/2016 (36 month in total) and is divided into 9 Work Packages.

At this moment, the project has concluded the first work package (WP1, Revision of existing and development of new undergraduate study programmes) and part of second work package (WP2, Upgrading teaching materials and methodology, and (re)training of teaching staff).

## 3 REVISION OF EXISTING AND DEVELOPMENT OF NEW UNDERGRADUATE STUDY PROGRAMMES (WP1)

The Work package 1 was successfully finished in September 2014 with the presentation of the Curricula and Syllabi Catalogues. The academic partners from Montenegro and Albania were main stakeholders within this Work package and outcomes were directly connected to them aiming to improve educational process in accordance with the latest international maritime requirements (STCW Convention with Manila Amendments).

### 3.1 Revision of existing study programmes

The first activity was to analyse current state and to identify possibilities and adequate harmonization strategy (model) for each mentioned PC institution.

The lead partners at this Work package (University of Split), together with other EU maritime partners created Subreports which were used as a basis for next implementation step - creation of the Guideline for the curricula revision and development. The Guideline was essential for the harmonization of existing and development of new undergraduate study programmes because it consists of information such as new courses have to be developed, number of hours should be changed per each course and specification of theoretical and practical topics should be implemented.

### 3.2 Development of new study programmes

The final step was to create syllabi per each course according to the accepted study programme curricula. In this implementation phase, the EU partners were engaged as auditors, just to monitor the implementation process and the main work was performed by the PC partners. The project industrial partners were also involved in this phase, mainly regarding the preparation of the course concept and practical exercises.

### 3.3 Restructuring of the Bachelor Programs in Navigation Studies (University of Vlora). Case Example

This section is an example of the work carried out during this stage. During the restructuring of the Bachelor program in navigation studies at the University of Vlora, work was focused in four main areas, aiming to achieve a harmonious structure of the programs, in accordance with the STCW standards.

Table 2 shows the current situation of distribution of programs as defined in the second meeting held in Split meeting.

## 4 UPGRADING TEACHING MATERIALS AND METHODOLOGY AND (RE)TRAINING OF TEACHING STAFF (WP2)

The aim of this WP2 is to bring teaching staff PCs to EU partner country institutions in order to help adopting good practice in teaching and presenting the key disciplines of maritime studies. After their return the trained staff will organize trainings in PCs. Reports on study visits, number of teachers (re)trained and the proposal for teaching materials development are the indicators of training performances. This WP started in September 2014 and has not been finished yet. At the

**Table 2** Current situation of distribution of programs of the Bachelor Programs in Navigation Studies (University of Vlora)

| English | Navigation | Cargo handling | Other STCW | General | Elective | On board |
|---|---|---|---|---|---|---|
| 75 | 615 | 75 | 450 | 450 | 0 | 75 |
| Total: 1740 | | | | | | |
| To cover IMO Model 7.01 (without English): 1215 | | | | | | |

**Table 3** The expected situation after restructuring of the Bachelor Programs in Navigation Studies (University of Vlora)

| English | Navigation | Cargo handling | Other STCW | General | Elective | On board |
|---|---|---|---|---|---|---|
| 225 | 615 | 150 | 450 | 525 | 75 | 150 |
| Total: 2190 | | | | | | |
| To cover IMO Model 7.01 (without English): 1365 | | | | | | |

Finally, the distribution of subjects after restructuring programs is drawn in Table 4:

**Table 4** Structure of the restructured Bachelor Program in Navigation Studies (University of Vlora)

| | | | | |
|---|---|---|---|---|
| **Compulsory Courses** | | | | |
| **General Formation Courses (40 credits)** | 1 | MAT 154 | Calculus I | 8 |
| | | MAT 155 | Calculus II | 8 |
| | 2 | KIM 143 | General Chemistry | 8 |
| | 3 | FIZ 151 | Introduction to Physic I | 8 |
| | | FIZ 152 | Introduction to Physic II | 8 |
| **Characterizing Courses of the program (87 credits)** | 4 | DET 211 | Maritime Safety | 8 |
| | 5 | DET 212 | Meteorology and Oceanography | 7 |
| | 6 | DET 213 | Coastal Navigation | 8 |
| | 7 | DET 221 | Ship Handling & Manoeuvring | 8 |
| | 8 | DET 222 | Operation of Emergency Onboard & Care for Persons | 8 |
| | 9 | DET 311 | Electronic Navigation | 8 |
| | 10 | DET 312 | Celestial Navigation | 8 |
| | 11 | DET 313 | Theory and Techniques of Maritime Transport | 8 |
| | 12 | DET 314 | Maritime Radio communication | 8 |
| | 13 | DET 321 | Ship Management | 8 |
| | 14 | DET 322 | Maritime Law | 8 |
| **Formative and integrative Courses (21 credits)** | 15 | NAV 223 | Ship Theory | 7 |
| | 16 | DET 223 | Basic Electronics&Navigational Technical Equipments | 7 |
| | 17 | DET 215 | Ship Knowledges | 7 |
| **Foreign Language and Informatics Courses (19 credits)** | 18 | ENG 132 | English | 6 |
| | 19 | DET 121 | Navigational Chartography | 8 |
| | 20 | DET 325 | Navigational Practical Training | 5 |
| **Elective Courses** | | | | |
| **Selective Courses (6 credits)** | 21 | DET 131 | Maritime Ecology | 6 |
| | | DET 132 | Maritime History | |
| | | CST 130 | Introduction to Computer | |
| **Diploma Thesis (7 Credits)** | 22 | DET 398 | Thesis | 7 |

**Table 5** Example of the STCW competences associated to Degree in Nautical Studies and Maritime Transport curricula and which one can be evaluated by FNB simulators

| Subject | STCW Competence | Evaluated by simulator | Evaluated by simulator at FNB |
|---|---|---|---|
| Maritime Technical English | 8 | No | |
| Coastal Navigation | 1B 1C* (1F2) 2E 4B2 5B | Yes | Yes |
| Maritime Medicine | 17 20C | No | |
| Technical English for Maritime Navigation | 8 | No | |
| Naval Construction | 12 14B | Yes | No |
| Ship Theory | 14A | Yes | No |
| Electronic aids to Navigation | 1D 1E 1G 2D 4A 4B1 4C 4D 5A | Yes | Yes |
| Stowage | 11 | Yes | Only oil takers |

end of September 2014, UPC identified the main STCW 95/2010 competencies in their syllabus within the nautical and engine degrees (considering FNB curricula) and which of them could be evaluated by approved simulator training simulator (see Table 5).

Each identified competency – subject, was sent to PC countries for getting the correlation between UPC and PC subjects. This was done to tune and refine the training to be carried out by UPC.

### 4.1. (Re) training of teaching staff

UPC organised in 17th September 2014 the Working meeting 4 of the research project at the Universitat Politècnica de Catalunya – Barcelona School of Nautical Studies (FNB) and during the working meeting held in Barcelona, we decided the training and the selection of teaching staff members to be future assistants from PCs. Detailed Agenda was negotiated between EU host and PCs and it was agreed to carry out the retraining of teaching staff during 24th-28th of November, 2014. Detailed Agenda was negotiated between EU host and PCs and it was agreed to carry out the retraining of teaching staff during 24th-28th of November. Second retraining of teaching staff was held during 26th-28th May 2015 in Barcelona School of Nautical Studies (UPC) and this time the retraining was focused on Maritime transport and management.

## 5 CONCLUSIONS

The overall objectives of this initial part of the project are achieved. In order to evaluate and restructure of programs, partners were based, mainly, on the conclusions of MArED meetings, standards and requirements provided by the IMO STCW, the comparison with similar programs of the other Universities partners, comments and suggestions made by the third part in Montenegro and Albania, the legal framework related with University Education and finally the requirements of the Bologna Declaration.

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# TECHNOLOGY AND SOCIAL MEDIA IN THE MARITIME CLASSROOM

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**Abstract**. When it comes to the use of technology in marine education, a pragmatic approach has been taken. While there are areas where technology is integrated and considered essential (such as bridge and engine room simulators), there have been recent advances that have provided learning opportunities which marine educators have not taken advantage of. Unfortunately, the typical new student these days has been exposed (and in many cases exposed for years) to these technologies and has come to rely on them.

Recent statistics show that in many countries, the number of cell phones outnumbers the number of people indicating a high level of penetration. For example, in Russia there are about 1.5 cell phones per person and in the Philippines there are about 1.1 cell phones per person. This high rate of usage combined with enhancements in the capabilities of smart phones indicates that their use will continue to grow as will student reliance on them.

In this paper the authors look at the opportunities provided by the integration of new technology, an enhanced communication infrastructure and social media. Applications such as Facebook, YouTube and Blogs are assessed based on two matrices. The first matrix looks at the applications in terms of their utilization in marine education. This covers things such as "will it be useful to the student", "will it enhance the goals of the class" and "will it provide an educational benefit". The second matrix looks at these applications from an Institutional point of view and will assess things such as security, privacy and potential institutional policy issues.

We hope that the information in this paper will allow maritime instructors to either enhance their use of educational technologies in their courses or at least assess whether there is a place for these technologies in their areas of expertise.

**Key words**: E-Learning, social media, modern technology, online culture

## 1 BACKGROUND

Students entering post-secondary education come equipped with tools and knowledge that is relatively unknown to many instructors. In addition they come with a mindset that encourages them to rely and use technology, and in particular hand held technology such as tablets and smart phones. As Szwed (2014) noted, “There is mounting evidence that digital technology impacts brain development”. In addition it can be arguably said that the student use of hand held technology is the first example of students driving change in class room technology.

In maritime education, technology has been relatively slow to be adopted. There are good reasons for this. The operation of ships is a critical function where even a small error can lead to catastrophic losses. When training for these conditions it is natural to rely on established technology (e.g. navigation and engine room simulators).

The casual observation of an increased use by students of hand held technology (as seen in the classroom by the authors and their colleagues) can be backed up by statistics. The date when the cell phone entered public usage is somewhat subjective, however it was 1987 when the total cell phone users topped 1 million. The extraordinary growth of cellphones can be noted from the fact that the number of users is estimated to top 9 billion by the end of 2015.

One of the most interesting aspects of this growth is that the highest growth rates take place where there is not as strongly developed telecommunication infrastructure. This seems somewhat surprising since it would seem logical that a country with highly developed telecommunication infrastructure like Canada would see high cell phone usage. However Canada is quite low down the list of cell phone usage per capita with 79 cell phones per 100 people ranking it 59$^{th}$ out of 70 countries. Table 1 shows the popularity of cell phones for selected countries (Wikipedia 2015).

**Table 1** Cell phone ownership for selected countries

| Country | Number of cell phones per 100 people |
|---|---|
| Panama | 203 |
| Russia | 156 |
| Malaysia | 144 |
| Poland | 124 |
| Philippines | 114 |
| South Korea | 112 |
| United States | 103 |
| China | 93 |
| Canada | 79 |

While the communications provided by cell phones is important, it appears to be the information access provided by smart phones that seems to be providing the greatest growth. Smart phones provide a great deal more in the way of services than regular telephone service. Email, access to the internet and apps (applications or programs that provide a range of functions) provide enhanced communications.

## 2 TOOLS OF SOCIAL MEDIA

With the idea that cell phones and in particular smart phones are prevalent in our culture and will only become more so in our educational facilities, we need to examine some of the tools available.

The term social media is somewhat subject to interpretation. In fact some find the term Web 2.0 to be a more formal description. Bennet (2012) states that the criteria to be considered Web 2.0 are that the application or tool must exhibit most of the following:

- Collaborative and distributed authorship
- Active, open access :”bottom up” participation
- Continuous production
- Openess of content and distributed ownership
- Lack of finality
- Taking place on the WWW or internet resources.

In this paper, the terms Web 2.0 and social media are used interchangeably.

There are a large number of social media tools available (literally hundreds); some are country specific and some have an international audience, but for the most part they are similar to one of the eight examples shown below.

- Facebook: An open application that can be used by anyone to set up a presence and connect with friends, family, students, etc. As described by Facebook, “[it] facilitates the sharing of information through the social graph, the digital mapping of people’s real world social connections.”
- Twitter: A source of instant information (in a social context) provided by friends and family. The format restricts posts to a limit of 140 characters. (To give some context of this limit, this sentence inside the brackets contains about 100 characters.) However the mandated short length makes updating easier and quicker.
- Blog (web log): A site maintained by an individual or a group. The site can be open to the public or restricted to certain individuals. Content can be almost anything digital although generally it is comprised of formatted text supported by images and sometimes sound or video.

– Wiki: A site that allows easy and collaborative creation of content. The content (usually text, images or videos) is usually centered around a theme and is linked to other pages of the wiki.

– Pinterest: This is similar to a blog except it is designed to make it easier to post pictures and graphics. Can be supplemented by a small amount of text.

– Youtube: This is the largest collection of video clips available on the internet. Generally the clips are original, although there are a number of already broadcast items from old movies to documentaries.

– LinkedIn: A social network but designed more for business and employment. Users can enter their professional information and then build a network of professional contacts of people they know and trust.

– Khan Academy: Not really a social network site but it provides a large amount of educational material and allows an educator to set up a small network of students and monitor their progress (while not really a social media site, it is included due to the educational nature of it).

The open nature and the fact that the apps above or similar ones are already being used by many students entering our educational institutes would, in theory, make them good candidates for inclusion in many educational programs. However, as will be seen in the next section, this does not seem to be the case.

## 3 SOCIAL MEDIA IN EDUCATIONAL SETTINGS

With the growth being experienced with smart phones and the suite of tools that the current generation of students is familiar with, it becomes imperative that social media tools be considered in an educational context. It is certain that social media provides an informal educational tool, and this is indeed the case in the author's experiences. The Authors both have high school age children who routinely discuss homework and assignments with their friends through various tools. However it is necessary to examine whether social media needs to be integrated into regular delivery. As Tess (2013) puts it, considering integration of these tools requires an examination of "... the theoretical framework for implementing the technology as a learning resource".

The theoretical framework is undoubtedly important but we are faced with the usual problem when education and technology intersect, i.e. the pace of the adoption of the technology falls far behind the pace of the technology development. As has been noted, it is hard to maintain the status quo when the status is no longer quo. The rapid adoption of the technology by our clients has forced the issue front and center and consequently we need to review the use of social media in the context of class use and educational administration.

One limitation that was introduced into this study was that we decided to not cover the social media-like tools found inside learning management systems (LMSs). There were two reasons for this. The first is that LMSs are still not found at all Universities while the tools listed above can be. The second is that the specific tools found inside an LMS are system dependent, so some tools are offered on one system and others on a different one.

In regards to class room use, the eight social network tools identified in the previous section are reviewed based on the criteria laid out in Table 1. The first 3 criteria are related to content; the last is related to the potential for interactive communications. The first content criterion is abundance and is a measure of the quantity of relevant information available on the tool. The second content criteria, "accuracy", is a measure of the technical exactitude of the content. The third content criterion is "timeliness" and is a measure of how recent the information is likely to be. The non-content criterion is interactivity and is an indication of the amount of feedback or discussion that a student can expect using the tool. By necessity, the measurements in both Table 2 and Table 3 are somewhat subjective.

**Table 2** Classroom criteria for social media tools

| Social Tool | Content abundance | Content Accuracy | Content timeliness | Interactivity |
|---|---|---|---|---|
| Facebook | very low | low | high | very high |
| Twitter | very low | low | very high | very high |
| Blog | moderate | moderate | low | very low |
| Wiki | high | moderate | high | moderate |
| Pinterest | low | moderate | moderate | low |
| Youtube | high | moderate | moderate | very low |
| Linkedin | moderate | high | moderate | high |
| Khan | high | very high | low | low |

**Table 3** Administrative criteria for social media tools

| Social Tool | Copyright | Security | Appropriateness | Infrastructure |
|---|---|---|---|---|
| Facebook | moderate | low | high | low |
| Twitter | very low | low | high | very low |
| Blog | moderate | moderate | moderate | low |
| Wiki | moderate | moderate | moderate | moderate |
| Pinterest | high | moderate | very low | moderate |
| Youtube | moderate | high | low | high |
| Linkedin | low | moderate | very high | moderate |
| Khan | very low | high | very high | high |

The category of educational administration has a different set of priorities and consequently a different set of criteria. It is concerned, not with the learning involved, but instead with ensuring that the rules (if any) are followed. For example copyright is a significant issue in many Universities these days. Where digital content is so easily copied and can be so widely disseminated, universities must be vigilant to protect themselves from legal issues involving intellectual property. Security is a category that is of critical importance as can be witnessed by several recent examples of large amounts of information being stolen. Appropriateness is a measure of the potential for the app to display content that would not be acceptable. What is acceptable would of course vary from country to country and even region to region. Finally infrastructure is a measure of the bandwidth that each tool would require.

Tables 2 and 3 provide some guidance regarding the potential use of and possible hindrances when looking at social media in the classroom. One important observation is that the more interactive a social media tool is, the lower the richness of the content. Thus for ideal use in the class room, instructor must strive to provide strong content but also encourage student engagement. Another point that can be seen is that most popular social network tools all produce high volumes of content but the quality may be questionable. This is the opposite of teaching where we strive for the highest quality but at a cost of lower volume.

The items in Table 3 are generally related to policy issues. Unfortunately this is an area where there is little guidance. While most Universities do have a policy for employees using social media, the policy covers personal use as use of social media in a non-teaching manner.

Seaman (2013) stated that the two main concerns of faculty in regards to adopting Web 2.0 into the classroom are 1) people not associated with the course gaining access and 2) the integrity of student submissions. Most Universities have policies in place for dealing with printed submissions and these can be extended to social media, but there are still concerns.

As was mentioned above, this study excludes LMSs. LMSs are set up to provide a protected learning environment, often with their own internal email systems. The restrictive nature of an LMS provides a much more controlled environment, but at the expense of potential content and student interaction. Applications, in their current state, provide none of these protections for the learning environment but do greatly enhance accessibility of the course content and discussions.

## 4 EXAMPLES OF SOCIAL MEDIA IN THE CLASS ROOM

The use of social media in university settings has been going on for several years. For example in 2009 Birmingham City University began offering a Master's Degree in Social Media. However that program seems oriented towards business uses, not teaching. In fact examples of social media in formal class room settings at a university level are scarce in the literature.

It is possible that this is because the adoption of social media by University Professors is so recent that there has not been enough time to migrate the use of social media into the classroom in a formal way and assess it (Hew 2013). If this is the case then we should soon start seeing more examples. However, there are some notable examples of social media being adopted that we can review now.

Bennett (2012) reported that a large first year chemistry class implemented a system where students were encouraged to take pictures of every day chemical reactions or chemistry related incidents that highlighted a principle shown in a recent class and post the photos on a common site. The students would also provide a brief description of the chemical principle involved and tag the image with an appropriate label. By the end of the class, 1894 images were posted. It is easy to see how this could be applied to a marine training program. Pictures of ships, engine parts, navigational aids etc. could make interesting and useful exercises and help link classroom theory with real world examples.

Bennet (2012) also provided an example of a first year university psychology class where the class was engaged in creating an wiki. The students were instructed on how to create an appropriate wiki style entry, complete with links to other wiki entries and to outside content. Students were also required to review entries besides their own and correct as appropriate. Again, it is easy to see how this type of tool could be used in marine education. A wiki set up to create entries on shipping accidents with causes and consequences would be educational and provide a tool that could be used for examination purposes or for reference.

A final example comes from Hung (2010) who points out that there is a social aspect to learning and used social media to enhance the “sense of classroom community”. He and a colleague used social media to encourage students to share experiences from both inside and outside the classroom. Content shared could be text, video, images and even research. At the end of the course the students were surveyed and over 80% found the experience useful and indicated that the use of social media enhanced the sense of community and consequently learning.

As the policies become clearer and educators gain more comfort with the media, it is expected that a majority of classes will eventually be seeing some form of social media in their classrooms.

## 5 HANDHELD TECHNOLOGY

As was mentioned at the start of this paper, one of the drivers of social media is the rise in hand held devices (i.e. cell phones and to a much lesser degree tablets). The Authors envisage a time in the near future when it will be possible to provide complete distance deliveries of courses using handheld devices. The entire course can be accessed, worked through and completed using nothing but handheld devices.

Several online course content authoring packages now provide responsive authoring options to permit the creation of content for multiple platforms simultaneously. When using a responsive authoring software package (e.g. Adobe Captivate), content such as text, graphics, interactions and audio are simultaneously created in two or three instances of the project. Each instance may then be customized with respect to the size and quality of graphics, the size and type of font and the position of all visual elements so that the same content on each ‘slide’ of the presentation are optimized for viewing and interaction on a suite of devices.

The devices that each instance of the project are authored for are defined very precisely in terms of screen size, screen resolution, interaction (e.g. Is the screen a touchscreen) and audio capability. The final output of the authoring software is smart enough to detect what device the learner is using to access the content item and to provide the correct version for the learner to access using their particular device.

The authors have created responsive projects such that the same interactive learning element may be accessed using either a PC, a tablet or a cellular phone.

## 6 CONCLUSIONS

The main goal of this paper is to begin a dialogue about the use of social media in the maritime class room. The demographics and current trends show that the use of cell phones in University students is high and will only become more. In addition students come with a familiarity with social media that allow them to communicate with each other through a number of options and media (i.e. share pictures as well as text). Their expectations are also beginning to drive a demand for social media in the classroom (as was asked of one of the Authors when instructing a technical topic, “Is there an app for that?”).

The ease with which students use social media has both promise and danger for classroom activities. As educators, we generally want a strong link and easy communication with our students. At the same time we must be aware that classroom information should be kept confidential and must ensure the integrity of any graded work.

This paper has also highlighted several examples of how social media can be used the classroom. It is anticipated that as social media becomes more accepted in the future there will be more examples, including ones from maritime educations.

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# RESEARCH USING MARINE BRIDGE SIMULATORS – HOW WELL DO THE RESULTS TRANSLATE INTO REAL WORLD OPERATIONS?

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**Abstract.** Marine Simulation has been used for training seafarers since the 1960's [1], and much has been published on the use of marine simulation for the purpose of training seafarers. The functional requirements for these simulators are established in the Standards of Training Certification and Watchkeeping (STCW) Convention [2]. Further use has been made of the simulators for the purposes of research, and although there are functional requirements for training, no such requirements have been created for research. How is it possible to determine how the research results from a training simulator translate into real world operations when there are no standards for the capabilities of the simulator?
The classification Society DNV-GL AS, has created technical standards to show that a particular simulation facility is capable of providing the mandatory training as required by the STCW convention [3].This standard includes requirements for realism, and is defined in the document as "the degree the simulator looks and feels like real equipment" [3] p 10 The standard also includes an assessment of the Dynamic Behaviour of the system. In essence these standards are designed to ensure that the trainee in the simulator experiences a realistic environment, and uses tools which may be generic in nature, but are used in the same way, and provide the same information as similar tools used at sea. The DNV-GL technical requirements are designed to allow a maritime administration to show that a marine simulator system meets the requirements of the Standards of Training Certification and Watchkeeping (STCW) Convention when used for mandatory training and assessment. Section A-1/12 of the STCW convention, [2] states in section1.2 that the simulator "be capable of simulating the operating capabilities of shipboard equipment concerned, to a level of physical realism appropriate to the training objectives." Are these poorly defined standards of physical realism and dynamic behaviour sufficient to translate research results to real world operations?
This paper will look at the question of the validity of the research results obtained from a bridge simulator, with a view to establishing any differences and gaps between the simulation requirements for training and the requirements for research, especially research which is industry or user driven. It will follow a typical research project carried out in a marine bridge-simulator, and establish the validity [4] and reliability which may be used for quality control of results following the use of simulators for research. It will further question whether this produces a result that provides external validity, allowing the results of the research to be directly related to real world operations.

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**Key words**: simulation, validity, research

# 1 INTRODUCTION

Marine Simulation has been used for training seafarers since the 1960's [2], with IMO requiring the use of simulation for training with the introduction of the Standards for Training, Certification, and Watchkeeping Convention in 1978 (STCW78). Since then, much has been published on the use of marine simulation for the purpose of training seafarers. The functional requirements for these simulators are now established in the Standards of Training Certification and Watchkeeping (STCW) Convention as amended [2]. These functional requirements, in short, refer to the simulator being suitable for the selected training objectives and training tasks, as well as ensuring sufficient behavioural realism. The requirements are written in general terms and are open to interpretation. For a flag state to approve a particular simulation facility as meeting the training requirements of IMO, the classification society DNV-GL has produced a standard for Maritime Simulator Systems [3] as "a method of carrying out such approval". Section 1.1.2.1. of the DNV-GL standard states "The purpose of the standard is to ensure that the simulations provided by the simulator include an appropriate level of physical realism in accordance with recognised training and assessment objectives". This is further supported by the International Marine Contractors Association (IMCA) who has published "Guidance on the Use of Simulators" [5]. The purpose of this document is to give guidance on simulators limited to the use for training and competence in the marine contracting industry. It states "It should be noted that the level of realism of each simulator will directly impact the effectiveness of the learning experience for the trainee".

If this same "training" simulator is to be used for research, how well do the results match what will be experienced in the real world?

# 2 RESEARCH USING SIMULATORS

Research using Marine simulators can be divided into two broad categories. The first is port and harbour development, involving the creation of new ports, extensions or adaptions to existing ports, or research looking at manoeuvring larger ships in an existing port. The second is the research looking at human interactions, either as members of a team, or individual's interaction with technology. The research approach for the two areas differs and so will be looked at separately.

## 2.1 Research for Ports and waterways

Ankudinov et al [6] noted that there is a value in using ship manoeuvring simulators to support harbour and waterway development. Working Group 20 of the Permanent International Association of Navigation Congresses (PIANC) reported in 1992 on The Capability of Ship Manoeuvring Simulation Models for Approach Channels and Fairways in Harbours [7]. This work is being extended in Working Group 171, with the title 'Ship Handling Simulation Dedicated to Channel and Harbour Design' [8]. Working Group 171 is not expected to complete their work until 2018.

In the PIANC report on Ship manoeuvring simulation models [7], the authors note that "attention in ship manoeuvring studies is generally focussed on the validity of the mathematical ship manoeuvring model. Although this is a very important aspect, other aspects deserve also attention. This applies to a proper problem formulation, the experimental design method, the choice of subjects (pilots and/or masters), and the method of data analysis and drawing conclusions form the investigation."(pp7). The report also details the various techniques used in ship manoeuvring simulation, and the uses to which they can be applied (see Figure 1). The report discusses at length the advantages and disadvantages of each method and notes that a ship manoeuvring simulator has advantages in allowing real-time simulation which will then demonstrate the influence of human reaction time on the events simulated, although this will introduce a stochastic element to the results due to the variability in human reaction times. The authors also note that there must be similarity between the simulator outfit and a real ship. In section 9 of the report, the authors' state "Compared to other models (civil engineering)..... ship manoeuvring models have probably a high degree of validity. With all these models it should be realised that, although they are not perfect, they increase our knowledge with regard to a problem very much. Doing nothing means knowing nothing, thus increasing the chance of errors."(pp27)

The International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), in Guideline 1058 reviews the use of simulation as a tool for waterway design [9], and suggests the use of simulation to supplement the "existing qualitative and quantitative IALA risk assessment tools". The Guideline states that "the purpose of simulation in AtoN planning and waterway design is to test, demonstrate and document various scenarios for deployment of various AtoN and waterway design under different conditions with the aim of identifying optimal operational safety and efficiency". The Guideline further provides information on the selection of different simulation tools for a given task, and the capabilities and limitations of the different simulation tools, and goes on to discuss accuracy and realism considerations.

A further PIANC publication, Approach Channels, A Guide for Design [10], does not discuss the mathemati-

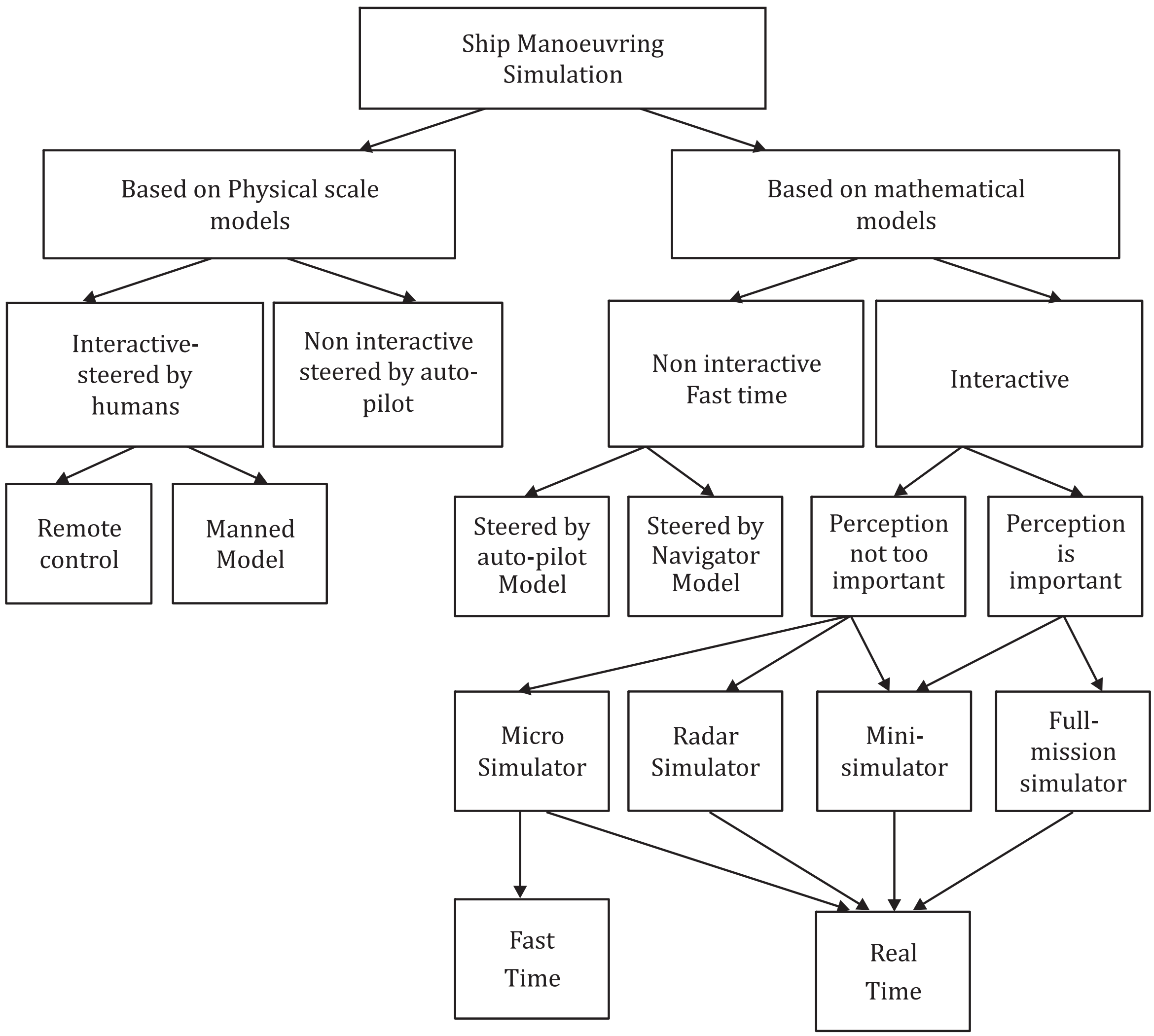


**Figure 1** Various techniques used in ship manoeuvring simulation
From Capability of Ship Manoeuvring Simulation Models for approach channel and fairways in Harbours (PIANC)

cal models used, but limits the discussion to the use and value of a Ship Manoeuvring Simulator to a designer. The authors note the importance of the selection of participants, acclimatisation to the simulator, careful recording of performance of the bridge team, and thorough de-briefing following a test run.

### 2.2 Human interactions

When carrying out a research project looking at human behaviour, perhaps the interactions between humans, their interactions with machines, or their behaviour carrying out a task, then the environment in which this project takes place will have an effect on the outcome. Anderson et al [11] compared the results of laboratory and field studies related to a wide variety of psychological phenomena, and discovered that studies conducted in the laboratory and those in natural settings lead to the same conclusions about human nature: "the psychological laboratory has generally produced psychological truths, rather than trivialities". Research in this area in the Maritime domain could be carried out by observation in the real-world, with the problem that there will be no control over the incidents presented to those involved in the trial. To control this variable, the situation for the trial is switched to a Ship Bridge Simulator, effectively a laboratory. This now defines the location of the research, but does not describe how realistic the environment needs to be.

## 3 ACCURACY OF THE SHIP BRIDGE SIMULATOR RESULTS

The PIANC publication Approach Channels, A Guide for design [10] refers to "Shiphandling Simulation: Application to Waterway Design" [12]. The authors of this volume state "a simulation will be considered accurate if it can produce piloted track predictions that are useful as a basis for a design decision concerning navigation and risk. Accepted guidelines for this accuracy apparently do not exist, and the accuracy requirement varies depending on the exact nature of the design problem."

None of the standards reviewed here ([2], [3], [5], [7], [9], [10]) give an indication of the measure of the accuracy with which the simulator reflects the real world, but that the accuracy should be checked. Webster et al [12] discuss this as measuring fidelity: the measure to which the simulation matches the "real" situation. The report uses the word fidelity, as it "refers to the appearance and functionality of the simulator as experienced by the pilot*"*. However, measures of fidelity will also include the mathematical model of the ship including the hydrodynamic coefficients used in its definition, the bathymetric model of the port, the visual model of the port, the realism of the bridge etc. The report [12] continues "Ideally, the pilots are provided an environment that so closely resembles a ship's bridge… that they are unable to detect that they are not aboard a ship. In other words, the ideal is a bridge that looks, smells, feels, moves, and sounds like a real bridge, and has views through the windows and ports that are absolutely lifelike. Such an environment would be referred to as having "perfect" fidelity"*.* The environment presented in a ship simulator will not achieve perfect fidelity, in part because there will always be clues that the pilot is not on board a ship, such as lack of movement, incorrect smell, visual scene as a computer generated image and so on. There does not appear to be a method to quantify the fidelity of the situation, other than by questioning the participants, and asking questions as to how well they fell they are on a real ship. This then leads to the stochastic influence in the results depending on the human subject taking part. This then leads to another question for the researcher to answer: Would reliable results be gained from using a larger group and assessing the results statistically improve the reliability of the results?

Kirk and Miller [13] describe the need for qualitative research to be objective, and they partition objectivity into two components, *reliability and validity.* They state "Loosely speaking reliability is the extent to which a measurement procedure yields the same answer however and whenever it is carried out; validity is the extent to which it gives the correct answer"

In their book "Scientific Method – optimising applied research decisions" [14] Ackoff et al state "The reliability of the model can be measured by estimating the variance (or some other appropriate statistic) of the deviations of the observed outcomes from those that were predicted. There are no simple criteria for determining whether the variance is too large: that is, whether or not the model is sufficiently reliable" (p394).There is thus no simple mathematical result from the data produced from the research which will show that it accurately mimics the real-life situation. It would be possible to show that the results have a certain variance, but how does this variance affect our ability to show that the results mimic the real situation.

There are two issues of validity to consider, those of Internal and of external validity. Leedy and Ormrod [4], define internal and external validity as follows. "Internal Validity of a research study is the extent to which its design and the data it yields allow the researcher to draw accurate conclusions about cause-and-effect and other relationships within the data", and "External validity of a research study is the extent to which its results apply to situations beyond the study itself-in other words, the extent to which the conclusions drawn can be *generalised* to other contexts"*.* These two aspects of validity need to be reviewed for the research project to ensure that it is possible to draw meaningful and defensible conclusions. Slack and Draugalis [15] define three steps in establishing internal and external validity. The first step is to assess the statistical conclusion, attempting to show that the results are not due to chance. Only if the results pass the statistics test, should the internal validity be assessed, this time on the basis of the experimental design and operational procedures. The final step is to review the external validity, principally looking at the inclusion and exclusion criteria and characteristics of the study participants. Although the paper is concerned with pharmaceutical experimentation, the process will be similar for research carried out in a simulator, namely that the results produced must be acceptable before internal validity can be reviewed. If the results are accepted for internal validity then an assessment of the external validity can be made.

Osman Balci in his chapter in the Handbook of Simulation, [16], titled Verification, Validation and Testing, states "The question is not to bring *a* solution to the problem, but to bring a sufficiently credible one that will be accepted and used by the decision maker(s)". How then, can the solution be shown to be credible? Perhaps this is the point: if the simulator is designed to reflect the real-life situation, and the models are shown to behave as the real ship will, then the results will translate directly to the real-life scenario. This is an area for further research, and at this stage the solution does not appear to be a trivial.

## 4 A TYPICAL RESEARCH PROJECT

In his book, Capt Henk Hensen [17] gives a series of 7 steps to setting up a research project, a phase he calls the Validation Phase. This process concerns the confirmation of the accuracy with which all parts of the simulation match the real-world, and uses the term validation with the meaning of a reliability assessment to show the fidelity of the simulation. The final assessment of validity in this case is carried out by professional mariners with experience in the port and with experience in the size and type of ship being used. The author notes "It is important to keep in mind, however, that professional mariners in general only have a feeling – i.e. a subjective indication – of a (simulated) ship's or tug's manoeuvring performance, and cannot provide objective performance criteria. For instance they may feel that speed deceleration at full astern is too fast, but they are seldom able to quantify to what extent". The book further goes into significant detail concerning the methods of confirming the accuracy (validity) of the simulation.

### 4.1 A Simulator Project

This is an example of how a potential research project used by clients to review a scope of works might be approached by a simulator centre operators.

Initially a client contacts the simulation department and discusses the reason for the project. In this case, the project is to look at the feasibility of extending the berths in a port, to accommodate larger tonnage. The plan also includes some dredging work. The creation of a new bathymetric model was deemed too expensive for the early scoping study, and it was agreed that a depth of 12 metres be applied across the whole model area, a value that could be entered into the operating system at 2 key strokes. This was the designed dredged depth for the port area, and the client was happy that this would not affect the outcome of the trials. The new berths were inserted as simple visual models giving visual clues as to the dimensions of the new port, and these were simply added to the existing port model. The client was offered the possibility of having a ship model accurately modelled for the new tonnage, but decided to use an existing model of similar dimensions. The next discussion was to decide on what the trial was trying to determine. The client, after some discussion wanted to know if the current masters and pilots would be able to manoeuvre larger ships in the port, and to test the environmental limits for the berthing and unberthing. The client provided wind and tide data for the port, and this was selected before each trial was run. The feasibility study could then be run cost effectively to the client's satisfaction.

Following the trial runs in and out of the port by a number of pilots and masters familiar with the port, it was decided that the larger vessel could safely use the new port, with a limit established to the acceptable wind speed. Was this a reasonable assumption?

The question can be answered in terms of the internal and external validity of the research. Was there sufficient data to show that there were no other possible explanations for the results, and can we be certain that the conclusions are warranted by the data [6]? If the answer is yes, then we have satisfied the internal validity of the research. Finally, the external validity: can the results be transferred to the real world, and here there is a problem. With the client deciding that the ship model is not based on the new tonnage to be engaged, that the bathymetric model is inaccurate, that the port visual model has been changed, can the conclusions drawn be transferred to the real-world situation? Referring back to Osman Balci's comment [16], we should ask are the results sufficiently credible for a decision to be made? The answer we leave to the client.

## 5 CONCLUSIONS

With no standards for Ship Bridge Simulators used for research purposes, we are generally reliant on the simulators produced to fulfil training requirements. The industry requirements for the use of simulators to support a decision making process in port development suggest that the simulator should be as accurate as possible, leaving the final decision on how much reliance to put on the results in the hands of the body initiating the study (the client). It is possible that further research will identify metrics for establishing the validity of a simulation study, or for setting the requirements for validity to be met during the research programme. This may in turn lead, perhaps, to the capability of applying a confidence level for the external validity of the research programme, which would aid decision making.

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# ENERGY EFFICIENCY ANALYSIS OF PUMP SYSTEMS IN A SHIP POWER PLANT AND A CASE STUDY OF A CONTAINER SHIP

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**Abstract.** Energy efficiency can be defined as the reduction of energy consumption per unit of service or product quantity that without causing a decline in the quantity and quality of production which the standard of living of the people and service quality, and industrial enterprises. In the other hand an energy efficiency is prevent energy losses in the gas, steam, heat, air and electricity; or to reduce the demand for energy without reducing the production recovery and evaluation or advanced technology of various waste, more efficient energy sources, advanced industrial processes, activities such as energy recovery is the whole of the building measures.

It is well known that the most of the electricity energy is consumed by the pump for applications at the buildings, industry and transportation. A research study, among the consume energy machinery, have illustrated that pumps are used the energy in 20%. Due to that pumps and pump systems have a great importance in term of energy efficiency in the different sectors.

There are many type of pumps and pump systems for different purposes in ships. They are often worked at full load in cruising, maneuvering and hotelling conditions. Therefore unnecessary energy consumption is realized. It is demonstrated that some simple measures or some minor changes can be saved energy between 20% and 30% in the industrial application from the pump systems. Accordingly, it may be mentioned from such a large energy savings potential from the ships.

In this paper, the energy consumption of pumping system of a container ship at the full ahead, half ahead and slow ahead situations are calculated. The pumping system's energy saving improvements and its effect to ship's annual energy consumption are calculated for the same ship, and the economic gain and efficiency increases are discussed.

**Key words:** container ship, energy cost, energy efficiency, marine power plant, pump

## 1 INTRODUCTION

The marine transportation sector is one of the major causes of global air pollution. Shipping emissions affect global air quality, people's health, the marine ecology, and global warming. Carbon dioxides ($CO_2$), carbon monoxide (CO), particulate matter (PM), nitrogen oxides ($NO_x$), and sulfur oxides ($SO_x$) are the most significant pollutants emitted from marine diesel engines. Emitting $CO_2$ from maritime transportation is responsible 3.3% of world total $CO_2$ emissions. Due to increased global fleet and freight volumes, they are predicted to increase by 150%-250% by 2050 [1]. By this reason, IMO is studying on some new regulations to reduce $CO_2$ emissions from shipping. There has been developed some techniques for reducing $CO_2$ emissions from shipping with an agreed timetable for adoption. An Energy Efficiency Design Index (EEDI) was set minimum limits on the emissions of $CO_2$ per unit of transport work from newly built vessels, and Ship Energy Efficiency Management Plan (SEEMP) was developed for all new and existing ships to improve awareness for energy efficiency and to reduce fuel consumption and $CO_2$ emissions.

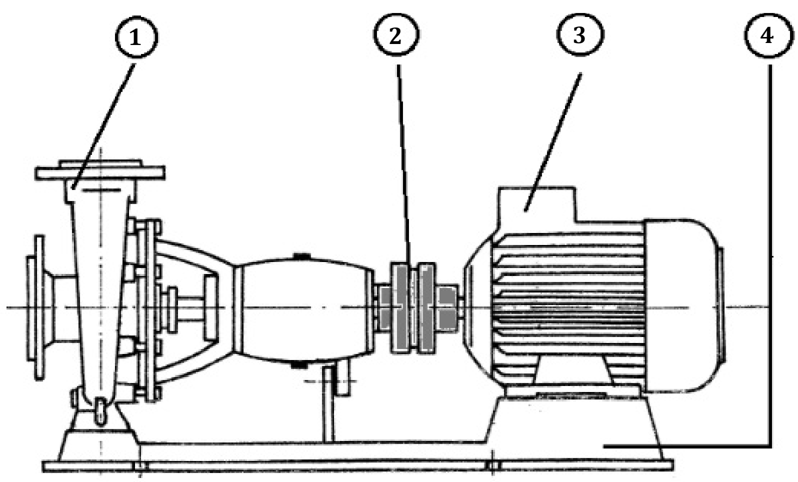
Energy and environmental efficiency is today one of the key capability factors for ship operators and therefore these aspects also have to be one of the core elements in ship design process. From main engine to cargo operations, energy efficiency has become the base to set up and plan any machinery or procedure. A number of components on board require electric or mechanical power. Pumps are often a major consumer in this category. A vessel's cooling water system is one of the main consumers among the auxiliary systems, requiring roughly a third of the electrical energy on board. The cooling water system consisted of three subsystems: the sea water (SW) cooling system, the low-temperature (LT) fresh water cooling system and the high-temperature (HT) fresh water cooling system. The SW system employed sea water to cool down the water of the LT circuit. The sea water pumps are always separate from the engine and electrically driven. The capacity of the pumps is determined by the type of coolers and the amount of heat to be dissipated.

In this paper, the energy consumption of pumping system of a container ship at the full ahead, half ahead and slow ahead situations are calculated. The pumping system's energy saving improvements and its effect to ship's annual energy consumption are calculated for the same ship, and the economic gain and efficiency increases are discussed.

## 2 PUMPS AND SHIP PUMP SYSTEMS

### 2.1 Pump, pump systems and pump efficiency

A pump is a device that moves fluids or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps. Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, come in many sizes, from microscopic for use in medical applications to large industrial pumps [2]. Typical pumps assembly is shown in Figure 1. As it can be seen




1 – Centifugal pump body; 2 – Coupling; 3 – Electric motor; 4 – Chassis

**Figure 1** A typical pump arrangement

in figure, a pump system consists of some parts. First part is a pump body which is actuated a fluid inside of its body. The second part is an electrical driver (motor) that supply power for the pump. Third part is a coupling that connects the pump body with the electric motor. All this equipment installed on a chassis that is the fourth part. Also there are some another parts for example pipes and fitting equipment that are not shown in figure 1.

Also a pump system should be works with efficiency. Pump efficiency is defined as the ratio of the power imparted on the fluid by the pump in relation to the power supplied to drive the pump. Its value is not fixed for a given pump efficiency (η) is a function of the discharge (Q, mass flow in cubic meter per hour or sometimes in liter per hour) and therefore also operating head (H) in meter [3].

For centrifugal pumps, the efficiency tends to increase with flow rate up to a point midway through the operating range ($\eta_{opt}$) and then declines as flow rates raise further. Pump performance data such as this is usually supplied by the manufacturer before pump selection (Figure 2). The efficiency of the pump depends upon the pump's configuration and operating conditions (such as rotational speed, fluid density and viscosity etc.) [4].

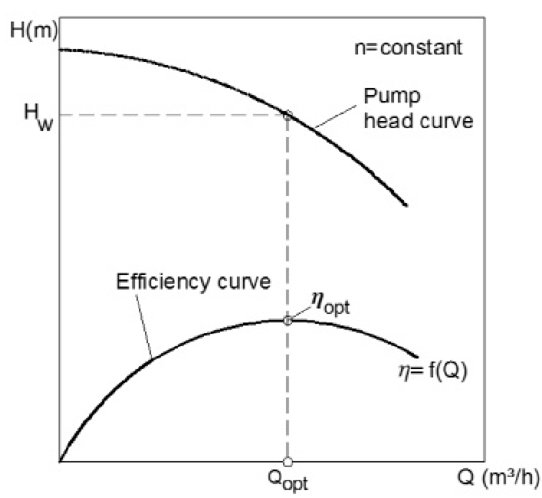



**Figure 2** Performance diagram of a pump

The power of pump shaft and the power of electric motor's shaft equations are shown in follow.

$$P = \frac{rQH}{367h}\ (kW) \tag{1}$$

$$P_M = a \times P\ (kW) \tag{2}$$

Where $\rho$ is specific mass in kg/m$^3$; $Q$ is mass flow in m$^3$/h; $H$ is head in meter, α is a multiply factor is given in Table 1.

**Table 1** The multiply factor for eqution 2 [2]

| P(kW) | α |
|---|---|
| < 1.5 | 1.50 – 1.40 |
| 1.5 – 4 | 1.40 – 1.25 |
| 4 – 35 | 1.25 – 1.15 |
| > 35 | 1.15 – 1.10 |

## 2.2 Ship pump systems

Pumps are used to differrent aims for various plant on shps. The ship systems consist of a fresh water (F/W) cooling system, sea water (S/W) cooling system, luboil (L/O) system, fuel system (F/O and D/O), balast system, bilge system, sludge system hydrophore system and fire fighting system in ships. Therefore it can be say that there are some different kinds of pumps (Table 2). However the centrifugal pumps are the most common used type of pumps on ship applications [5].

**Table 2** Some type of pumps on ships

| Systems | Quantity of pumps | Types of pumps |
|---|---|---|
| HTFW cooling system | 2 | Centrifuge |
| LTFW cooling system | 2 | Centrifuge |
| SW cooling system | 2 | Centrifuge |
| Fire system | 2 | Centrifuge |
| Hydrophore system (S/W,F/W) | 6 | Centrifuge |
| F/O,D/O transfer system | 3 | Screw |
| L/O system (M/E, D/G) | 3 | Screw |
| L/O system (M/E, D/G) | 6 | Centrifuge |
| Bilge and sludge system | 1 | Centrifuge |
| Bilge and sludge system | 1 | Screw |
| Bilge and sludge system | 1 | Piston |

The sea water pumps is the most important pumps include cooling service for a ship and such ship service systems as ballast and fire main. The main sea water cooling system will normally consist of two supply pumps and distribution piping. The system may supply water to the main engine L/O coolers, main engine F/W coolers and main engine air coolers services. On tankers the main sea water cooling system may also serve a condenser for cargo and ballast pump turbines.

According to tropical condition standards, every cooling pump capacities are designed at 110% more than normally load condition on ships. This means that pumps are working inefficiency when the ambient conditions are not unsuitable to tropical conditions. The tropical conditions value is shown in table 3. In actually, the sea water temperature is variability for different region in the world and the ships are constantly cruise from a port to another port. Due to needed cooling capacity is variable. Therefore pumps should be operated for different capacity on ships but it is not suitable yet.

**Table 3** Tropical conditions standards for ships

| | |
|---|---|
| Sea water temperature | 32 °C |
| Central water temperature | 36 °C |
| Ambient air temperature | 45 °C |
| Barometric pressure | 1 bar |

Changing the fluid temperature are parameters that directly affect the pump performance. However seawater pumps always work according to the initial design value, despite continuously changing fluid temperature. In addition the pump capacity may be reduced further in the ship maneuvering conditions. Thus, in this case it leads to energy loss of the sea pumps.

## 3 CALCULATION METHODS OF ENERGY EFFICIENCY

This section consists of calculation methods for a sea water pumps. As it well known a great number of pumps are installed on ships. However it was considered only a sea water pump accounts to be easy and straightforward. A sea water cooling pump of a container ship is used in the calculations as an example. The calculation method covers an energy losses calculation, an energy cost accounts and an environmental effects from a sea water pump that installed to consider container ships. The container vessel sea water cooling systems are given in Figure 3 as schematic. Also it is developed a scenario under a case study title for calculation.

Fresh water circuit system is divided two sections which are high temperature fresh water (HTFW) system and low temperature fresh water (LTFW) system. High temperature fresh water system associated with main diesel engine and low temperature fresh water associated with low temperature fresh water coolers which are air coolers, lube oil coolers, air compressor coolers, air conditioning cooler etc. Both high temperature fresh water system and low temperature fresh water system can be connected with three way flow control valve in circuit line. If main engine jacket water temperature is sufficiently lower, the fresh water flows down to the low temperature fresh water and mixed with it. Thus the jacket cooling fresh water temperature can be decreased and then flow back to the main diesel engine inlet. At same time the low temperature fresh water temperature can be increased. Before the LTFW inlet to the fresh water pump, it is cooled by fresh water coolers. Thus the circuit is completed. If engine jacket water temperature is higher, the fresh water inlet to the fresh water cooler directly and after then cooled, it cross the LTFW pump, LTFW cooler and three way flow control valve and goes to main engine inlet.

The problem is when does the fresh water bypass line is open there is a inefficiency application on the system. Because if some fresh water bypassed the fresh water cooler, the sea water pump which working constant speed and supply a constant quantity mass flow for cooling, high capacity while it is not necessary. This problem will increase further when the main engine speed is decreases. Eventually it can be say that the energy is wasted and therefore very high costs of energy and have an adverse effect on the environment.

A simple calculation method is used for estimating a wasted energy, an energy costs and an environmental effects from sea water pump system on the container ship. The scenario is explained as follow:

The container ship starts to cruise from Istanbul to New York. The distance is approximately 5025 Nautical miles. The container ship's speed is 25 knots. It is assumed that a container ship may cruise nearly 275 day per year. There are maneuvers both of ports and it is assumed approximately 5 hour per one service (Table 4). On the other hand the cruising time is 201 hour per one service by ship. That is the total service time is 206 hour between ports per one service. As a consequently the container ship totally have 6440 hours in cruising mode and 160 hours in maneuver per years. The results are shown in Table 5 in briefly.

**Table 4** The data of case study

| | | |
|---|---|---|
| Distance | 5025 | NM |
| Ship speed | 25 | knots |
| Maneuver time in Istanbul | 2.5 | hour/a service |
| Maneuver time in New York | 2.5 | hour/a service |
| Cruising time | 201 | hour/a service |
| Total time | 206 | hour/a service |

**Table 5** The annually service time on container ships

| | | |
|---|---|---|
| Total cruising time | 6440 | hour/year |
| Total maneuver time | 160 | hour/year |
| Total service time | 6600 | hour/year |

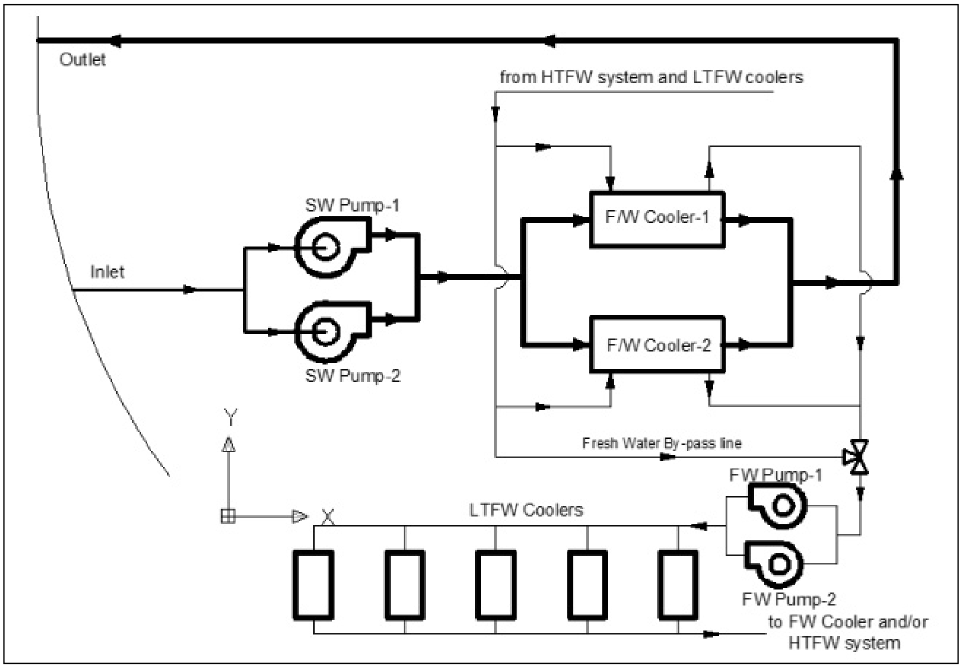



**Figure 3** Sea water circuit system of a container ship

**Table 6** Data of fresh water cooler inlet and bypass mass flow

| $T_D$=20 °C | | | |
|---|---|---|---|
| **M/E loads (%)** | **M/E speed (rpm)** | **Inlet mass flow to FWC (t/h)** | **Bypass mass flow (t/h)** |
| 100 | 102 | 1219 | 378 |
| 75 | 80 | 480 | 945 |
| 50 | 58 | 245 | 995 |
| 25 | 36 | 94 | 1120 |

The fresh water cooler (FWC) inlets and bypass mass flow data is shown in table 6 as a sample for sea water temperature at 20 °C. Also there are same table data's for the different sea water temperature in 18 °C, 15 °C, 13 °C.

Data including in the table 6 is regarding with main engine variable loads. The 100% load means that the main engine is in full speed conditions. The other loads 75%, 50%, 25% is half speed, slow speed and dead slow speed respectively. The inlet fresh water mass coming up from high temperature circuit (HTFW) and/or from low temperature fresh water (LTFW) circuit. When the fresh water temperature is lower, the fresh water mass can be separate to two line. First line is the inlet line to fresh water cooler and the second line is bypass line. By the time the bypass line is open, inlet fresh water mass flow was decrease. Even though to this situation sea water mass flow should be decrease, it is not possible in actually. That means the sea water mass flow is constant. Due to these conditions there is waste energy, waste money and inefficiency operation on the ship's sea water circuit system.

## 4 RESULTS AND DISCUSSION

For calculation the wasted energy cost and wasted $CO_2$ which is release to atmosphere there are some assumption. The assumption is 1 kWh electrical energy is equal to 0.65 kg $CO_2$ and a unit energy price is equal to 0.076 $/kWh. From this approaches the wasted energy, wasted energy costs and the emissions of $CO_2$ are calculated and the results are illustrated in tables of 7, 8, 9 and 10.

The wasted energy is 932 MWh per year in totally on the container ship while the sea water temperature is equal to 20 °C. Also it can be understand from the table 7 cost of wasted energy is approximately 71,130 $ per year in totally. However the ship released about 633,316 tones $CO_2$ per year to atmosphere due to the waste energy. It is clearly understand that when the main engine speed decreases at first all the parameters decrease to minimize point and after then to increase again. It means that there is a optimum point for main engine speed in term of waste energy and also waste energy cost and $CO_2$ production on ships.

**Table 7** Calculation results for the sea water temperature 20 °C

| Main engine loads (%) | Wasted energies (MWh/year) | Wasted energy costs ($/year) | Released $CO_2$ emissions (t/year) |
|---|---|---|---|
| 100 | 382 | 29,157 | 14,730 |
| 75 | 60 | 4,605 | 14,770 |
| 50 | 124 | 9,499 | 62,850 |
| 25 | 365 | 27,869 | 540,966 |
| Total | 932 | 71,130 | 633,316 |

**Table 8** Calculation results for the sea water temperature 18 °C

| Main engine loads (%) | Wasted energies (MWh/year) | Wasted energy costs ($/year) | Released $CO_2$ emissions (t/year) |
|---|---|---|---|
| 100 | 626 | 47,792 | 39,575 |
| 75 | 66 | 5,021 | 17,561 |
| 50 | 145 | 11,068 | 85,329 |
| 25 | 436 | 33,291 | 771,934 |
| Total | 1273 | 97,172 | 914,399 |

**Table 9** Calculation results for the sea water temperature 15 °C

| Main engine loads (%) | Wasted energies (MWh/year) | Wasted energy costs ($/year) | Released $CO_2$ emissions (t/year) |
|---|---|---|---|
| 100 | 937 | 71,530 | 88,652 |
| 75 | 82 | 6241 | 27,131 |
| 50 | 178 | 13,592 | 128,670 |
| 25 | 636 | 48,521 | 1639,814 |
| Total | 1833 | 139,884 | 1,884,267 |

**Table 10** Calculation results for the sea water temperature 13 °C

| Main engine loads (%) | Wasted energies (MWh/year) | Wasted energy costs ($/year) | Released $CO_2$ emissions (t/year) |
|---|---|---|---|
| 100 | 1131 | 86,303 | 129,052 |
| 75 | 92 | 7,042 | 34,536 |
| 50 | 203 | 15,498 | 167,287 |
| 25 | 656 | 50,043 | 1,744,267 |
| Total | 2082 | 158,885 | 2,075,142 |

The table 8 shows a similar property with table 7. Only the numerous are varies. For instance the wasted energy is 626 MWh per year in totally on the container ship while the sea water temperature is equal to 18 °C. It can be understand from the table 8 cost of wasted energy is approximately 97,172 $ per year in totally. However the ship released about 914,399 tones $CO_2$ per year to atmosphere due to the waste energy. If compared the tables of results, it can be say that there are adverse relations between sea temperature and waste energy, waste costs and $CO_2$ emission release. For instance while the sea water temperature equal to 20 °C, the total waste energy is equal 932 MWh per year; on the other hand while the sea water temperature equal to 18 °C, waste energy increasing about 341 MWh per year.

The table 9 and 10 are also similar with table 7 and 8. The waste energy and waste energy costs are 1833 and 2082 MWh per years in the sea temperature 15 °C and 18 °C, respectively. Additionally, the wasted energy costs are 139,884 $ per years and 158,885 $ per years, respectively.

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# A DECADE OF DELAY IN RATIFICATION OF THE BALLAST WATER MANAGEMENT CONVENTION AND FURTHER UNDERLYING PROBLEMS

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**Abstract.** Ballast water is a major transport mechanism responsible for the introduction of invasive aquatic species to marine ecosystems around the world. The threat posed by ballast water for future spread of aquatic organisms has been a concern for the international community since the early 1990s.

The International Maritime Organisation introduced the Ballast Water Management Convention in 2004. Global enforcement of this Convention will occur after ratification by at least 30 countries representing not less than 35% of the gross tonnage of the world's merchant shipping. However, after over a decade the tonnage requirement has not been reached and the Convention has not yet entered into force.

The unfamiliarity of stakeholders with multi-dimensional issues of Ballast Water and the lack of technological knowledge has created resistance to ratifying the Convention and hence a delay of over a decade. Collecting representative samples and developing reliable detection tools has been identified as causing delay to the implementation of the BW Convention. However, solutions have been sought for many of the initial Ballast Water issues but not all. This paper discusses three main issues in greater detail: 1. treatment systems, 2. sample size and 3. sample analysis, describing and highlighting the importance of certain underlying problems that still exist and may continue even after implementation of the Convention.

**Key words:** ballast water Convention, enforcement, delay, compliance

## 1 INTRODUCTION

The first reported marine introduction was the Asian phytoplankton algae *Odontella sinensis (syn: Biddulphia sinensis)* in the North Sea in 1903 [21]. It was not until the 1970s that the scientific community began reviewing the problem in detail. In the late 1980s, Canada and Australia were among those countries experiencing particular problems with invasive species, and they brought their concerns to the attention of the Marine Environment Protection Committee (MEPC) at the International Maritime Organisation (IMO) [1].

Invasive aquatic species (IAS), such as the zebra mussel, lionfish, comb jellyfish and planktonic forms (bacteria, microbes, small invertebrates, eggs, cysts and larvae of various species), are one of the four greatest threats to the world's oceans [2]. However, climate change, over-fishing and oil pollution represents the biggest threat to the health of our ocean [37].

Shipping is reported to be responsible for the majority of aquatic organism movement as a sole vector (i.e. ballast water, hull fouling, sea chests) and combined with other vectors (including aquaculture, intentional release), e.g. [32]. The expansions of the Suez and Panama Canals will impact invasion rates through altering shipping traffic (e.g. [33]) and enhancing the potential for natural dispersal [34]. While climate change can impact the range of native organisms, it can also aid invasive species by providing a suitable climate for the organisms to spread further [35]. The shipping industry is continually growing and in the future the number of organisms vessels transport may continue to increase. The ballast water capacity of a vessel varies as a function of the cargo carrying capacity and ship type, with an average value of 33 % of the vessel's DWT [22]. At the time this paper is written the world seaborne trade amounted to around 9.5 billion tonnes of cargo per annum [23].

The effects of invasive species in many areas of the world have been devastating and in many cases their damage to the environment and local economies can be irreversible, e.g. [29 – 31]. In one well-known case the comb jelly, *which* was first recorded in the Black Sea in 1982, spread rapidly to the Azov, Marmara and Eastern Mediterranean Seas. Towards the end of 1999 it was recorded in the Caspian Sea where its biomass eventually exceeded levels ever recorded in the Black Sea. It had a devastating impact on commercial fisheries as it competed for food with local species. Landings of anchovy dropped to one-third of their previous levels and caused losses of around $500 million per year. Similar reductions in the biomass of kilka were experienced in the Caspian Sea [2].

The IMO took the lead in addressing the transfer of IAS and developed Guidelines through the MEPC in 1991 [3]. The IMO Assembly supported the move by adopting a resolution [4] in 1993 and invited the member states to adopt a subsequent resolution [5] in 1997. After many years of debate over ballast water's (BW) complex issues, and with hope of a significant step towards protecting the marine environment, the IMO adopted the International convention for the control and management of ships' ballast water and sediments [6] in 2004 (hereafter referred to as the "Convention"). The estimated amount of BW transported at the time was around 3 billion tonnes every year [7].

The defined criteria to bring the Convention into force have still not been achieved after a decade, underpinning the difficulties associated with implementing these regulations.

Figure 1 highlights the challenges that have been encountered in implementing the convention since 2004. In efforts to minimise future invasions due to BW two important regulations were formed: Regulation D-1 (BW Exchange Standard) and Regulation D-2 (BW Performance Standard). Regulation D-1 requires vessels to exchange their ballast water while in the open ocean during transit. This process replaces coastal water picked up in the port of origin with oceanic water containing organisms that should be less well adapted to survive in the port conditions at the destination. BW exchange has been in mandatory use for many years now, and thus associated problems have been identified and solutions developed. The shipping industry and in particular, seafarers were familiar with the operations expected from D-1. The second regulation, D-2 is based on a defined concentration of live organisms that can be present in BW at the point of discharge. In order to obtain this concentration of live organisms, vessels must employ treatment systems to kill individuals present in ballast water. The unfamiliarity of stakeholders with multi-dimensional issues of Ballast Water and the lack of technological knowledge created a resistance to ratifying the Convention and hence a delay of over a decade. This paper describes several issues that have delayed ratification of the Convention and highlights the importance of certain underlying problems that still exist and may continue even after implementation of the Convention.

The Convention will enter into force 12 months after ratification by 30 States, representing 35 percent of world merchant shipping tonnage. The current status by August 2015 indicates ratification of 44 states having 32.86 percent of tonnage. However, a number of additional countries with an aggregate of more than 2% of the tonnage have indicated their intention for ratification, which may accede to this Convention in the near future.

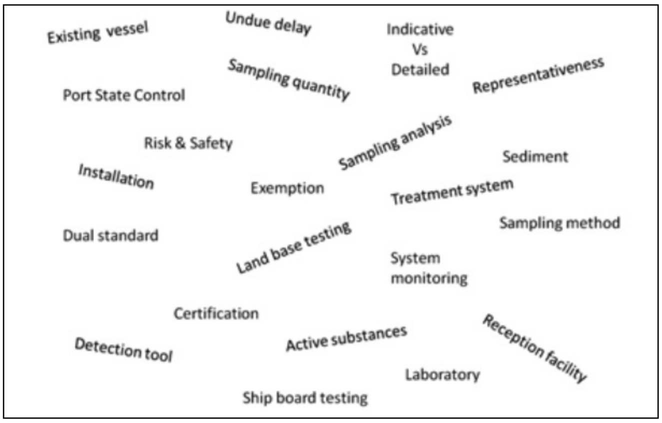


**Figure 1** Challenges at the time of introduction of Convention in 2004

The Convention was drafted with an implementation schedule and since it is clear that Entry Into Force (EIF) will not occur before 2016, therefore, the latest position on compliance as per the IMO-Resolution A.1088(28) is:

| | |
|---|---|
| All ships over 400 GT | To comply with the D-2 standard |
| With keel laying dates before EIF | On her first IOPP renewal survey after EIF |
| With keel laying dates after EIF | On delivery |

## 2 OVERVIEW OF THE LAST DECADE

There will be several complications in compliance monitoring at the time of introducing BW Convention. Evaluating ballast water treatment technologies installed on vessel, including issues with sample size and sample analyses [24] are three main concerns, which have been very difficult to resolve. Scientific and technical research would play an important role in addressing these issues. The Convention also required a review to be undertaken to determine whether appropriate technologies are available to achieve the discharge standard.

### 2.1 Treatment systems

In order to standardise the approval of ballast water management systems the IMO introduced the G8 guidelines: "Guidelines for approval of ballast water management systems". Many of the developed systems were expected to use Active Substances (e.g. biocides, chlorination) and therefore the IMO introduced a two-tier approval process including separate evaluations of the treatment system and the active substance. The G9 Guidelines ("Procedure for approval of ballast water management systems that make use of active substances") were developed to ensure that active substances utilised by certain ballast water management systems do not pose an unreasonable risk to the environment, human health or resources.

Initially industry used existing water treatment technologies e.g. UV light and chlorination, on ballast water to determine their efficiency in treating marine organisms. This was considered to be a shorter route to finding a solution as the technologies had already been used successfully in a range of applications, e.g. purification of swimming pool water, drinking water, irrigation water and aquaria.

Currently, there are reviews that have used vendor supplied survey information or data to evaluate the availability and potential efficiency of these systems [25]. Due to the inherent complexities in determining the efficacy of ballast water treatment systems, an overview of their capabilities is given in the next section. Some of these systems were less successful in the initial stages of defined projects [26], and some could not pass the rigorous land-based testing. However, a few technologies were more promising and current systems in the market are mostly designed and manufactured based on those technologies.

BWTS are broadly based on three main processes: physical separation, biocidal treatment, and physical-chemical processes. This section discusses two biocidal treatment systems (Hydrogen peroxide & Ozone) and three systems using physical-chemical processes (Heat treatment, Biological de-oxygenation and Ultraviolet irradiation). Some BWT systems incorporate a combination of these processes.

**Heat treatment**

Heat basically appeared to be an effective solution in treating IAS and there are good records of the projects that have researched thermal treatment. One of the advantages of using this treatment is the availability of a large quantity of wasted heat on board every ship. That could be an attractive option for many owners as installing such a system would be more economical to run.

In one of the European projects MARTOB [8], the effects of temperature on phytoplankton and zooplankton were tested under laboratory and ship board conditions. The results indicated that high temperature was effective, however, experiments carried out at lower temperatures (40° and 45°C) resulted in a significantly lower reduction of chlorophyll *a*. Temperatures of 50°C and above were more efficacious at reducing phytoplankton biomass [9]. In theory, exposure to high-temperature treatment for a few seconds could be sufficient to cause the denaturation of organisms in ballast water, but a necessity for any high-temperature treatment option is steam. Given the amount of BW to be treated, this option was not economically feasible and hence was not welcomed by the industry.

**Biological de-oxygenation**

The aim of this approach was to develop a de-oxygenation process that could be applied in large-scale and used efficiently on selected organisms. Biological de-oxygenation is based on the fact that the addition of nutrients to ballast water will stimulate the growth of the bacteria in the ballast water. The growth of the bacteria will consume the available oxygen in the water, and when the ballast water becomes anoxic, organisms that require a steady supply of oxygen will die.

In a series of laboratory studies, biological de-oxygenation of the seawater killed all added zooplankton species [27]. The killing rate increased with increasing time under anoxic conditions while available oxygen in the seawater decreases. Temperature variation plays an important role in mortality rate and treatment could be as long as 3-4 days at 4°C.

In another approach, the uploading BW is mixed with the low-oxygen gas (inert gas) to strip out the dissolved oxygen. Therefore, the system establishes low oxygen equilibrium in the ballast tanks. This system was suitable for tanker ships that have an inert gas generator and could avoid the high costs of installing a complete BWTS.

Published research suggests the killing effect on phytoplankton in both systems was limited and the change in the concentration of chlorophyll *a* was not significant. The addition of inorganic substances with possible consequences on metal corrosion and coatings was another source of uncertainty and a considerable increase in the concentration of bacteria made biological treatment methods less attractive to industry.

**Oxicide treatment**

Hydrogen peroxide ($H_2O_2$) is an oxidising compound and can be produced by an electrochemical conversion of dissolved oxygen in an electrochemical reactor. Hydrogen peroxide is known to be of limited risk to humans, but at low concentrations it can prove toxic to plankton and microorganisms [10]. It has been used in to treat swimming pool water as an alternative to chlorine based disinfectants. It decays within a period of days to a few weeks [11], and breakdown results in the formation of water and oxygen. Therefore, it was considered to be a good solution for the BW treatment.

Application of Oxicide on BW was promising and the result of tests on zooplankton indicated a high kill rate [12]. A higher concentration of $H_2O_2$ was required for some species. Unfortunately, exposure of phytoplankton to Oxicide did not provide an intense kill rate and therefore, this technique was not recommended for BW treatment. In addition, the production of $H_2O_2$ significantly increases the Redox potential of the water, which has a negative effect on the metal in terms of corrosion and coatings.

**Ultraviolet irradiation**

Ultraviolet (UV) light uses short wavelength to kill or inactivate microorganisms [13]. It is effective in destroying the nucleic acids in these organisms so that their DNA is disrupted by the UV radiation, rendering them unable to perform vital cellular functions. Since UV had been employed to sterilize drinking-water and waste-water, it was a good solution to destroy or render the BW microorganisms inactive.

At the time of introduction of the Convention, it was known that UV disinfection was more effective on bacteria and viruses, yet the effectiveness had to be tested for zooplankton and phytoplankton. Stehouwera have showed by experiment [36] that organisms can regrow after treatment by the BWTS using UV radiation when provided with optimal growth conditions. This means that the risk of invasive species is not eliminated by ballast water treatment.

**Ozone**

An ozone generator uses ambient air and concentrates oxygen content through a nitrogen stripping process, producing Ozone ($O_3$) by a high frequency electrical field. The Ozone is then injected into the incoming ballast water to oxidize and destroy the aquatic organisms. Ozone is a powerful oxidizing agent that reacts with other chemicals in seawater to form Total Residual Oxidants (TRO). TRO is composed of hypobromous acid and a hypobromide ion and can effectively neutralise viruses, bacteria, algae and organic material.

One major drawback of using ozone for BW treatment is that it impacts corrosion rates. There are certain materials that are not recommended for use with ozone, e.g. ozone can break down carbon steel within days or even hours of use and therefore is unsuitable for BWTS. However, in cases where ships take on fresh water as ballast brominated compounds are not formed, and the Ozone alone acts as the Active Substance.

**2.2 Current technology for BWTS**

To date a number of techniques have been proved to treat ballast water effectively. It seems that the technological barrier for treating ballast water has been removed and systems are progressing through the approval processes for global use. MEPC has conducted a number of such reviews and agreed that appropriate technologies are available to achieve the standard contained in regulation D-2 of the BWM Convention.

In addition to the plankton suspended in the water column ballast tanks contain sediment deposits home to benthic organisms and the resting stages of plankton (e.g. diatoms and dinoflagellates). A further challenge to BWTSs is to effectively kill the viable organisms present in this sediment. Little research has been published on the efficacy of different technologies to treat resting stages, e.g. [36] and [37]. As treatment systems are approved and put into use vessels must address the presence of these ballast tank sediments as a habitat for viable organisms.

Filtration effectively removes sediments and larger aquatic species from the ballast water, and can enhance the effectiveness of a secondary treatment step, e.g. UV light.

Thus, filtration has become routinely implemented in BWTSs. Many of these filtration technologies are geared with an automatic self-cleaning mechanism to improve efficiency without interrupting ballasting operations. Hence, the majority of BWTSs available on the market consist of two main configurations:

– Filtration and UV
– Filtration and biocide.

**Filtration + UV**

This combination provides a better robust and reliable system. The current filters are capable of removing organisms above 25 microns and can handle high sediment loadings. Automatic back-flushing keeps the ballast flow rate high in a low differential pressure, allowing the use of standard ballast pumps. Subsequently, UV disinfects the BW effectively by killing the organisms without any chemical additives.

Nevertheless, there are still challenges in optimising the UV system design. Several approved systems may not be able to cope with the low UVT in turbid water, where the difference in performance can be significant. Turbidity is a condition that ships meet in real operation. Power requirements are high and even systems capable of treating BW with lower UVT consume a lot of energy.

**Filtration+ Biocide**

These types of systems have grown faster in the market due to some advantages: require lower initial investment, energy consumption, maintenance and operation. Systems that employ electro-chlorination have resolved the disadvantage of storing chemicals on board by producing the biocide using seawater.

In one of the two-stage treatment system shown in figure 2, particles, organisms and sediments are separated during BW upload with the means of mechanical filtration. In the second step, the hydroxyl radicals produced by the electrolysis cell disinfect the BW, killing bacteria and organisms, prior to transferring it to the BW tanks.

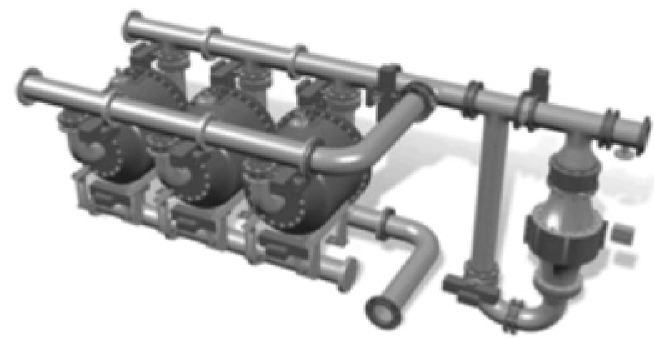

**Figure 2** Two stage BW treatment system: filtration and electrolysis. Courtesy of RWO, http://www.veoliawaterst-sea.com/industries/others/marine/

An alternative method uses sodium hypochlorite for the BW treatment. After filtration, the system electrolyses seawater to produce high concentration of sodium hypochlorite solution for disinfection. Sodium hypochlorite is widely used as a general-purpose disinfectant with proven safety and global availability. However, if active oxidants are detected to be higher than a set level during de-ballasting the BW must be neutralised prior to discharge. This therefore requires additional chemicals to complete the treatment process.

## 3 SAMPLING: A REQUIREMENT OF CONVENTION

At the time the Ballast Water Management Convention was introduced there was no standard protocol for on-board testing. Thus, sampling methods and detection technologies were the primary concern for verifying compliance. Ships are subject to inspection in ports as per the Convention's requirements and a port state control officer may collect samples of the ballast water. A standard sampling method to detect whether or not a ship's ballast water meets the Discharge Standard must be developed.

A suitable method should be rapid to allow multiple replicate samples to be collected and analysed for statistical accuracy. It is always difficult to draw conclusions from an individual sample because the outcome is influenced by the natural variation of species in BW. It is even more uncertain when the sample is turbid as this can make detection extremely demanding and time-consuming.

Some of the initial challenges were to identify appropriate sampling techniques, equipment and standardised protocols that are universally acceptable and scientifically verifiable. It was also necessary to identify sampling points on-board ships, sampling equipment and ballast tank locations, in order to assess and provide a frame-of-reference with which the on-board sampling regimes can be benchmarked [14]. Several criteria had to be defined such as: accessibility, safety, cost, simplicity, support, training, time, representativeness and interferences.

Approaches by individual parties to find solutions carry with them various limitations of different measures, since the "Guidelines for ballast water sampling (G2)" provided only general recommendations. Nine years after the introduction of the Convention a technical discussion [15] was issued to be employed for enforcement. This discussion provided background information on the development and use of methodologies for both indicative and detailed analysis. It also includes appropriate sampling method as well as analysis of the sample at an accredited laboratory.

### 3.1 BW sampling and analysis

Since sampling and associated analysis is a complex issue the guidelines highlight two performance steps to simplify the process: 1. detailed analysis and 2. indicative analysis.

### 3.2 Detailed analysis

The Convention states that representative samples must be collected to determine whether a vessel's ballast water meets the D-2 standard. To be considered representative the samples collected should be of sufficient quality and quantity to provide a precise measurement of organisms' concentration in the entire ballast water discharge [16]. However, developing a protocol to achieve this has been a challenge since the Convention was introduced. In order to simplify the process and avoid performing detailed analysis on every vessel, indicative analysis was introduced.

The MEPC guidelines [15] have defined 10 detailed analysis methods for use when testing for compliance with D-2 standard; yet level of confidence or detection limit and citation for validation studies of each method needs to be determined. It indicates that not only the complication in analysis has caused over a decade of delay but also there is still a long way to go in order to convince the stakeholders on a unified approach.

### 3.3 Indicative analysis

Indicative analysis was introduced as a first step to establish whether a ship is potentially compliant with the D-2 Regulation [16]. This analysis is used as a means of screening and does not supersede detailed analysis for the final judgment. A dispute could arise if indicative analysis is positive and a ship detained, but detailed analysis shows the ship is fully compliant with the D-2 standard. In such cases, there is a possibility that the port State and/or port authority would be challenged or sued by the shipping company as a result of the indicative analysis being incorrect [17].

The MEPC guidelines have defined eight indicative analysis methods for use when testing for potential compliance with D-2 standard [15], yet the level of confidence or detection limit and citations for validation studies are still to be determined. It is a similar case as for the detailed analysis, where no international protocols for analysis thus far have been introduced.

Many options are now available for indicative analysis after a decade of research considering all the potential methods, but each of them suffers from one or more issues in terms of practicalities, applicability or limitations [15]. Some of these methods are: Adenosine triphosphate (ATP), chlorophyll *a*, dissolved oxygen levels, residual chlorine levels and nucleic acid [15]. Detection tools are still under development and some of the advanced technologies that have great potential are:

- FlowCam (Fluid Imaging Technologies)
- MALDI-TOF (Matrix Assisted Laser Desorption/Ionization-Time Of Fly)
- Ovizio microscopes, based on 'Differential Digital Holography'

Sampling is required for compliance inspection should there be any doubt about the quality of BW treatment throughout the ship's passage. There are many ways to prove whether the discharge of a ship is meeting the D-2 standard, but they are limited to the requirements of the methodologies available for sampling the BW discharge. The MEPC guidelines [15] have defined five general approaches for sampling but the sample error and detection limits are still to be determined.

The organisms present in ballast water tanks are known to be heterogeneously distributed throughout the tanks [28], and therefore, ballast drawn from a discharge with a population varies significantly. So after a decade of discussion the challenge remains to determine the volume of water that must be sampled to accurately assess compliance and identify methods to collect and analyse these samples.

## 4 CONCLUSIONS

The applicability of each ballast water treatment is limited by factors such as cost, biological effectiveness and possible residual environmental toxicity. It has been a long process to develop a mature system and thus build the confidence in the stakeholders. The lengthy process has been a major drawback and delayed the enforcement of the Convention. However, some technologies proved to be efficient and a number of systems are now on the market.

Sampling analysis was the focus of the BW Convection since the beginning, and many guidelines have been established by the IMO to address this issue. However, the proposed methods are not comprehensive enough to be acceptable worldwide. There is a definite need for a standard sampling protocol, which would be applicable to every port and received by each party.

Further study should be undertaken to establish sampling size, since this issue has not been resolved yet. The large sample size is always in contrast with avoiding undue delay to the vessels activities, which has been well emphasised in the Convention. Research is still needed to develop an innovative assessment method, which automatically takes and analyses samples. Ideally, technologies will be developed that can analyse the sample during discharge events and enable crew to stop discharge if the system shows an exceedance of the D-2 Discharge Standard.

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# TECHNICAL AND ECONOMIC STUDY OF LNG DIESEL POWER (DUAL FUEL) SHIP

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**Abstract**. LNG (Liquefied Natural Gas), a substitution of crude oil, is a clean energy and has witnessed a rapid development since its first application in shipping industry at the beginning of this century. Generally, fuel costs account for nearly 20-50% of the operation cost in a particular shipping company. Due to IMO's regulation on reduction of emissions of sulphur oxides, the required sulphur maximum content in fuel needs to drop from 4.5% at present to 0.5% by 2020 and from 1% down to 0.1% at present in Emission Control Areas (ECAs) for example Baltic and North sea. It's an urgent issue for shipping companies to cut emission and fuel consumption by using a cleaner fuel—mostly LNG to replace. Although major roadblocks still exists as lack of bunkering supply system and loss of cargo space occupied by LNG tanks, LNG as a ship fuel has great potential: Clean burning which meets all current and future emission standards, lower cost than diesel fuel and manageable vessel regulatory issues. Since pure LNG power ships are expensive in building which most carriers cannot afford, many new-buildings are LNG and diesel hybrid technology, so called dual fuel. This article mainly proposed three technically effective alternatives to satisfy the current and future emission control regulations and laws in shipping. LNG-diesel dual fuel power technology was introduced through feasibility study on several aspects including research development, retrofitting methods, vessel type, safety issues and other technical characteristics. Based on sample ship and route, I conducted economic evaluation on these three alternatives. Cost-effectiveness of each project was detailed in the calculation of net present value(NPV) and payback time via discount cash flow method. The findings show that LNG-diesel dual fuel power technology performs best among three alternatives. Due to the impact of fuel price on the conclusion, two scenarios were carried out in sensitivity analysis which witnessed a variation of NPV with the fluctuation of fuel price. 29.31% oil fuel slump and 35% LNG fuel rise are the turning point between project I and project III, left project II the least cost-effective method in three alternatives. And further study is recommended for the deficits of this article.

**Key words**: LNG, dual fuel, net present value

## 1 INTRODUCTION

Recent years has witnessed a growing attention on environment protection. Governments formulated several measures to reduce air pollution. In shipping industry, particularly, there are EN 2005/33/EC from EU Directive, MARPAL(Marine Agreement Regarding Oil Pollution And Reliability) convention made by IMO(International Maritime Organization) and CARB Title 13/17 in California USA, all of which stipulated a detailed schedule and technical guide for emission control of shipping. (See table 1)

From the picture above, we can see that this year a stricter emission control on Sulfur Oxides(SOx) has come into effect in the so called ECA(Emission Control Area) area where the sulfur content will be restricted in 0.1%, while 0.5% is allowed worldwide until 2020. What's on the way is the limitation on Nitrous Oxides(NOx) with the operation of IMO Tier III from next year, see Figure 1 below.

Under this circumstance, companies and shipowners usually have three alternative choices to overcome the environment regulations. Firstly, remain current ship state and reduce SOx and NOx emission respectively through technical means like add a scrubber and SCR(Selective Catalytic Reduction) system. Secondly, change the bunker fuel refined to lower sulfur content and add SCR system. Thirdly, using new energy like liquefied natural gas(LNG) as ship fuel. All these three alternatives are proved to meet the requirements of emission regulations and laws.[2]

North Europe is the cradle of LNG technology on board the ship. Det Norsk Veritas(DNV) ship classification society, now merge with Germanischer Lloyd(GL) as DNV·GL, is the pioneer to classify LNG fueled ships and enjoy a large share of its world fleet. However, LNG fueled ships are still a regional product due to many reasons such as lack of bunkering supply system and loss of cargo space. Most studies mainly focus on environmental, technical and economic issues.

Environmentally, LNG is acknowledged as a clean fuel with no SOx and little NOx emission that complies with all the current and future regulations. But problem occurs when applied to a normal diesel engine. The so called CH4 'slip' will increase the pollution of greenhouse gases. Only the slip controlled in 2% or less can highlight the advantage of LNG in environment protection.[2]

Technically, about the physical and chemical characteristics of LNG, Jerzy Herdzik's research found that the burning speed is too slow to use in a diesel engine directly, instead, a spark ignition engine don't have such problems.[10] However, with the increment of engine load, risk of energy loss and self-burning may rise and the jet system need to make a retrofit accordingly.

**Table 1** Emission Control Regulations & Conventions

| Regulations/convention | S% | Date into execution | area |
|---|---|---|---|
| MARPOL VI | 3.5 | 2012.1.1 | Out of ECA |
| | 0.5 | 2020.1.1 | |
| | 1 | 2010.7.1 | In ECA |
| | 0.1 | 2015.1.1 | |
| EU | 0.1 | 2010.1.1 | EU ports |
| CARB | 1.5 | 2009.7.1 | 24 nm off California coast and within ports |
| | 0.5 | | |
| | 1 | 2012.8.1 | |
| | 0.5 | | |
| | 0.1 | 2014.1.1 | |
| | 0.1 | | |
| S% of 1.5 and 0.5 aim at MDO and MGO respectively | | | |

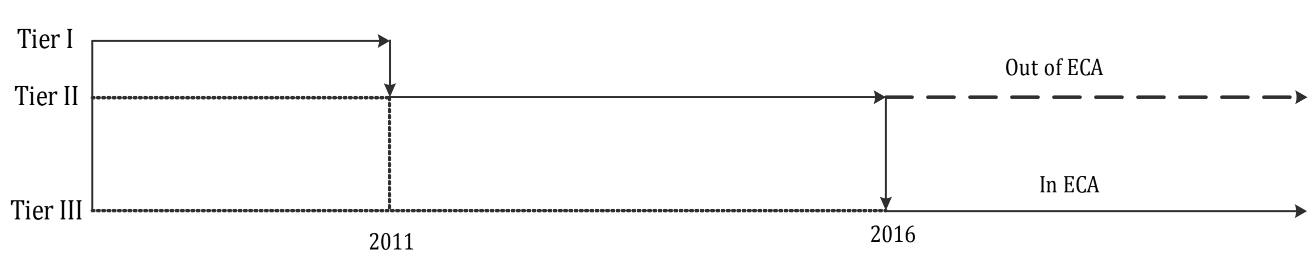


**Figure 1** Time Schedule of IMO Regulation for NOx

Economically, compared with traditional bunker fuel, LNG has a lower price at most scenario and the operation cost of a ship, either. Quantitative analysis show that the annual fuel and maintenance cost may decrease by 39% and 40% with LNG instead of diesel oil.[1]In contrast with the high fluctuation of heavy fuel oil(HFO) affected by many factors like political and regional issues, LNG price is more stable from a historic view which implies LNG as a good alternative for traditional fuel.[10]

Meanwhile, Transport Research Board(TRB)'s report about LNG as ship fuel made an elaborate of the ship type, propulsion options, LNG fuel system and bunkering, operation and design of LNG fueled container ships.[3] It indicates that suitable ship types for LNG power are restricted in tug, ferry and other short route or coast sailing ships. Further, construction and equipment costs as economic analysis factors were compared between two container ships around 1000TEU, one in LNG fuel and the other in marine gas oil(MGO). Statistics show the construction cost of LNG powered ship is 20% higher than its counterpart but will be covered by its fuel cost savings and other environmental value, for example, LNG don't have to pay the carbon tax and have tax concession in some ports as an incentive.

GL ship classification society and MAN the engine builder jointly conducted a cost-effectiveness analysis of LNG as fuel on container ships with a size range from 2500TEU to 18,000TEU.[7] Four technical solution were proposed as Scrubber, Scrubber and Waste Heat Recovery(WHR) System, LNG system and LNG with WHR system. The findings shew that sailing time in ECA, price spread between LNG and oil and retrofitting cost were the main factors affecting shipowners' decision making. And when the price of LNG comes lower or equals HFO(Heavy Fuel Oil), 2500TEU container ship is in a better economic scenario.

On the other hand, the world crude oil price experienced a big slump since the latter half of year 2014 that gave breath to the depressed shipping market. The drop of crude oil price directly led to a decrease of bunker fuel taking up more than 50% of the operation cost of a liner shipping company. So price of bunker fuel immediately affects the profit of a shipping company. But there is a small probability that the fuel price stay low after this period due to the diversification of effect factors of oil price from production process to geopolitics resulting in intense price fluctuation. Companies have to find another way out to lock their cost for risk control. Then comes the application of new energies as wind, solar, fuel cell, LNG and so on. Most of which are under construction and feasibility studies that do not adapted to modern merchant shipping except LNG. Comparatively, LNG is in a more mature market as LNG carriers have existed for decades. Although major roadblocks still exists as lack of bunkering supply system and loss of cargo space occupied by LNG tanks, the application of LNG as a hybrid fuel on board is on its way in non-LNG carriers and excepted to have a prosperity in the near future.

Above all, researches about LNG as ship fuel have made progress. LNG-diesel dual fuel was accepted by the industry and expounded and proved in reality which shew better environment protection and cost-efficiency. Nevertheless, thanks to low price of oil fuel at present, environmental regulation under formulation and extra cost for new technology, LNG is only a regional solution especially in north Europe. At the same time, little studies focused on the effect of price fluctuation on cost efficiency of LNG diesel fuel ship, nor did on bigger ships. Based on these situations, this article try to make a further step on the techno-economic study about ocean transportation LNG diesel dual fuel power ships and other technical alternatives complying with present and future emission regulations and the effect price factor in these alternatives.

## 2 METHOD

In order to highlight the cost-efficiency of new technologies, three common alternatives complying with current and future emission control regulations talked above are introduced hereunder:

(i) IFO+Scrubber+SCR

(ii) Diesel+SCR

(iii) LNG-diesel dual fuel

For (i), it means remaining current ship state in Intermediate Fuel Oil(IFO) and reducing SOx and NOx emission respectively through technical proposals by retrofitting a scrubber and SCR(Selective Catalytic Reduction) system. (ii) suggests to change the bunker fuel refined to lower sulfur content here called diesel, Marine Gas Oil(MGO, 0.1%S) or Marine Diesel Oil(MDO, 0.5%S), then retrofit a SCR system. (iii) uses liquefied natural gas(LNG) as main power fuel and diesel as auxiliary fuel in a dual fuel engine like Wärtsilä X92DF.[13]

We selected a real vessel operating on Asia-Europe route as our sample ship, COSCO VIETNAM, to conduct the cost-efficiency analysis. COSCO VIETNAM is a 8501TEU container ship operated by COSCO(China Ocean Shipping Group Company) on its Line NE6 start from port of QINGDAO to Port of HAMBURG at north Europe via the Suez canal with a round voyage in 77 days. Particular parameters see Table 2 & 3 below.[5, 14]

**Table 2** Voyage Schedule

| Port of call | ETA | Time | ETD | Time |
|---|---|---|---|---|
| QINGDAO | Sat | 0 | Sun | 1 |
| GWANGYANG | Tue | 3 | Thu | 3 |
| PUSAN | Wed | 4 | Tue | 5 |
| SHANGHAI | Fri | 6 | Sat | 7 |
| YANTIAN | Mon | 9 | Tue | 10 |
| SINGAPORE | Fri | 13 | Sat | 14 |
| ALGECIRAS | Wed | 32 | Thu | 33 |
| HAMBURG | Mon | 37 | Wed | 39 |
| ROTERDAM | Thu | 40 | Sat | 42 |
| LE HAVRE | Sun | 43 | Mon | 44 |
| ALGECIRAS | Thu | 47 | Fri | 48 |
| SINGAPORE | Thu | 68 | Thu | 68 |
| YANTIAN | Tue | 73 | Tue | 73 |
| QINGDAO | 周六 | 77 | | |
| ETA/ETD:: Estimated time of arrival/Departure | | | | |

**Source:** www.cosco.com

**Table 3** Ship Parameters

| | |
|---|---|
| Capacity | 8501 TEU |
| LOA | 334 m |
| Lpp | 319 m |
| B | 42.8 m |
| D | 14.61 |
| Main engine output (Total) | 68,530 mkW (97 rpm) |
| Auxiliary output (Total) | 11,000ekW (60 Hz) |
| Fuel consumption | 250 t/day (24.5 knot) |
| Chartering rate of sister ships | 24,000 $/day |

**Source:** Clarkson

Table 4 lists the engine output, fuel consumption rate and switch of fuel of each project. (i) and (ii) remain the diesel engine while (iii) is retrofitted to a two stroke dual fuel(DF) engine with a load decline to 58,400kw according to Masaki Adachi's research.[12] Given a ten years' evaluation time, the operation program is divided into two phases, five years each, mainly on the different fuel decision out of ECA due to the upcoming emission regulation in 2020. The first phase is shown as 'out of ECA (1)' which represent year 2015 to 2020 and 2021 to 2025 as 'out of ECA (2)' in Table 4. As described above, project (i) still use the bunker fuel of current quality, most IFO380 in practice, what so ever, in or out of ECA during the whole time schedule. For (ii) and (iii), IFO will be applied out of ECA in first phase and MDO with 0.5% S will replace as one of the dual fuel while MGO with 0.1% S is accepted in ECA during both two phases.

**Table 4** Engine Parameter and Fuel Choice

| Project | (i) | (ii) | (iii) |
|---|---|---|---|
| **Main engine** | | | |
| **Type** | **Two-stroke diesel** | **Two-stroke diesel** | **Two-stroke DF** |
| Total output | 68,530 KW | 68,530 KW | 58,400 KW |
| Fuel rate (g/kwh) | 152 | 152 | 174 |
| **Auxiliary** | | | |
| Type | Diesel | Diesel | Dual fuel |
| Units | 4 | 4 | 4 |
| Per output | 2750KW | 2750KW | 2700KW |
| Fuel rate (g/kwh) | 197 | 197 | 217 |
| **Fuel** | | | |
| In ECA | IFO | MGO (0.1% S) | LNG+MGO |
| Out of ECA (1) | IFO380 | IFO380 | LNG+IFO380 |
| Out of ECA (2) | IFO380 | MDO (0.5% S) | LNG+MDO |

**Source:** Author and asaki Adachi etc.

Moreover, we have to notice that LNG as ship fuel has special requirement for storage. As per IMO's regualtion, Type C storage tank should be used to reduce the percolation of heat and thus vaporization of LNG. Due to the fact of inevitable vaporization when LNG bunkering, 100% bunkering cannot be promised, so here we see a ratio of bunkering at 93.6% according to asaki Adachi's study. So the capacity of the tank should be 14,583 cubic meter at least convert from the equation, 1.2 cubic meter LNG = 1 kg oil fuel, and depending on statistics of Figure 3 & 4.

In order to simplify the calculation, the Boil off Gas are completely and nicely used in working of boiler and SCR burning system.

## 3 COST-EFFICIENCY ANALYSIS

Cost-efficiency analysis are adapted to measure the difference among three alternatives and divided into three parts: retrofitting cost, operation situation and fuel cost. There are some assumptions in this article:

1. Time in calculation is 10 years, that means depreciation expense are divided into ten equivalent parts in each year and the scrap value of each alternative will be 0 $ after 10 years.

2. Unit price to retrofit main engines, auxiliaries and accessories, as per market price, 0.5 $/w in (ii) and 0.55 $/w in (iii) [12]

3. Unit cost of SCR system is 50 $/kw [4]

4. Cost of LNG and Scrubber system refer to Triality's study of a VLCC [8]

5. Discount rate i = 10%

6. Ignore the consumption of igniting fuel (only 1% of total consumption)

7. Mixing ratio of gas and fuel is 7:3 and apply to the whole voyage.

### 3.1 Retrofitting cost

Based on the statistics of Figure 3 & 4 and assumptions above, the retrofitting cost of main engines, auxiliaries, Scrubber, SCR and LNG systems are calculated below, in Table 5, the price spread between project (i) and (ii) is 440 m$ and 1131.6 m$ between (ii) and (iii). The retrofitting cost of LNG system seems to be far more higher than the other two alternatives.

### 3.2 Operation situation

Operation situation in this article including annual revenue and operation cost of emission control system. With regard to liner shipping practice, income mainly comes from the freight revenue while the cost contains shipping maintenance, harbor dues, crew fee, insurance, so on so forth. For the reason given above that his article focus on project evaluation, so we hereby ignore these costs and take the operation cost of the retrofitting systems into account only.

As freight revenue equals freight rate times freight volume (in TEU), we need to know freight rate and volume on the Asia-Europe route. The latest report of UNCTAD[6] and Clarkson [5], the annual container freight rate from Shanghai to north Europe are listed in Table hereunder. (2015 is the first quarter of this year) Excluding the unusual value in 2010 and 2011, taking average of left 5 years, the average annual freight revenue is 1212 $/TEU. And we set the rate from north Europe to Shanghai is two-thirds of it, approximately 800 $/TEU based on market experience.

| $/TEU | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|
| SH-NE | 1395 | 1789 | 881 | 1353 | 1084 | 1172 | 1056 |

What's more, we choose the findings of Masaki Adachi in the handbook of Ocean Commerce that the loading factor of our sample ship is 76% from Asia to Europe and 34% conversely.

Depending on the study of MAN Diesel & Turbo, SCR system has a 0.3% capacity loss.[7] When it comes to project (iii), the LNG tank may occupy the cargo capacity directly by 471TEU converting from 14,583 cubic meter. And we can find the capacity loss on the annual revenue, see Figure 2.

**Table 5** Retrofitting Cost of Each Project

| Million $ | IFO+Scrubber+SCR | MGO+SCR | LNG+MGO |
|---|---|---|---|
| Main engine | 34.265 | 34.265 | 32.120 |
| Auxiliary | 1.375 | 1.375 | 2.700 |
| Scrubber | 4.400 | 0.000 | 0.000 |
| SCR system | 3.564 | 3.564 | 0.000 |
| LNG system | 0.000 | 0.000 | 15.700 |
| Total | 43.604 | 39.204 | 50.520 |

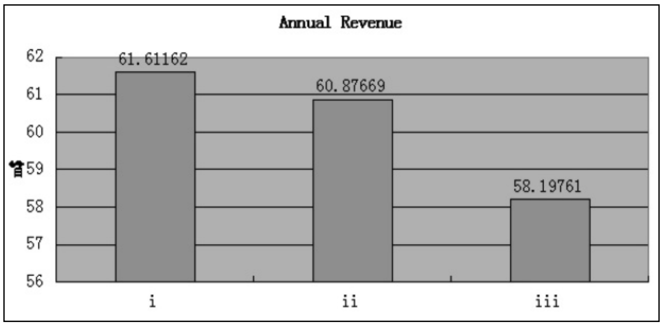


**Figure 2** Annual Revenue

With respect to the operation cost including the consumption of material and maintenance, each system has its own factors need to be considered.

A Scrubber is used to filtrate the sulfur in the exhaust gas. The operation rely on the sodium hydroxide consumption, pumping and water consumption. Unit all in cost of its operation are 6 $/mkwh, said by Wärtsilä. [13] Considering its working hour in ECA, this article set the starting point at port of Algeciras and end at the same port after its voyage back from port of hamburger. Refer to Table ?, its about 42.66 days in ECA, thus the annual cost of Scrubber system is 437,876 $.

The International Association for Catalytic Control of Ship Emissions to Air (IACCSEA) has lucubrated the efficiency and cost of SCR system, according to its report, the unit cost of the material, mainly urea, and maintenance are:

(1) Urea consumption: 0.063 $/kwh

(2) Maintenance: 0.01 $/kwh

So as the calculation of Scrubber system, the annual cost of SCR system is 5,327,490 $. Here we don't count the cost of LNG system. As Meike Baumgart said in their study [9], the LNG diesel dual fuel engine has a longer life time than other ordinary diesel engines which have a potential benefit for future utility, this may exceed the maintenance cost of all years.

### 3.3 Fuel cost

Given the fact shipping companies always always choose Singapore and Rotterdam as port of bunkering because of the comparatively low fuel price in Asia and Europe. To simplify the problem, we suppose shipping companies have fuel hedging to lock their fuel cost, so in this chapter, the fuel price is the average price in December, 2014. From the report of Bunkerworld [11] and Clarkson [5], we found the price of Singapore of different kinds of fuel: IFO380 = 366 $/t, MDO = 592.5$/t, MGO = 602.5$/t. And Rotterdam: IFO380 = 322.5$/t, MDO = 548.5$/t, MGO = 558.3$/t.

The price of LNG is estimated from the local market of Rotterdam who have realized the construction of LNG bunkering system invested by Shell last year and Singapore on Jurong island in 2013. As per ICIC's report, the corresponding price of LNG in those two ports are 332.8 $ and 249.6 $ per cubic meter respectively.

Above all, we got the annual cost of each alternative in Table 6.

## 4 NET PRESENT VALUE

Net Present Value (NPV) is defined as the sum of the present values (PVs) of incoming and outgoing cash flows over a period of time. Incoming and outgoing cash flows can also be described as benefit and cost cash flows, respectively.[15] We use NPV as a financial indicator to make comparison with each project so as to decide which one is the best for shipowners. The formula is:

$$NPV = \sum_{j=o}^{n} \frac{C_j}{(1+i)^j} = \sum_{j=1}^{n} A_j (P/\mathrm{A}, i, j) + R(P/F, i, n) - P \quad (1)$$

$j$ is the number of year; $A_j$ and $C_j$ stand for the revenue and net cash flow respectively in year $j$; $n$ is its life time, set as 10 years in this article; $i$ represent the discount rate, 10%; $R$ as scrap value, 0 at year 10 and $P$ is initial investment of each project.

**Table 6** Annual cost

| Cost/$ | Fuel | Scrubber | SCR | Total |
|---|---|---|---|---|
| | | **Annual cost 2015-2020** | | |
| (i) | 26517309.25 | 437876 | 5327490 | 32282675.25 |
| (ii) | 29035987.01 | 0 | 5327490 | 34363477.01 |
| (iii) | 21967462.91 | 0 | 0 | 21967462.91 |
| | | **Annual cost 2021-2025** | | |
| (i) | 26517309.25 | 3746477.73 | 5327490 | 35591276.98 |
| (ii) | 44050759.74 | 0 | 5327490 | 49378249.74 |
| (iii) | 22917712.91 | 0 | 0 | 22917712.91 |

After calculating via Excel, we find that the project (iii) is the highest, either in NPV or NPV rate, see Table below:

| Project | NPV | NPV rate |
|---|---|---|
| (i) | 145.63 m$ | 3.34 |
| (ii) | 103.48 m$ | 2.64 |
| (iii) | 189.34 m$ | 3.75 |

The value seems to be high due to excluding of construction cost and other operating cost. It is obvious that Project (iii) performs best among these alternatives while (ii) beyond our expectation which indicate that changing fuel is not a good idea in the game between cost efficiency and emission control. In details, year by year, from Figure 3, the curve of project (i) is smooth while the other two have a drop after 5 years because of switching of fuel. That means project (ii) and (iii) are more vulnerable to the fluctuation of fuel price.

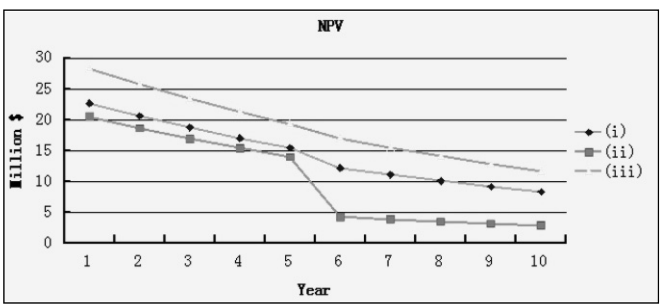


**Figure 3** NPV year by year

In addition, pay back time(PBT) of each alternative, depending on the formula indicate the risk of projects:

$$PBP = \frac{\lg \dfrac{A}{A - Pi}}{\lg(1+i)} \tag{2}$$

A is annual revenue; P, i is the same in the formula above. So PBT of (i), (ii), (iii) are 2.07, 2.06, 2.01 respectively, which means project (iii) have the lowest risk in three alternatives.

## 5 SENSITIVITY ANALYSIS

In the last eight years since 2008, the fuel price fluctuated between 250-664.1 $/t (IFO380) and 479.5-958.3 $/t (MGO) which left a big space for sensitivity analysis. Our analysis concentrate on the rise of LNG price and slump of oil. Rate of change were set by 10%, 15%, 20%, 25% and 30%. Figure 4 is the situation that oil price drop while LNG price keep steady. The intersection of curve (i) and (iii) is at nearly 30%, precisely 29.31%, where (i) catch up (iii) becoming the most profitable project. And Figure 5 shows the scenario of rising LNG price and steady oil. The intersection also express that when LNG price rise by 35%, (i) will be the best performer.

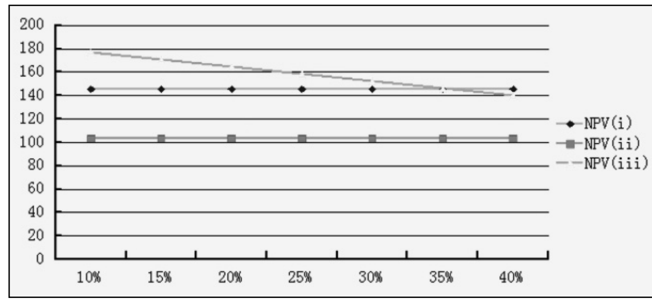


**Figure 4**

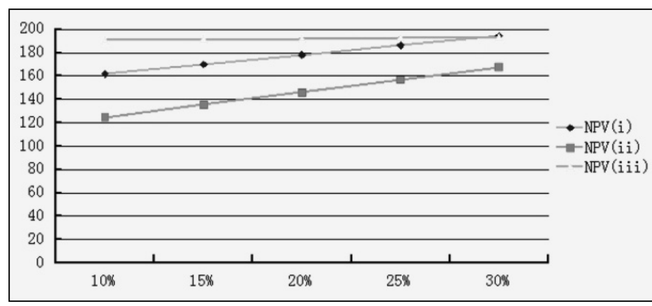


**Figure 5**

## 6 CONCLUSION

This article mainly proposed three technically effective alternatives to satisfy the current and future emission control regulations and laws in shipping. The findings show that LNG-diesel dual fuel power technology performs best among three alternatives. Due to the impact of fuel price on the conclusion, two scenarios were carried out in sensitivity analysis which witnessed a variation of NPV with the fluctuation of fuel price. 29.31% oil fuel slump and 35% LNG fuel rise are the turning point between project (i) and project (iii), left project (ii) the least cost-effective method in three alternatives. However, factors like ship size, load distance, route choice, stricter regulation, technology breakthrough, will have an impact on the outcome and further affect the decision of shipowners. So future study is recommended on these factors.

**Acknowlegements**

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# EXPERIENTIAL LEARNING IN MARITIME EDUCATION: MOVING BEYOND BOUNDARIES

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**Abstract.** The International Maritime Business (IMB) program at Massachusetts Maritime Academy (MMA) was recently accredited by IACBE (International Assembly of Collegiate Business Education). In their decision letter, IACBE commended the program for weaving current practice in the industry into the curriculum through various experiential learning processes. This included cooperative education, a mandatory sea term and various exchange program opportunities. As the shore based maritime jobs become more demanding with regard to proficiency in business and management strategies, information technology, safety and security related issues, environmental protection and awareness of cross cultural dynamics, such experiential learning opportunities emerge as key components in the curriculum of a maritime business program. This is also critical because, although the seafaring side of the shipping industry experiences a cultural immersion due to their job description as they visit various ports around the world, the shore side maritime professionals are generally recruited from the corporate headquarters with little cross pollination. A shore side vessel operator may have very little understanding about the cultural dimensions of a multinational crew aboard a vessel as a consequence. However, due to increasing enrollment and enhanced demand for license track majors, beginning in 2016, IMB students will no longer be able to participate in the sea term. We needed to take corrective action in the curriculum design in order to compensate this loss of an important piece of experiential learning. This paper explores the corrective strategy and evaluates the various experiential learning options that are now available to our students who end up working on the shore side of the maritime industry. Specific initiatives undertaken by the IMB program at MMA are discussed in detail.

**Key words**: maritime education, experiential learning, cultural immersion

## 1 INTRODUCTION

Just as planes and pilots do not represent the entire commercial aviation industry, similarly, just ships and seagoing professionals do not represent the commercial maritime sector in its entirety. It is important that we recognize the role of the shore based maritime professional for the smooth functioning of this industry. Some of the key personnel on the shore side are maritime educators, shipping management professionals, brokers, freight forwarders, emergency management personnel, environmental protection experts, surveyors, loss adjustors, ship builders, naval architects, parts and repairs providers, logistics providers in ports and inland transportation etc. This is by no means an exhaustive list but provides some understanding of the significant support system that needs to exist on the shore side for the safe and efficient operation of ships. Every day, thousands of vessels sail the waterways of the world but the real journey does not begin and end in a port and on a ship. It begins with the demand for a product in one corner of the world and the supply coming from another, and is accomplished by various professionals in complementary roles involved in this journey. A manpower study in Singapore that was jointly commissioned by the Maritime and Port Authority of Singapore (MPA) and the Ministry of Manpower (MOM)/Workforce Development Agency (WDA) in June 2003, showed that there were about 116,800 persons employed in the Singapore maritime industry. Of these, about 70% were engaged in shore-based employment, while 30% were sea-going personnel. The shipping management sector, ship chartering, ship agencies and ship-broking activities, happened to be the largest employment sector, absorbing about 40% of the maritime workforce. The specific segments with the highest employment growth were considered to be shipbuilding and repair, freight forwarding, shipping management and cargo terminals. Although this is relevant for a single nation, the study demonstrated the tremendous significance of efficient shore side support for the maritime sector. Singapore happens to be a leading hub port of the world, handling 580.8 million tonnes of cargo, and a container throughput of 33.9 million TEUs in 2014 as mentioned in a report published by the Maritime and Port Authority of Singapore (2014).

In the study, 'A vision for the 21$^{st}$ century', the US Maritime Administration (2007) recognizes the importance of transitioning into seamless door to door service from just port to port service to meet the current demands of the marketplace. In the report, marine transportation is considered to be 'a system of systems' an integrated global network, focused on efficiency, safety, security and environmental protection. Although these trends are quite significant, very often, when we have a discussion on maritime training and education, we focus only on the seafaring side.

Also, shipping is a truly global business. However, much of the maritime training takes place within national boundaries in a mono-cultural environment. This paper outlines the various experiential learning initiatives undertaken by the International Maritime Business program (IMB) at Massachusetts Maritime Academy (MMA) that focus on meeting the education needs of the shore based maritime professional in a truly global context.

Section 2 provides a brief background of experiential learning programs in colleges and universities in the US with a special focus on maritime colleges. Section 3 discusses the motivation behind the development of an experiential learning piece in the IMB curriculum at MMA. The existing and upcoming experiential learning initiatives are discussed. Section 4 provides conclusions.

## 2 EXPERIENTIAL LEARNING IN THE US MARITIME CONTEXT

In its simplest form, experiential learning means learning from experience or learning by doing.

"Experience and Education" (John Dewey, 1938) serves as a foundation piece of literature when discussing experiential learning. Dewey's philosophy points out that the strict authoritarian approach of traditional education was overly concerned with delivering preordained knowledge, and not focused enough on students' actual learning experiences. In Dewey's experiential learning theory, everything occurs within a social environment. Knowledge is socially constructed and based on experiences. The experiences are based on the capabilities and readiness of the learners. Upon completion of the experience, learners have the knowledge and ability to apply it to different situations, thus creating new knowledge.

The history of post secondary education in the U.S., and the role of experiential learning in its improvement are discussed in detail by Keeton (1976). Topics of discussion include: the relationship of experiential learning to individuals' information processing, the need to clarify objectives, and the potential effect of new educational objectives on teaching and institutions of higher education. The cost effectiveness of experiential learning and implications for university administration are also discussed. The book discusses the assessment of experiential learning, recommends standards for assessment, and suggests approaches for the improvement of assessment practices.

David A. Kolb, in his seminal work defined the theories and principles of experiential learning pedagogies

(Kolb, 1984) and explained the dynamic process of learning through doing. He believed that effective learning involves four different kinds of abilities—concrete experience abilities, reflective observation abilities, abstract conceptualization abilities and active experimentation abilities. In the decades since the publication of Kolb's thesis on experiential learning, there have been trends in colleges and universities in the United States that are increasingly supporting curricula and programs that promote academic experiential learning. The United States Department of Education notes that higher education credit can be awarded for experiences and training obtained outside the higher education system. Common examples include credit for military training programs, employer training and certification and refresher training done as part of the requirements of professional associations and licensing authorities. Credit can also be earned for self-study and other experiences that provide evidence of learning under some circumstances.

Many colleges and universities in the US now have Office of Experiential Learning such as the University of Central Florida where each year, over 20,000 students participate in co-op, internships and service learning. Experiential Learning collaborates with academic and student development departments on campus to provide integrated programs so that all constituencies can benefit from participation. With this approach, the academic and development needs of students, the instructional and research needs of faculty, and the workforce competency needs of employers can all be met.

The University of Denver has an Experiential Learning Center which promotes development of knowledge, skills, and values from direct experiences outside a traditional academic setting. Experiential learning encompasses a variety of activities including internships, service learning, undergraduate research, study abroad, and other creative and professional work experiences.

However, the types of experiential activities vary according to the institutional priorities, and available resources. Whether it is the 'Theory-Practice Learning' initiative at Emory University, 'Office of Service-Learning' at Bentley University, 'Office of Fieldwork' at Vassar College or 'Community Based Learning Program' at Mt. Holyoke, the trend of awarding academic credits for various initiatives where academic study is combined with real world experiences and/or service activities that address community needs, is gaining momentum.

The experiential learning piece is an integral element of the curriculum in maritime colleges in the US. The International Convention on Standards of Training, Certification and Watch-keeping for Seafarers (STCW) 1978, as amended in 1995 and again in 2010, sets standards that govern the award of certificates and controls watch-keeping arrangements. Its provisions not only apply to seafarers, but also to ship-owners, training establishments and national maritime administrations.

A maritime licensed officer must meet minimum requirements in respect of standards of competence and seagoing service time. The officer should possess a valid certificate of competence according to rank and functions on-board. Thus an experiential learning element of sea going service time in a training vessel or a commercial ship is a critical degree requirement for seagoing officers. The United States Maritime Administration (MARAD) provides limited funding to the six State Maritime Academies (SMA's): California Maritime Academy, Maine Maritime Academy, Massachusetts Maritime Academy, Great Lakes Maritime Academy, Texas A&M Maritime Academy, and the State University of New York Maritime College. It also supports the United States Merchant Marine Academy (USMMA), a federal service academy that educates and graduates licensed Merchant Marine officers. MARAD also provides training vessels to all six State maritime academies and USMMA for use in at-sea training and as shore-side laboratories. The vessels are part of the Maritime Administration's assistance to the academies to train highly qualified licensed officers.

## 3 MASSACHUSETTS MARITIME ACADEMY EXPERIENTIAL LEARNING INITIATIVES

The sea going license track students of MMA complete their sea going experiential training aboard the training vessel T.S. Kennedy and other commercial shipping voyages. A minimum of 180 sea-time training days, established by the U.S. Coast Guard (USCG), are required of all students seeking a license as a Third Assistant Engineer. The cruises are accomplished in the following order on the following vessels: Academy training ship, training or commercial ship followed by Academy training ship. The USCG 3rd Mate license candidates will be required to complete 365 days sea time. This experiential element is an integral part of the academic curriculum for the license track programs and carries credit for graduation.

However, a non license track shore based major like IMB also has a significant experiential learning component. This major prepares graduates to enter the maritime shipping and transportation industry as a business professional. The emphasis on curricular design is aligned to the educational philosophy of the Academy: Learn–Do–Learn. The original framework of the curriculum was based on the following model.

Through academic coursework, students learn the concepts and principles of international maritime business. They then apply this learning in a professional context during sea-term and internships. In order to graduate, students need to complete a minimum of two internships. Based upon that experience, students then improve and adapt their understanding of the concepts and theories of maritime business. The academic curriculum includes courses in economics, finance, accounting, business of shipping, supply chain management, chartering and brokerage, marine insurance, admiralty law, international business, negotiations and organization management. It also includes a capstone seminar in international maritime business during the senior year.

Originally, the curriculum was designed with a practical component of one freshman sea term and two internships. The common freshman sea term gave students the opportunity to cycle through the offerings of various departments so that they get the whole picture of the maritime industry. During sea term, each student took classes in Marine Transportation, Marine Engineering, International Maritime Business, Marine Safety and Environmental Protection and Emergency Management. They also stood deck and engine watch and engaged in shipboard maintenance. However, due to the increasing enrollment and enhanced demand for license track majors, beginning in 2016, non-license track majors like IMB will no longer be able to participate in the six credit sea term. This difficult yet unavoidable decision took away a critical experiential learning piece of the IMB program.

The displacement of IMB Freshman students from the common freshman sea term came at a critical juncture after a successful IACBE accreditation bid. The IMB Department had serious concerns about losing the freshman sea term as several IMB students find employment opportunities in oil drilling rigs, supply vessels, as well as several shipping companies where employers consider this experience to be critically important. However, a successful business professional always responds to change efficiently and turns it into an opportunity. As a department, we had to carefully consider restructuring our curriculum in response to this change and use input from employers, Advisory Board and the recent accreditation exercise to propose a curriculum alteration that was approved by college governance.

Given that students in the IMB program have an understanding of general business courses as well as specialized maritime business related knowledge, we have typically placed students in both maritime as well as general business sectors. The employers highly value internships. They also believe that an international experience and immersion in a foreign culture would enhance the skill set of an international business student. A sea term is important to a shipping company that hires an IMB student. Keeping in mind this diversity in preference pattern of our employers, we proposed the following:

– An upper class maritime –OR– international experience:

Rather than a required sea term experience for all freshmen, for which there was no room on the ship, IMB students will be required to engage either in an upper class sea term experience or an upper class international experience. Both will be worth six credits.

i. International Experience: After completing some introductory instruction and orientation, students will travel abroad for three to five weeks on a faculty-led program that introduces them to other cultures and includes visits to shipping business and maritime infrastructure in other countries. This could also include spending the time in a foreign maritime institution completing six credits of coursework.
ii. Sea Term Experience: This program will allow a few juniors (or seniors in some cases) to sail aboard the training ship during the traditional sea term. They will be engaged in an IMB-specific training program both while underway and ashore (with visits to shipping business and maritime infrastructure in the ports of call) with faculty supervision. This program will provide them vital maritime experience that is relevant to IMB maritime related positions.

The IMB program has developed a few exciting international experiential learning opportunities and more are on the way. We believe that it would be much wiser to take smaller groups of mature students who are either juniors or seniors and have some understanding of the subject matter to have a meaningful learning experience in various capacities. Of the two options mentioned above, the international experience will require considerably more advance preparation and resources. This experience will help students develop their cross-cultural and global awareness by visiting other countries. It will also provide them an opportunity to observe international maritime business in practice at various ports and related maritime interests. It ties in nicely with MMA's Learn-Do-Learn model.

IAMU provides a wonderful platform for collaborative initiatives in this regard. As we continue to design and develop the international experiential learning piece, we can enhance our partnerships with IAMU member schools. We currently have established partnerships with Shanghai Maritime University (SMU) and Dalian Maritime University (DMU) through regular student exchange programs. Over the past year or so, we have been working with Kobe University to develop a MIX (Maritime International Exchange) program that creates an opportunity for MMA students to work collaboratively with students from Kobe online and then meet at a location to jointly solve an applied maritime problem.

The department is also engaging its advisory board members from various segments of the industry to bolster the international experiential learning initiative. We are designing a new initiative in Calcutta and Singapore and a pilot program will start in January 2016. A faculty led student team will first stop at Calcutta to understand the workings of a very traditional riverine port that handles international cargo. It is perhaps the only one of its kind left in the world and is the major gateway to landlocked Nepal and Bhutan. We will also visit the sister port of Haldia which is further downstream and has lesser draft restrictions. Port of Singapore Authority (PSA) is managing the container berth in Calcutta which has significantly improved throughput. We will try to include a certification course for students in the Institute of Port Management in Calcutta. The next segment will be in Singapore which is a short flight away and happens to be a major global hub port. With the guidance and support of our advisory board member, we will be setting up tours of the port of Singapore and leading shipping companies in Singapore. We are trying to include a short course offered by Singapore Maritime Academy. These experiences will not only be fantastic educational opportunities for students in the IMB program, they will also pave the way for better trained and culturally sensitive prospective employees for maritime companies that have a global presence.

## 4 CONCLUSION

Today's maritime students are exposed to a world that require considerable cross cultural understanding and recognition that education is far more than learning facts about specific disciplines while sitting in a classroom. Based on the generally accepted premise that learning occurs through experience, international experiential learning can be a critical component of education in maritime institutions. As highlighted by Montrose (2008):

> The importance of an international experience for the purpose of language development, cultural immersion, service projects, discipline-specific studies, or enhancement of a student's world view cannot be underestimated. Although there is little doubt about the benefits and importance of encouraging students to participate in study abroad, in many cases there is a lack of integration between the experience and the learning or educational value that can be derived from it. Experiential learning is a pedagogy with a long tradition of theory, research, and practice. Although the methods are not the same as traditional educational approaches, the structured approach is significant in transforming experience into a worthwhile academic experience, deserving of academic credit.

The purpose of this paper was to demonstrate the initiatives taken by the IMB program to hone this tool in the absence of a freshman sea term. With the help of strategic partners, we have been able to identify opportunities that will strengthen the IMB program at MMA. It is my hope that this will encourage further avenues of experiential learning cooperation among IAMU member institutions. As indicated by past research, such experiential learning exposes learners to authentic, globally aware, meaningful life experiences that are more likely to engage them in socially responsible behaviors, transforming them into agents of positive social change within the global community.

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# THE IMPLICATIONS OF OUTSOURCING SEAFARER EMPLOYEES GLOBALLY: THE POSSIBLE IMPACT OF AUTHENTIC ASSESSMENT

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**Abstract.** The Standards of Training, Certification, and Watchkeeping (STCW) Code was introduced by the International Maritime Organisation (IMO) to globally regulate the standards for competence assessment and certification of seafarers. However, flexibility and vagueness in the Code has led to a lack of uniformity in the adopted assessment methods and the resulting competence standards of the graduating students worldwide. Variability and inconsistencies in employee competence on board ships may have profound ramifications on seafarer employers that intend to outsource employees from the global labour market as a benefit of globalisation. Such employers are increasingly demanding evidence of achievement of the STCW standards or more from maritime education and training (MET) institutes. Due to impracticality, the solution may not lie in increasing global regulation of training but exploring innovative assessment practices that may be implemented nationally to improve the certification and resulting evidence of competence of seafarers. This paper provides theoretical justification to support authentic assessment as a possible alternative to current assessment practices. Based on a review of literature in the area of authentic assessment, the paper argues that student performances in a real-world context captured through rubrics provide contextual evidence of competence to perform on-board tasks. Such contextual evidence can then be used to gauge the standards of training and improve on them by stakeholders such as educators, employers, and national regulators.

**Key words**: authentic assessment, globalisation, STCW, seafarer, training and assessment

## 1 INTRODUCTION

The first half of this paper contends that five shifts in the political economy of global merchant shipping have occurred since the 1970s. These five shifts have culminated in the restructuring of the global labour market for seafarers. However despite these profound shifts a sixth shift in the education and training of seafarers has yet to materialise. To complete the transformation of the labour market for seafarers, a shift in the andragogy has to be made towards authentic assessment as a globally meaningful and recognised way of certifying seafarer competency.

There are five Post-Fordism tendencies precipitated by shipping capital that have contributed to manufacturing insecure labour markets for merchant navy seafarers. These tendencies are: (1) the delinking of the nation state from labour regulation processes, (2) the shift to cheaper labour markets, (3) the casualisation of seafaring labour, (4) organisational restructuring of shipping companies, and (5) the impact of new technologies on labour market security. These tendencies have revolutionised the ways in which global seafaring labour markets operate and make it an ideal case study to reflect on the usefulness and purpose of globally regulated training standards. As part of the process to regulate and restructure labour markets the Standards of Training, Certification, and Watchkeeping (STCW) Code was introduced by the International Maritime Organisation (IMO) to globally regulate the standards for competence assessment and certification of seafarers (Bloor et al., 2013a; Bloor, Sampson, & Gekara, 2013b). However, flexibility and vagueness in the Code has led to a lack of uniformity in the adopted assessment methods and the resulting competence standards of the graduating students worldwide.

Variability and inconsistencies in employee competence on board ships may have profound ramifications on seafarer employers that intend to outsource employees from the global labour market as a benefit of globalisation. Such employers are increasingly demanding evidence of achievement of the STCW standards or more from maritime education and training (MET) institutes. Due to impracticality the solution may not lie in increasing global regulation of training but exploring innovative assessment practices that may be implemented nationally to improve the certification and resulting evidence of competence of seafarers.

## 2 GLOBALISATION AND REGULATORY COMPLIANCE IN THE SHIPPING INDUSTRY

Bloor et al. (2013a) demonstrate in their empirical investigation into the global compliance of training standards of seafarers, that global regulation of STCW standards and certification is beset with issues. They argue that: *"Despite long-standing efforts by international bodies to standardize and regulate the education and training of seafarers, variations in practices and standards persist. Employers exercise contradictory influences on education and training providers, on the one hand demanding the urgent provision of more recruits (encouraging corner-cutting), and on the other complaining about the poor quality of recruits received (urging crackdowns on poor quality providers and more rigorous examinations) – the training double bind".*

Post-Fordism labour market practices such as flag of convenience (FOC) shipping, outsourced labour and the delinking of the nation state from global regulatory policies have culminated in this double bind. More than any other industry the shipping industry and its crewing practices have been transformed by the various processes of globalisation. There is arguably a single global labour market (Bloor et al., 2013b) that is dominated by seafarers from nine countries (the Philippines, Russia, the Ukraine, China, India, Poland, Indonesia, Turkey, and Myanmar). Collectively nationals from these countries supply two-thirds of the million seafarers in the international fleet (Wu and Sampson 2004). Given the diversity of national training regimes, the STCW requirements are a requirement to standardise certification and quality across this variable labour market landscape.

Despite the IMO setting up a 'white list' system in 2003 as a strategy to audit national MET institutions' compliance with STCW requirements, there is little evidence to demonstrate that the general standard of education and training has improved globally in this industry (Sampson, 2004). Many countries, including some of the 'white list" nations, allow METs to operate with training and assessment regimes that barely meet the minimum compliance of STCW. For example, a study by Sampson (2004, 251) showed that Philippines is a 'white list' nation that has allowed sub-standard METs to operate in spite of falling short of STCW expectations. The ethnographic study focused on Singapore, United Kingdom and Philippines and comprised of thirty in-depth interviews with company managers, college lecturers and trainers, union officials and a member of the IMO.

Whilst some METs have closed, there has been little overall impact on the quality of training that seafarers receive. The polycentric governance structure of the shipping industry (Black, 2008), whereby national states have little to no control over the regulation of certification of their seafarers, means that certification and compliance management is often a fragmented process in which "state actors are both regulators and [the] regulated" (Bloor et al., 2013a, 172). This also means that the 'idea' of a global STCW certification and compliance regime is more appealing as an 'idea' than in actual practice. In a world with no political, economic, uneven labour markets and social inequities, global standards of quality certification would be relatively easy to maintain.

The Post-Fordism shift of shipping companies outsourcing labour recruitment to crewing agencies has resulted in concomitant shift of the training burden from shipping companies to seafarers themselves, especially in the developing world (Bloor et al., 2013b; Ruggunan, 2015). Thus quality of training and cadetships that would normally be controlled by shipping operators is no longer guaranteed. The impact of this outsourcing or 'just-in-time' training of seafarers has profound consequences for the legitimacy of STCW and hence the global labour market for seafarers. For just-in time crewing agencies, paper certification is an adequate indication of the seafarers' competence to work on an appropriate vessel. However in practice ship owners are finding variability and inconsistencies in crew competence (Ghosh et al 2015).

On the national level, local peculiarities of political economy and resources determine how implementation and practice of STCW takes place. Given that the majority of seafarers are supplied from developing countries (Ruggunan, 2015), it seems remiss to ignore the peculiarities, challenges and constraints faced by these labour supply countries in ensuring the quality of their STCW training. In South Africa for example, as in other developing countries, resources at white listed METs (there are only two in South Africa) are limited. There is a shortage of qualified lecturing staff in maritime education and training in the developing world, for meaning that lecturing staff are often overworked. One way of ameliorating this overwork is to engage in assessments methods that are viewed as less labour intensive. This includes a shift towards multiple choice questions as preferred methods of assessment in licensing exams for seafarers. Secondly, there is increased pressure from the State to increase the number of cadets trained by METs without a concomitant increase in resources. This necessarily impacts on the assessment methods. Thirdly, States like South Africa require that STCW certification occur within the university system of the country as opposed to occurring in dedicated METs. Therefore all the pressures of traditional universities equally apply to maritime studies departments.

## 3 OUTSOURCING OF TRAINING AS A POST-FORDISM STRATEGY

Outsourcing is a key feature of the Post- Fordism era. This feature is part of the flexible accumulation strategy of neoliberal globalisation as argued by Harvey (2014). For Harvey (1996; 2014) the shift to 'new times' or post Fordism is very much a shift to a new mode of regulation for capitalism. He terms this new strategy 'flexible accumulation' (Harvey, 1996, p.141; 2014). Flexible accumulation strategies were very much a response to what capitalists and some economists saw as the all too rigid accumulation strategies of Fordism (Harvey, 2014; Piketty 2014). The mass production systems, labour markets and commitments of the state were seen as too rigid and because of their rigidities unable to cope with the several economic shocks that characterized the 1970s (Harvey, 1996, 144). Flexible accumulation therefore marked 'a direct confrontation with the rigidities of Fordism' (Harvey, 1996, 147).

The key features of this new type of accumulation are firstly a shift to flexible labour processes, secondly the creation of flexible labour markets and thirdly the creation of flexible products and patterns of consumption (Harvey, 1996, 147) and fourthly in the case of global industries such as shipping, an outsourcing of training to seafarers themselves. Shipping companies and crewing agencies do not subsidise or pay for the training of ratings and officers. Seafarers are expected to lay out the costs of their own training which has to be globally compliant. This means a massive financial saving for shipping companies who historically have trained seafarers at their own cost. This is part of a global trend towards shifting the financial burden of training to individuals and away from employers.

However, the International Safety Management (ISM) Code developed for the safe operation of ships clearly states that it is the responsibility of the seafarer employers to ensure their employees are competent to work on board ships (IMO, 2002, 8-9). The IMO authorises national regulators to investigate seafarers' competence through inspections and surveys, amongst many other regulatory requirements, to identify and deter substandard ships from operating (AMSA, 2011, 15). Ships can be detained and registers cancelled if serious deficiencies are found in an operators' ability to perform workplace tasks safely (Department of Infrastructure and Transport, 2012, 18-19). Due to a global shortage of seafarers, the training period of trainee cadets have been reduced and young officers with a reduced sea experience are being promoted (Listewnik, 2009, 34) to fill up the higher ranks of responsible officers on ships, on obtaining the CoC for the appropriate level of responsibility. Hence, many progressive employers are investing large amounts of capital for training seafarers (Sadjadi and Perkins, 2010, 57-58) in METs expecting the certification process to result in graduates that have high standards of competence.

Literature on outsourcing of training in industries such as construction, computer services and telecommunications indicate that employers often have to intervene to quality manage training standards from outsourced suppliers or agencies (Mackenzie, 2000). Forde et al. (2008) in Bloor et al. (2013a) demonstrated that industries sometimes refuse to hire prospective employees from agencies because of perceived problems with quality of training. In the global labour market for computer software engineers, nurses and doctors it is not uncommon for nation states to insist on a national set of examinations or assessment to be undertaken before these candidates can be considered competent. As processes of globalisation such as flows of people and capital increase, the shipping industry is going to struggle further with regulating the quality of STCW qualifications.

A system of double certification may come into play where employers introduce a second tier of assessments whereby cadets have to demonstrate certain competencies as proof of their employability and to give credence to their paper qualifications. It is precisely this double certification regime which this paper argues is a potential crisis in the current globally regulated STCW training regime. The second half of this paper suggests that further regulation and management by compliance may not be the most practical solution going forward. What may be needed is a shift towards new types of assessment practices. Given the casualised and insecure nature of the global labour supply countries for seafarers there is a strong reliance on the credibility of the STCW qualification when employing seafarers. However, a substantive body of work empirically demonstrates the disparities in the competencies of seafarers from different (as well as within) countries (Sampson, 2004; Sampson & Bloor, 2007; Bloor et al 2013a, b).

In Bloor et al. (2013b), the authors demonstrated that there are three general models used to assess seafarers' competencies. Of interest is that the three models differ not only across countries but sometimes differ within countries as well. Maritime nations often have excessive competition amongst its METs. The METs need to provide economical and affordable training to attract more students (Bloor and Sampson, 2009, 718) due to which they may not invest in costly simulators and other training/ assessment facilities. Another view of the same issue can be seen from the eyes of the METs from developing or low cost nations who intend to fully comply with STCW. However, they may be unable to afford costly training and assessment facilities like simulators and seek support from other stakeholders, such as the national government. In many instances, such support might not be available (Baylon and Santos, 2011, 40) to METs from its stakeholders. Moreover, STCW'95 did not fully eliminate the vagueness in assessment standards as it specified methods to demonstrate competence but did not provide specific methodologies, leaving it to the discretion of the assessor (Robson, 2007, 248). For example, how sophisticated and advanced should the simulators be to reflect STCW standards? The STCW only provides recommended performance standards for non-mandatory types of simulators.

Even after the last revision in 2010, the vagueness in STCW continues to leave too much room for interpretation by METs, who are using varying combinations of assessments (Bhardwaj, 2009, 29; Drown et al., 2010, 1-3; Kean et al., 2011, ii) for students to demonstrate the performance standards described in the STCW Code. Assessments ranged from multiple choice questions, traditional written examinations, simulator tests and oral examinations. New labour supply countries tended to use less labour intensive approaches to assessment due to a range of human resource constraints as opposed to traditional maritime nations that tend to employ more labour intensive approaches. As averred to earlier, the globalisation of the shipping industry has resulted in five shifts in the industry, but the sixth shift towards valid and reliable assessment and training practices has yet to occur. The shift towards a globally regulated STCW standard is a promise half-filled as borne out by the evidence of the last 25 years. For the sixth shift to take place, a serious consideration of authentic assessment practices needs to take place. It is this shift that the second part of our paper focuses on.

## 4 AUTHENTIC ASSESSMENT AS A WAY FORWARD

The standards of the STCW convention constitute a compromise between the capabilities of developed countries, which can meet the highest requirements, and the situation in those countries where resources are insufficient to satisfy them (Walczak, 1999). Such flexibility allows developed and developing nations to adhere to STCW requirements and hence may be considered a practical approach to globally regulate standards. However, it makes it challenging to achieve standardisation in approaches to training and assessment. Even if standardisation is achieved through traditional assessment methods (e.g. multiple choice questions, oral examinations, or written examinations) that may be conveniently adopted universally; the assessment methods may fall short of its intended purpose of assessing competence. Traditional assessment methods may be effective in assessing lower order cognition skills of memorising and regurgitating but are restricted in their ability to design tasks that are re-

**Table 1** Example of how contextual evidence of competence may be generated for tasks listed in the STCW'95 Code

| Unit of Competence | Context of Assessment | Outcome Achieved | Evidence |
|---|---|---|---|
| Prevent, Control, and Fight Fires | Simulated fire scenarios in enclosed structures and open spaces;<br>Theory applied in classroom-based tests. | Students wear fireman's outfit; and operate fire extinguishers, fully charged fire hoses, and fixed fire-fighting installations to extinguish and control simulated fires;<br>Students demonstrate theoretical knowledge of prevention, control, and fire-fighting. | Students should provide an advanced fire-fighting course completion certificate from a training institute approved by the national regulator;<br>Certificate should be accompanied with written documentation on tasks completed successfully during the course. |

quired to be performed at the workplace. Authentic assessments are defined as performance-based assessments that are applied in real-world contexts or situations that are contextually similar to the professional world (Wiggins, 1993; Meyer, 1992; Reeves and Okey, 1996).

Employers may be sourcing seafarers from the global market but essentially want evidence of the employees' ability to perform at the workplace before they can be assigned roles on board ships. Due to complexities in recreating shipboard scenarios in land-based MET institutes, authentic assessments for seafarers may not always be conducted in accurate workplace settings. If real life contexts and complexities (task centred approach), cannot be created in assessments, they should then focus on the selected constructs (construct centred approach) of knowledge and skills (Messick, 1996). For example, assessments designed in METs may not be able to assess a student's competence to manage large crowds as is required on passenger ships but they may be designed to assess a student's competence to do so through their ability to analyse risks associated with such management or developing crowd management plans. Although such assessments may take place in controlled situations, the authenticity will be reflected through ways in which the same skills would be applied in real-life contexts (Messick, 1994). However, authentic assessments are required to generate contextual evidence of competence (Gulikers, Bastiaens, & Kirschner, 2004), as shown in Table 1, which will inform employers on the workplace activities that students can actually perform under particular contexts. This information can be used by employers to identify gaps in the knowledge and skills of their student employees and fill the gaps with additional training, if required.

Assessments that do not provide contextual evidence may leave employers clueless as to what should the additional training should focus on. Costs of additional training are often bore by the employer (Hanzu-Pazara and Arsenie, 2007, 314). Although employers have training obligations for preparing their employees for specific types of vessels, costs borne for aimless training should be avoided as it can cause a significant impact on the employers' budgets. Many employers already feel reluctant to spend capital on employee training due to the risk of them being poached by other companies offering higher salaries (DEEWR, 2010).

However, the contextual evidence of competence in isolation does not inform the concerned stakeholders on the details of the learning outcomes achieved. It needs to be supported by statements that comprise of essential dimensions of outcomes known as criteria along with standards for levels of performance against those criteria. Such statements can be provided through assessment rubrics (Jonsson and Svingby, 2007).

Standards in rubrics are defined as levels of definite attainment and sets of qualities established by authority, custom, or consensus by which student performance is judged, whereas criteria are essential attributes or rules used for judging the completeness and quality of standards (Sadler, 2005). One of the key characteristics of authentic assessments requires it to provide statements of performance expected from students at the beginning of the learning period, allowing allows students to learn and educators to adopt appropriate instructional strategies to guide students towards the achievement of the desired outcomes (Archbald, 1991). Table 2 provides an example of how rubrics can be constructed to provide details of tasks that students can actually perform and their level of performance towards achievement of broad learning outcomes.

Statements of competence to perform workplace duties should not only encompass technical skills but also the cognitive and underpinning soft skills such as problem-solving and decision making which are essential for employability. The practice of assessing a limited range of technical skills can curtail the development of a holistic portfolio all the necessary skills (Cox, 2009) required for supporting workplace performance at a particular level of responsibility. For example, essential underpinning skills for the STCW unit of competence of 'Prevent, control, and fight fires on board' can be identified as communication, teamwork, ability

**Table 2** Example of how rubrics can inform on individual tasks and levels of performance towards outcomes achievement

| Criteria | Standard 1 (Deemed insufficient to be competent at any level) | Standard 2 (Minimum required to be deemed competent at support level) | Standard 3 (Minimum required to be deemed competent at operational level) | Standard 4 (Minimum required to be deemed competent at management level) |
|---|---|---|---|---|
| Identify the class of fire and choose the correct extinguishing system | Unable to identify the class of fire and/or choose the correct extinguishing system | Identify the class of fire and choose the correct extinguishing system in less than 3 minutes | Identify the class of fire and choose the correct extinguishing system in less than 2 minutes | Identify the class of fire and choose the correct extinguishing system in less than 1 minute |
| Operate the fire extinguisher as per the manufacturer's instructions | Unable to operate the extinguisher and/or to follow the instructions | Used the fire extinguisher using manufacturer's instructions in less than 4 minutes | Used the fire extinguisher using manufacturer's instructions in less than 3 minutes | Used the fire extinguisher using manufacturer's instructions in less than 2 minutes |
| Wear the fireman's outfit and as per the manufacturer's instructions | Unable to wear the fireman's outfit and/or follow manufacturer's instructions | Wear fireman's outfit as per manufacturer's instructions in less than 6 minutes | Wear fireman's outfit as per manufacturer's instructions in less than 5 minutes | Wear fireman's outfit as per manufacturer's instructions in less than 4 minutes |

to work under pressure, leadership, etc. Authentic workplace tasks will require underpinning skills to be identified and incorporated in the assessments.

## 5 CONCLUSION

The flexibility in the STCW'95 Code has allowed nations to adopt differing approaches to seafarer training and assessment. This has resulted in employers finding inconsistencies and variability in competence of their employees irrespective of whether employees are being outsourced globally or within the same country but graduating from different maritime training institutes. Current assessment methods provide no indication or reliable evidence of a graduating student's competence and whether it can be transferred to workplace contexts. This paper acknowledges that achieving standardisation in global training and assessment practices can be challenging. Moreover if the standardisation is achieved through assessment methods that are convenient to adopt universally but are failing to assess holistic competence of seafarers; the expectations of the employers will not be met successfully. Authentic assessment conducted in real-world contexts is suggested as a possible solution. Authentic assessment will require students to apply knowledge and skills developed in classrooms to workplace or contextually resembling workplace scenarios. The students would require an integration of competence developed in individual tasks as well the use of the underpinning skills which will promote a holistic approach to competence assessment. Authentic assessments may not create standardisation in global assessment practices but it essentially requires contextual evidence of competence to be generated which can be used by employers to gauge the contexts under which the competence of the employees have been developed. The evidence would provide reliable indications of employability or the ability to recognize gaps that can be filled with additional training. Future research should aim to empirically investigate if authentic assessment can be used within the confines of the STCW Code to meet employer and regulator expectations with the seafarer training process.

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# USING AUTHENTIC ASSESSMENT TO ENHANCE SEAFARER STUDENT ENGAGEMENT AND THEIR ABILITY TO TRANSFER LEARNING

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**Abstract**. Past research shows that seafarer employers are critical of some of the assessment methods adopted by the educators at maritime education and training institutes (METs) to assess the competence of seafarers. The criticisms included the failure to develop and assess the holistic skills required to deploy competence in a range of contexts. Moreover, the decontextualized scenarios used in assessment methods disengage students from the learning process as they fail to recognize the significance of learning to the real-world. This paper argues that seafarer students can be engaged through authentic assessments conducted in real-world contexts that will test their ability to put theoretical knowledge developed in classrooms to practical settings resembling workplace scenarios. The arguments are based on the theories of constructivism and self-efficacy that underpin the concept of authentic assessment. The theories are used to explain greater student engagement through involvement in the process of knowledge construction that also develops metacognitive skills for the transfer of learning to different contexts. The theoretical arguments are supported with empirical evidence from past research to provide a robust justification for the use of authentic assessment in seafarer training to obtain similar outcomes.

**Key words:** seafarer, authentic assessment, student engagement, learning transfer

## 1 AUTHENTIC ASSESSMENT PROMOTE STUDENT ENGAGEMENT

Student interviews during the course review of deck officers (Australian Maritime College (AMC), 2011) carried out in the Australian Maritime College (AMC) revealed that seafarer students felt disengaged with traditional assessments when used for assessing their competence to perform workplace tasks.

Traditional assessment methods such as pen and paper testing, oral exams, and multiple choice questions (MCQs) may be effective in assessing lower order cognition skills of memorising and ability to regurgitate which is necessary but not sufficient for performing in workplaces such as ships, where a higher level of cognition is required to assimilate, analyse and structure (Wiggins, 1990) information for decision making and problem solving. For example, Table 1 shows how seafarer assessments may use a combination of traditional and authentic assessments to assess competence to perform STCW tasks to workplace standards.

However, an ethnographic case study involving a small sample of 16 students carried out by Emad and Roth (2007) in a Canadian maritime institute, revealed that students were aware of the fact that traditional exams comprised mainly of the questions which were drawn from a question bank. Over time they could predict the range of questions and prepare accordingly. Such assessments that lack innovation in design can encourage memorizing to pass examinations instead of the deployment of critical thinking and problem-solving skills that are essentially required at every workplace.

Assessments designed to assess professional competence of seafarers to perform real-world tasks should ideally create similar scenarios for student performance. For example, student interviews at the AMC (AMC, 2011) revealed their preference for assessments that are contextually similar to challenges found at workplace, in order to relate classroom learning to professional practice. Lack of contextual similarity in learning and assessment makes it difficult for students to relate how skills and knowledge developed in classrooms can be applied in workplace contexts (Findlay, 2013). It also raises the questions of validity where students start to question the relevance of the assessments and the competence it purports to assess, thus disengaging students. Assessments that are designed in real-world contexts are defined as authentic assessments (Wiggins, 1990; Archbald, 1991; Gulikers, Bastiaens, and Kirschner, 2004; Darling-Hammond and Snyder, 2000).

Meaningful contexts through real-world scenarios create high level of student engagement and commitment. For example, interview of six students in a study by Richards Perry (2011) revealed students' preference for meaningful and relevant learning experiences; and authentic learning. The convenience sample was kept to a low number of six students to gain a greater depth of inquiry through an extensive interview protocol. However, to be engaged in learning, students will not only require meaningful contexts but also to be active participants in the knowledge construction process that precedes the assessments (Hart et al., 2011). Although the uniqueness of authentic assessment lies in the setting of tasks in real-world contexts, drawing upon the literature (Wiggins, 1990; Archbald, 1991; Darling-Hammond and Snyder, 2000; Gulikers et al., 2004; Gulikers, 2006), authentic assessment herein will encompass:

**tasks** *resulting in outcomes* in a *real world context* that require an *integration of competence* to solve *forward looking questions* and *ill-structured problems*; **processes** that require *performance criteria to be provided beforehand* and *evidence of competence to be collected by the student*; and **outcomes** that result in *valid and reliable student performance, contextual and multiple evidence of competence, higher student engagement, and transfer of skills to different contexts*.

**Table 1** Extract from the STCW Code'95 for the function of navigation at the operational level

| Competence | Knowledge, understanding and proficiency | Methods for demonstrating competence | Criteria for evaluating competence |
|---|---|---|---|
| Respond to a distress signal at sea | Search and Rescue<br>Knowledge of the contents of the International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual | Examination and assessment of evidence obtained from practical instruction or approved simulator training, where appropriate | The distress or emergency signal is immediately recognized<br>Contingency plans and instructions in standing orders are implemented and complied with |

Ability to respond to distress signals to workplace standards should be assessed via authentic assessments

Knowledge-based components of competence may be assessed via traditional pen and paper, MCQs, or oral examinations

Traditionally, seafarer education has been teacher-centric where students have been passive receivers of knowledge (Lewarn, 2002). This does not allow seafarer students to become active participants in the learning process. In active learning, students are not only mere receivers of knowledge but also involved in the construction of it. According to the learning theory of constructivism, construction of knowledge allows students to develop a deeper understanding of the learning content. Authentic pedagogical practices are influenced by the constructivist philosophy of student-centred learning where students create meaningful knowledge in real-world tasks (Morrissey, 2014), thus engaging students in the learning process. For example, a study by Quartuch (2011) showed that the use of authentic assessments allows students to become civically engaged demonstrating key content knowledge, critical thinking, and understanding complex issues from multiple perspectives. However, these findings are reliant on a small sample of 11 students from a 12th grade college preparatory American Government and Economics class in a large urban high school in eastern Pennsylvania.

Seafarer students are expected to achieve learning outcomes driven by the Standards of Training, Certification, and Watchkeeping (STCW) Code. However, lack of descriptive outcomes in the Code (Ghosh et al., 2014a) and traditional teaching practices often do not provide the students with clear expectations of learning standards to be achieved. In authentic assessment, the teacher provides a roadmap of the entire subject to be learned while allowing students to construct their understanding of the topic. Having standards of performance provided beforehand, would provide opportunities to seafarer students to reflect on their learning and carry out self-assessments of their thinking and practices towards achievement of the required standards. As learning progresses, learners assume increasingly more control over the sequence in which they want to engage their learning (Schell, 2000) and gain mastery over knowledge and skills learnt through strategic and critical thinking (Fredricks and McColskey, 2012) For example, a study by Findlay (2013) revealed that relationship between student-teacher based on the qualities of authenticity, belief, empowerment, and life-long learning, enhances student motivation and engagement. While the student and teacher relationship in authentic teaching was found to create a positive learning environment; belief, empowerment, and life-long learning was promoted through student reflection and self-assessment achieved through self-efficacy in the constructivist view of learning.

'Meaningful reflection' allows individuals to reflect on acquired knowledge in different situations encouraging them to become life-long learners (Schon, 1983). The technical term for this type of reflective process is metacognition (Scott, 2000). Metacognitive reflection and self-assessment teaches students to identify the gaps between their current competence and those required by educators or employers at the workplace (Boud and Walker, 1998).

This is a key requirement for transfer of learning to take place (McCarthy, 2013).

## 2 AUTHENTIC ASSESSMENT PROMOTE TRANSFER OF LEARNING

Official investigations and analysis of marine accidents have revealed that seafarers assessed as competent in the use of particular skills in a context have failed to apply them in another (Pecota and Buckley, 2009). Although reliant on a small sample, a study that comprised of a series of seventeen interviews with employers in the UK, Philippines, and Singapore, Sampson et al. (2011) discovered that employers were critical of some of the current assessment methods in use for seafarer assessment. The interviewees were fleet personnel managers from both owner operator companies and of ship management companies, involved in the employment of seafarers largely from countries like India, Myanmar, and Philippines and from Eastern Europe. According to the employers, current assessments assess a limited range of job specific skills (Cox, 2009; Cross, 2007), in settings that provide insufficient cues to the students on how the competence acquired in classrooms can be used in different contexts.

Students who are able to frequently reflect on their learning to recognize gaps in their own construction of knowledge and improve on them, begin to grasp cues on applying the same knowledge (developed in a specific context) to different contexts (Leberman, 1999) causing a transfer of learning (Donovan, Bransford, and Pellegrino, 1999) Authentic assessment are formative assessments that provide students with frequent opportunities to reflect (Herrington, Reeves, and Oliver, 2010), acting as a "pit stop" where students and assessors can reflect on the application of their skills (Curry, Caplan, and Knuppel, 1994) in a particular context and identify additional training requirements for different contexts.

Metacognitive reflection and self-assessment during construction of knowledge have been shown to increase the degree to which students will transfer to new situations without the need for explicit prompting (Bransford, Brown, and Cocking, 2000) For example, a study by Sator (2000) showed that metacognitive reflection as a thinking skill was evoked by all the reflection exercises in the Skills Transfer learning module of a bridging online course. The course was part of an online co-operative education (learning strategy that provides a structured method for bridging academic learning with practical experiences in the workplace) preparatory curriculum where the 28 participating students revealed strong evidence of metacognitive reflection in strategies adopted for successful transfer. The study involved a qualitative content-analysis of online discussion to understand if the thinking skills exhibited were consistent with the understanding of bridging techniques that support transfer of learning.

Seafaring assessments are usually summative carried out at the end of the learning period, not allowing the students to engage in deep reflection during the assessment process. Implementing formative authentic assessments would allow seafarer students to engage in metacognitive reflection to recognize the gaps that exist in their understanding. As gaps are recognized and become significant to students, they may locate, apply, and connect previous learning as well as new knowledge (Scott, 2000) and skills causing transfer of learning.

According to the self-efficacy theory by Bandura (1977), construction of knowledge as promoted by authentic assessment, develops critical thinking skills enabling students to re-evaluate their learning, causing behavioural changes that promote positive growth in cognitive development which can be used to assimilate, analyse, and structure information for decision making and problem solving as required on ships. For example, through a survey of 2567 participants in the graduate studies in education program, Saunders et al. (2001) found positive correlations between authentic assessment and adult learner's cognitive skills. Cognitive development through self-efficacy provides students with the belief and confidence to transfer newly acquired knowledge and skills (Merriam and Leahy, 2005). Learners draw on and extend previously learned knowledge and develop their own cognitive maps to interconnect facts, concepts and principles. As learning progresses, understanding becomes integrated and structured leading students to gain mastery over content (Scott, 2000). Past research suggests that the students' ability to transfer is enhanced when they are able to use the deep understanding of the learning content to interconnect facts and apply it to different contexts (Mestre, 2002).

However, according to the constructivism theory of learning, transfer can be enhanced when learning is contextualized in authentic tasks designed in meaningful contexts (Ertmer and Newby, 1993). Decontextualized learning does not allow students to recognize the connectedness of learning and application of skills developed to the real world which may have a negative impact on transfer (Mbawo, 1995). Due to complexity in recreating ships as workplace on land-based maritime educations and training institutes (METs), most of the learning and assessment in seafarer education takes place in decontextualized scenarios. Transfer is more likely to occur when instructional and application settings are nearly identical (Schell, 2000).

Authentic assessments conducted in real world contexts will provide 'cues' to students on strategies to adopt when performing in the real world. For example, in a study by Herrington and Herrington (1998), six pre-service teachers were assessed at the workplace to study their ability to transfer skills and knowledge developed through authentic pedagogical practices in classrooms. Interviews revealed that all six students had successfully used strategies without the need of prompting from the supervising teacher and attributed their use to the authentic teaching and assessment. Although the findings were derived from a small sample, the emphasis on meaningful authentic contexts in learning being necessary in preparing students for professional practices was highlighted. Contextualised authentic tasks may not recreate all the conditions of ships as a workplace but may replicate the complexities and challenges faced by seafarers in the real-world.

## 3 THE WAY FORWARD

Students engaged in analysing their own work against pre-established standards of achievement can provide critical feedback to teachers on how engaged the students are (Munns and Woodward, 2006). Concurrently, provision of clear expectations on standards of performance beforehand also allows educators to adopt appropriate pedagogical practices to guide students towards achievement of the desired outcomes (Archbald, 1991), which may improve learning practices. Improving learning practices may allow educators to meet student needs for higher engagement. Students engage in different ways and at times the expectations are not met due to a narrow vision of engagement held by educators (Trygstad, 2010). What may be authentic for educators may not be authentic for students. Educators may require additional training to develop their ability to create authentic assessments that reflect contemporary workplace needs.

In creating authentic ship-based or contextually similar scenarios to assess seafarer competence, educators must investigate the current needs of the employers and workplace expectations.

Student engagement lies more with pedagogical strategies. Contemporary pedagogy that treats students as stakeholders in the educational process may enhance student engagement. Education system must consult those that are designed to serve (Ozimek, 2000). This may allow educators to improve student perceptions of authenticity and in the process enhance engagement that may result from it. Students should be consulted in developing rubrics that provide clear outcomes intended to achieve from the learning process. Students will not only feel involved as an integral part of the learning process but will also provide valuable feedback that may improve the pedagogical practices and the outcomes resulting from it. Educators may also require additional training to develop their ability to create rubrics which can be used for instruction as well as assessment.

Authentic assessment research so far has not investigated its impact on seafarer training outcomes (Ghosh et al., 2014b). Future research needs to investigate if authentic assessments reflecting ships as workplace or contextually similar scenarios can be recreated in METs; and if such practices enhance the ability of seafarer students to transfer their learning from classrooms and simulators to workplace contexts.

Most of the studies used in this paper reveal findings based on a small sample of research participants. Future research needs to corroborate these findings using a larger sample of participants.

## 4 CONCLUSIONS

The literature examined in this paper indicates that students are engaged when they are able to develop a deep understanding and mastery of the learning content. This occurs through meaningful reflection and self-assessment; actively involved in the construction of knowledge; and form a deep connectedness of learning with real-world applications. In this way, student engagement can be used as an indicator to measure the quality of learning and teaching in universities.

Traditional learning and assessment methods in seafarer education are largely failing to engage the students in learning; and developing their ability to transfer learning acquired in classrooms to workplace settings. This paper presents a shift from teacher-centric education as currently practiced in seafarer education to learner-centric authentic pedagogical practices, as a possible solution. Student-centred education allows the students to be part of the knowledge construction process where they are fully aware of the learning expectations from the beginning of the learning period. This reduces uncertainty with assessment practices and creates higher student engagement. High student engagement promotes deep understanding of learning content and motivation to master skills and knowledge. Students develop a higher cognition to relate previous learning and newly acquired knowledge to apply in different contextual settings, which may assist in transfer of competence. The ability of students to perform workplace tasks is then not limited to specific classroom or simulator scenarios, as found currently with seafarer students.

However, contexts of learning and assessment needs to be meaningful for students to relate classroom learning to real-world practices as decontextualized scenarios make transfer nearly impossible. Such meaningful contexts can be achieved through real-world scenarios in authentic assessment. Future research needs to establish if authentic assessment in seafarer training can enhance student engagement and their ability to transfer learning to different contexts, making graduates more competitive in a global shipping world. As most of the studies used in this paper reveal findings based on a small sample of research participants, future research on authentic assessment in the area of seafarer training needs to consider larger number of respondents.

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# AN INVESTIGATION FOR THE RELATIONSHIP BETWEEN THE EMOTIONAL INTELLIGENCE, LIFE SATISFACTION AND LEISURE TIME SATISFACTION OF SERIOUS AND CASUAL PARTICIPANTS AMONG SEAFARERS

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**Abstract.** Social isolation of the seafarers on board is an important problem driver in the ship environment. Social isolation based problems occur due to the gaps in the use of emotional intelligence between the seafarers while serving on board the vessel. Accordingly, Maritime Labour Convention (MLC-2006) point out that the significance of providing the recreational facilities on board to overcome these gaps and resultant problems. In this context, the aim of this study is to determine leisure participants who might belong to the "serious and casual" and to compare them with their leisure satisfactions, emotional abilities, satisfactions with life and to understand the relationships between the leisure satisfaction, emotional intelligence and life satisfaction of the seafarers while they are on board. Thus a survey has been conducted among 200 seafarers by means of a questionnaire including "Serious and Casual Leisure Measure (SCLM)", "Leisure Satisfaction Scale (LSS)", "Shcutte Emotional Intelligence Scale" and "Satisfaction with Life Scale (SWLS)", and the results have been evaluated. It is found that the leisure participants could be categorized into two groups, as serious and casual. Besides, serious leisure participants have more ability to manage emotions, higher scores of life and leisure satisfaction than casual ones. Also, a large correlation between leisure satisfaction and emotional intelligence has been obtained; whereas, it is observed that there is a moderate correlation between leisure satisfaction and life satisfaction. Consequently, the results show that the proper and being aware of using leisure equipment, and facilities can increase the emotional intelligence and life satisfaction by breaking social isolation, and promoting motivation and work performance as well as health and well-being.

**Key words**: leisure, life satisfaction, emotional intelligence, recreation, seafarers

# 1 INTRODUCTION

In modern society, people separate varied behavioural roles, that are part of their daily lives such as family life, work, recreational activities, recuperation and they appoint particular spaces for these aspects to take place in (Fernandez & Krootjes, 2007). On the other hand, the ship is a total institute, both leisure activities and work take place within the same limited area. The ship is not only workplace for seafarers, but it is also their living place for an extended period of time (Fernandez & Krootjes, 2007).

Nowadays, seafarer has to work long hours, with voyages lasting many months and with short time shore periods (Ellis & Sapmson, 2013). Accordingly when it comes to seafarer's rest, the standards accommodation and recreational facilities supplied to them may have remarkable importance in assisting to rescue from mental and cognitive fatigue, and stress (Mass, et al., 2009 Van de Glind, et al., 2007; Kaplan, 1995).

According to study of Ellis & Sapmpson (2013), the most commonly provided recreational facilities on-board are DVD libraries, followed by books, and less frequently music systems, computer terminals, karaoke machines, and games.). The most infrequently provided recreational facility is internet access/Wi-Fi (Ellis & Sapmson, 2013). Also, most of ships have recreational room containing different facilities such us; fitness equipment, table tennis, dart charge, etc. Besides, a lack of recreational facilities is well-known fact that many seafarers experienced negative aspects of it (Ellis et al, 2012).

The human element is considered as a main factor contributing to incidents at sea (Hetherington, Flin and Mearns, 2006). The reason of human factor causing marine incidents and marine retentions is mostly based on social isolation and its effects on seafarers (Sampson & Thomas, 2003). Emotions serve social and communicative functions, carrying off information about people's thoughts and intentions and coordinating social encounters. (Keltner & Haidt, 2001). So emotional abilities are considered to be important for social interaction. Therefore, it is required to handle emotional information and to manage emotional dynamics intelligently to maintain the social world (Lopes et al, 2004). In other words, emotional competencies are able to break social isolation which induces human factor in marine incidents.

It is suggested by some researchers that ordinary participation in leisure activities and positive leisure satisfaction can enhance individual emotional development by cutting back personal anxiety, depression, and anger (Wu, 2010; Dumazedier, 1967). Also, leisure activities provide physical and mental health as well as an improved social interaction, psychological security, happiness and self-esteem (Wu, 2010; Iso-Ahola, 1997).

Furthermore, International Labour Organization (ILO) (2014) points out the significance of providing the recreational facilities on Maritime Labour Convention, 2006 (MLC-2006). Owners are held responsible for providing and maintaining "decent accommodations and recreational facilities for seafarers working or living on board, or both, consistent with promoting the seafarers' health and well-being in accordance with the ships' national legislation" (ILO, 2014). Also, MLC-2006 "contains a significant level of technical guidance with respect to national implementation of the standards for on-board accommodation and recreational facilities" (ILO, 2014). It has been noted the importance of providing not only on-board facilities but also shore-based welfare centres which are "located in or near ports, are important way to provide seafarers, who may be on extended voyages at sea, with access to health and welfare services in a foreign country, as well as a social environment" (ILO, 2014). It is also required to provide that "meeting and recreation rooms"; "facilities for sports and outdoor facilities, including competitions"; "educational facilities"; "where appropriate, facilities for religious observances and for personal counselling" (ILO, 2014). Besides, according to ILO (2014), all on-board recreational facilities must be "inspected and certified as complying with the national laws and regulations or other measures implementing the requirements of the MLC, 2006".

# 2 BACKGROUND

## 2.1 Emotional intelligence

It is known that the emotional intelligence is useful tool for improving the quality of life and the people performance within work (Saricam et al, 2015).

Emotional intelligence is described as the perception of the feelings of self of the individual and others, and using this in steps of problem-solving process (Mayer, Caruso, &Salovey, 2000; Salovey, 1990).

Emotional intelligence in workplace is a multi-dimensional constituent (Goleman, 1998). It is composing of self-awareness, self-regulation, motivation, empathy, and social skills. High levels of self-awareness provide executives to boost their self-confidence and take others attention by gaining more respects.

Through self-regulation, they can purposefully comprehend other people's needs. Executives play a positive role in motivating others by being balanced, self-motivated, optimistic and highly-spirited. Being capable of empathizing with others as well as managing interpersonal relations provides positive effect on motivating subordinates. The executives' emotional intelligence allows them to treat subordinates as individuals with unique needs and talents.

Empathetic executives use their social skills to help subordinates to establish their positive feelings and emotions in order to achieve their goals. Consequently, emotional intelligence create enhanced performance on the part of employees (Behbahani, 2011).

### 2.2 Life satisfaction

Life satisfaction indicates the well-being and it relies on doing well in large areas of life, such as relationships, health, work, income, spirituality and leisure (Diener, E., Biswas-Diener, R, 2008). High score of life satisfaction provides meaningful life and sharing goals and values which are important for them. Work performance and influences upon others can be improved by increasing of life satisfaction (Ignat & Clipa 2012).

### 2.3 Serious and casual leisure participation

Since its beginning, it has widely gained acceptance in the field that Stebbins's (1982, 1992, and 1997) theory on serious leisure (SL) and casual leisure (CL) has served as a beneficial framework in discussions about "optimally healthy or beneficial leisure" (Shen & Yarnal, 2010; Hutchison & Kleiber, 2005). Especially, there has been carried out a lot of studies about concept of serious leisure over the past 30 years (Shen & Yarnal, 2010). In comparison with serious leisure, there has been inadequate attention on casual leisure's concept and it has gained few empirical studies (Hutchinson & Kleiber, 2005; Shinew & Parry, 2005; Stebbins, 2004). In addition, Stebbins (2007) expresses that all nature and characteristics of casual leisure are ill defined in many cases and the studies on this issue are still continuing (Shen &Yarnal, 2010).

#### 2.3.1 Serious Leisure

Stebbins (1992) constructs the concept of serious leisure and defines it as "the systematic pursuit of an amateur, hobbyist, or volunteer activity sufficiently substantial and interesting for the participant to find a career there in the acquisition and expression of a combination of its special skills, knowledge, and experience" (Stebbins, 1992).

It is identified by Stebbins that "serious leisure is further distinguished from casual leisure by six characteristics found exclusively or in highly elaborated form only in the first. These characteristics are: 1) *need to persevere at the activity*, 2) *availability of a leisure career*, 3) *need to put in effort to gain skill and knowledge*, 4) *realization of various special benefits*, 5) *unique ethos and social world*, and 6) *an attractive personal and social identity*" (Stebbins, n.d.). Those qualities can be respectively shortened that 1) *perseverance,* 2) *leisure career,* 3) *significant effort,* 4) *durable outcomes,* 5) *unique ethos,* 6) *strong identification*.

Altogether, Stebbis' researches basically provide the theoretical development of serious leisure. So far, other researchers have contributed by consulting the SL theory and "many focused on identifying or elaborating on one or more of the six SL qualities outlined" (Shen & Yarnal, 2010).

#### 2.3.2 Casual Leisure

Casual, or unserious, leisure is identified as "the immediately, intrinsically rewarding, relatively short-lived pleasurable core activity, requiring little or no special training to enjoy it" (Stebbins, 1997). It is suggested that casual leisure's types are: play, relaxation, passive entertainment, active entertainment, sociable conversation, sensory stimulation, casual volunteering, and pleasurable aerobic activity (Stebbins, 2004; Stebbins, n.d.). According to Stebbins (2001), casual leisure has five benefits: encouraging "creativity and discovery", providing educational entertainment or "edutainment", affording "regeneration or re-creation", developing and maintaining "interpersonal relationships", and enabling participants to boost "well-being and quality of life".

### 2.4 Leisure satisfaction

It has been constantly indicated that the principal benefit of leisure activities is satisfaction (Hultsman, Hultsman, & Black, 1989). In order to comprehend this concept, it has been defined by many researchers that leisure satisfaction is a relative concept which is always evaluated in relation to a standard (Franckend & van Raaij, 1981; Lounsbury & Hoopes, 1985). According to Beard and Ragheb (1980), leisure satisfaction consists of the positive perceptions or feeling which an individual constitutes, reveals, or obtains as a result of engaging in leisure activities. It is the level to indicate pleasure with participants' general leisure experiences and situations (Beard & Ragheb, 1980). Satisfying individual needs provides participants to gain satisfaction of positive feelings (Du Cap, 2002). Level of leisure satisfaction shows extent of participants' perceived satisfaction through leisure activities (Beard & Ragheb, 1980).

## 3 METHOD

### 3.1 The purpose of the study

The aim of this study is to determine leisure participants who might belong to the "serious and casual" and to compare them with their demographic specifications, leisure satisfactions, emotional abilities, satisfactions with life and to understand the relationships between the leisure satisfaction, emotional intelligence and life satisfaction of the seafarers while they are on board.

### 3.2 The participants

Survey has been conducted among 200 seafarers by means of a questionnaire from different levels of competency; 6.5% Master, 54.0% Deck off., 21.0% Engine off., 12.5% Crew, 6.0% catering crew.

### 3.3 The instruments

#### 3.3.1 Schutte Emotional Intelligence Scale Revised (EI):

Schutte Emotional Intelligence Scale which is developed by Schutte, Malouff, Hall, Haggerty, Cooper, Golden and Dornheim (1998), revised as 41 items by Austin, Saklofske, Huang and McKenney (2004), adapted to Turkish by Tatar, Tok and Saltukoğlu (2011). Each item is answered according to 5 rated answering system (1 = strongly disagree to 5 = strongly agree). Points can be got from the scale is at least 41 and at most 205. Relative fit index values [$\chi^2$ (347): 2647.35 ($p<0.001$); GFI = .88, AGFI = .86; RMSEA = .06 and RMR = .09] are found by confirmatory factor analysis. Cronbach-alpha internal consistency coefficient for whole scale is found .89, for Optimism/Mood Regulation .75, for Utilisation of Emotions .39 and for Appraisal of Emotions .76.

#### 3.3.2 Satisfaction with Life Scale (SWLS):

SWLS is developed by Diener, Emmons, Laresen and Griffin (1985) and adapted to Turkish by Durak, Senol-Durak, Gencoz (2010). Scale consists of 5 items. Each item is answered according to 5 rated answering system (1 = strongly disagree to 5 = strongly agree). Total points can be got from the scale is at least 5 and at most 25. Translation of the scale, validity and reliability study are done by Durak (2010). In terms of reliability, the SWLS is found to have high internal consistency, and the item-total correlations are quite adequate. The results of the validity studies further confirm that the SWLS is suitable to use with different samples of Turkish participants, wide range from adolescents to elderly (Durak et al., 2010), (consistency coefficient = .81, IFI = .994, TLI = .987, CFI = .994, SRMR = .020, RMSEA = .043).

#### 3.3.3 Serious and Casual Leisure Measure (SCLM) & Leisure Satisfaction Scale (LSS):

SCLM and LSS are developed by Akyildiz (2013). Both of two scales have answering system from 1 (strongly disagree) to 5 (strongly agree). SCLM consists of 42 items and it is developed to determine leisure participant whether he/she belongs to the "casual or serious", respectively and to classify leisure participants into two groups as casual and serious. Scale has good consistency coefficient (0.95) and suitable factor structure (CFI = .98; GFI = .89; RMSEA = .051; $\chi^2$: 3608.57 ($p = .000$)).

LSS consists of 5 items and provides an image for the general satisfaction with leisure. The instrument has a good reliability (Cronbach alpha .85). Confirmative factor analysis results show that this scale has perfect factor structure (CFI = 1; GFI = .99; RMSEA = .050; $\chi^2$: 17.99 ($p = .000$)).

### 3.4 Procedure

The study is investigated by means of a questionnaire sent to 650 seafarers working on different types of ship. All seafarers is Turkish citizens. The questionnaire is returned by 200 seafarers (20 of them are women).

There is assured the confidentiality of the answers for all participants. Questionnaires is carried out via e-mail and web-based systems.

Normality test is conducted for EI, SWLS and LSS to determine correlation method used. After all scales are found to be normal distribution, it is decided to use bivariate correlations with Pearson correlation coefficients between all mentioned scales.

Furthermore, Hierarchical cluster analysis with ward method is conducted to determine number of groups, and after hierarchical cluster analysis, K-means cluster analysis is conducted to test reliability of classification and to define number of participant into groups. After determining group distribution, crosstabs are used to compare serious and casual participants' profile into all variables.

## 4 RESULTS

### 4.1 Normality test

According to George & Mallery (2010), the values for skewness and kurtosis between -2 and +2 are considered acceptable to prove normal univariate. All scales have acceptable value to be normal distribution shown as Table 1 and Figure 1.

### 4.2 Correlation matrix

*Hypothesis 1.* There is correlation between seafarers' leisure satisfaction and seafarers' emotional intelligence.

*Hypothesis 2.* There is correlation between seafarers' leisure satisfaction and seafarers' satisfaction with life.

Pearson correlation measures the existence (given by a p-value) and strength (given by the coefficient r between -1 and +1) of a linear relationship between two variables. It should only be used when its underlying assumptions are satisfied. If the outcome is significant, once can conclude that a correlation exists.

**Table 1** Descriptive items for scales

| Mean | | LSS | | EI | | SWLS | |
|---|---|---|---|---|---|---|---|
| | | **Statistic** | **Std. Error** | **Statistic** | **Std. Error** | **Statistic** | **Std. Error** |
| | | 4.0430 | .04335 | 152.6050 | 1.03445 | 3.2950 | .04572 |
| 95% Confidence Interval for Mean | Lower Bound | 3.9575 | | 150.5651 | | 3.2048 | |
| | Upper Bound | 4.1285 | | 154.6449 | | 3.3852 | |
| 5% Trimmed Mean | | 4.0544 | | 152.5833 | | 3.2900 | |
| Median | | 4.0000 | | 153.5000 | | 3.2000 | |
| Variance | | .376 | | 214.019 | | .418 | |
| Std. Deviation | | .61305 | | 14.62939 | | .64658 | |
| Minimum | | 2.60 | | 119.00 | | 1.20 | |
| Maximum | | 5.00 | | 191.00 | | 5.00 | |
| Range | | 2.40 | | 72.00 | | 3.80 | |
| Interquartile Range | | 1.00 | | 16.75 | | .95 | |
| **Skewness** | | **-.075** | .172 | **-.096** | .172 | **-.056** | .172 |
| **Kurtosis** | | **-.840** | .342 | **-.111** | .342 | **-.011** | .342 |

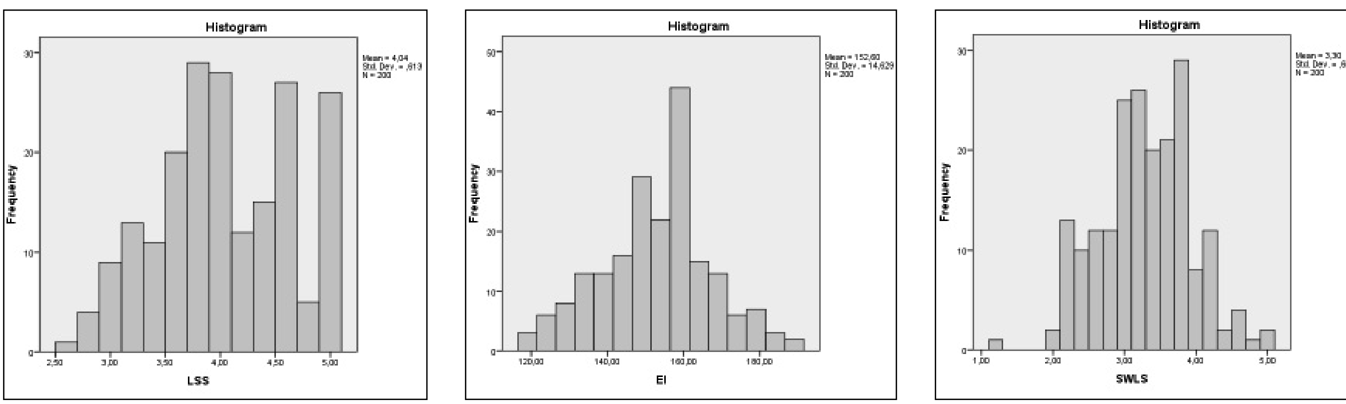


**Figure 1** Normal distribution of LSS, EI, SWLS

**Table 2** Correlations between LSS and EI, and SWLS

| | | LSS | EI | SWLS |
|---|---|---|---|---|
| LSM | Pearson Correlation | 1 | .509* | .353* |
| | Sig. (2-tailed) | | .000 | .000 |
| | N | 200 | 200 | 200 |
| EI | Pearson Correlation | .509* | 1 | .528* |
| | Sig. (2-tailed) | .000 | | .000 |
| | N | .353* | 200 | 200 |
| SWLS | Pearson Correlation | .353* | .528* | 1 |
| | Sig. (2-tailed) | .000 | .000 | |
| | N | 200 | 200 | 200 |
| *. Correlation is significant at the 0.01 level (2-tailed). | | | | |

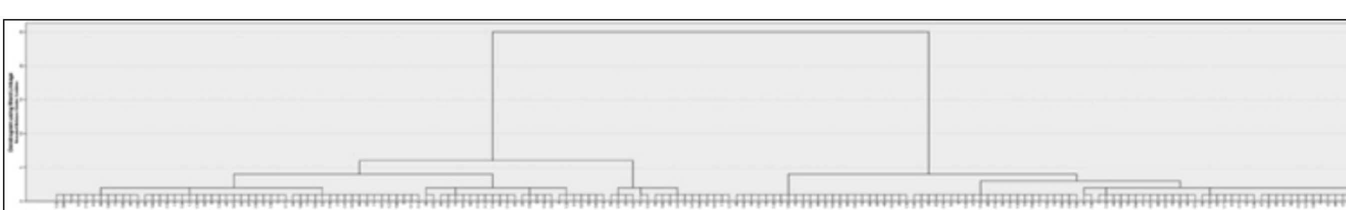

**Figure 2** Hierarchical Cluster Analysis of SCLM

**Table 3** K-means Cluster Analysis

| Factors | Cluster | | F | Sig. |
|---|---|---|---|---|
| | 1 | 2 | | |
| Perseverance | 2.62 | 3.72 | 119.664 | .000* |
| Leisure Career | 2.53 | 3.89 | 226.408 | .000* |
| Personal Effort | 2.20 | 3.93 | 277.955 | .000* |
| Psychosocial Benefit | 2.54 | 3.74 | 143.355 | .000* |
| Therapeutic Benefit | 3.58 | 4.35 | 69.466 | .000* |
| Social World | 2.94 | 3.63 | 38.036 | .000* |
| Devotion | 2.01 | 3.30 | 116.209 | .000* |
| Sense Of Competence | 2.08 | 3.58 | 176.174 | .000* |
| Count | 84.00 | 116.00 | | |
| % | 42 | 58 | | |
| *p <.001 | | | | |

**Table 4** Scores of groups depending on factors

| Factors | Cluster | |
|---|---|---|
| | Casual | Serious |
| | 1 (n=84) | 2 (n=116) |
| Perseverance | Low | Medium |
| Leisure Career | Low | High |
| Personal Effort | Low | High |
| Psychosocial Benefit | Low | Medium |
| Therapeutic Benefit | Low | Medium |
| Social World | Medium | High |
| Devotion | Medium | High |
| Sense of Competence | Low | High |

According to Cohen (1988) an absolute value of r of 0.1 is classified as small, an absolute value of 0.3 is classified as medium and of 0.5 is classified as large.

Taking into account of Cohen's (1988) suggestions, in order to verify hypotheses, it is calculated the Pearson correlation (all scale has normal distribution). The results (Table 2) show that there is a large correlation between seafarers' leisure satisfaction and seafarers' emotional intelligence (.509) and there is a medium correlation with seafarers' satisfaction with life (.353). On the other hand, there is also large correlation between seafarers' satisfaction with life and seafarers' emotional intelligence (.528).

### 4.3 Cluster analysis

It is observed from Hierarchical cluster analysis that SCLM has two meaning full group shown in Figure 2.

This two group structure is tested with K-means cluster analysis. Results of ANOVA and number of participants for each cluster are shown in Table 3. ANOVA's outputs which shows whether there exists significant difference between clusters in terms of each factors or not is evaluated and difference between clusters is found to be significant at the level of .01. (p <.001). One of the two clusters gained by analyses has 84 and another one has 116 leisure participants.

As a result of cluster analyses, it is found that second cluster has paid more attention for all factors than first cluster. In other words, average of second cluster's scores are greater than average of first one's scores in all factors (Table 4).

### 4.4 Crosstabs

Crosstabs are utilized to display comparison between casual and serious participants depend on all variables' scores shown in Table 5.

## 5 DISCUSSIONS

The aim of this study is to understand the relations between leisure satisfaction, emotional intelligence and satisfaction with life among seafarers. By statistical calculations, it is determined that there is a positive good correlation between leisure satisfaction, emotional intelligence and satisfaction with life. Accordingly, it is obtained that a good level of leisure satisfaction contributes to the satisfaction with life and good structure of emotional intelligence. In order to enhance the seafarers' emotional intelligence and satisfaction with life, the leisure and recreational facilities both on-board and onshore should be provided them. In addition, specific training programs for encouraging seafarers to participate recreational and leisure activities could be conducted by authorities.

It is found that leisure participants can be divided into two groups as a serious and casual. Beside, seafarers' serious or casual leisure participation makes a difference regarding leisure satisfaction, satisfaction with life and emotional intelligence. This study figures out significant difference among seafarers with serious leisure participation and ones with casual leisure participation. Thus the serious leisure participants have more emotional intelligent and more satisfaction with their leisure time and their life than casual ones.

## 6 CONCLUSIONS

We could conclude that good leisure satisfaction of seafarers is correlated with a positive attitude toward satisfaction with life and emotional intelligence. The results show that the serious leisure participants have more leisure satisfaction than causal ones, and it produces more life satisfaction and more emotional intelligence.

It is found in this study that seafarers who possess high level of leisure satisfaction with serious participation have also high emotional intelligence and satisfaction with life. Furthermore, there has been conducted

**Table 5** Scores Depend on Groups (Casual and Serious)

| Frequency of Doing Leisure Activity, SWLS, EI, LSS | | Participants | | Total |
|---|---|---|---|---|
| | | Casual | Serious | |
| The frequency of doing leisure activity selected by him/herself | A few times a contract | 4 (4.8%) | 0 (0.0%) | 4 (2.0%) |
| | Once a month | 0 (0.0%) | 5 (4.3%) | 5 (2.5%) |
| | Several times a month | 9 (10.7%) | 5 (4.3) | 14 (7.0%) |
| | Once a week | 8 (9.5%) | 9 (7.8) | 17 (8.5%) |
| | Several times a week | 38 (45.2%) | 55 (47.4) | 93 (46.5%) |
| | Everyday | 25 (29.8%) | 42 (36.2) | 67 (33.5%) |
| SWLS | Very Low | 28 (33.3%) | 22 (19.0%) | 50 (25.0%) |
| | Low | 32 (38.1%) | 19 (16.4%) | 51 (25.5%) |
| | Medium | 9 (10.7%) | 11 (9.5%) | 20 (10.0%) |
| | High | 11 (13.1%) | 39 (33.6%) | 50 (25.0%) |
| | Very High | 4 (4.8%) | 25 (21.6%) | 29 (14.5%) |
| EI | Very Low | 27 (32.1%) | 13 (11.2%) | 40 (20.0%) |
| | Low | 21 (25.0%) | 22 (19.0%) | 43 (21.5%) |
| | Medium | 23 (27.4%) | 24 (20.7%) | 47 (23.5%) |
| | High | 5 (6.0%) | 25 (21.6%) | 30 (15.0%) |
| | Very High | 8 (9.5%) | 32 (27.6%) | 40 (20.0%) |
| LSS | Very Low | 40 (47.6%) | 18 (15.5%) | 58 (29.0%) |
| | Low | 19 (22.6%) | 10 (8.6%) | 29 (14.5%) |
| | Medium | 12 (14.3%) | 28 (24.1%) | 40 (20.0%) |
| | High | 8 (9.5%) | 34 (29.3%) | 42 (21.0%) |
| | Very High | 5 (6.0%) | 26 (22.4%) | 31 (15.5%) |
| Total | | 84 (100.0%) | 116 (100.0%) | 200 (100.0%) |

many studies that show positive relation between work performance and emotional intelligence (Carmeli, 2003; Rosete & Ciarrochi, 2005; O'Boyle et al, 2011). In addition, high level of satisfaction with life refers to meaningful life, well-being and brings out work performance (Diener et al., 1985; Ignat & Clipa 2012).

In this point of view, proper using of recreational facilities provided on-board boosts seafarers' leisure satisfaction, so it enhances emotional intelligence and satisfaction with life of seafarers, and accordingly promotes motivation and work performance as well as health and well-being.

There is also obtained from some researches that there are benefits of providing good accommodation and recreational facilities from the perspective of the company (Ellis & Sapson, 2013). Progoulaki and Roe (2011) suggest that, "a competent, rested and well-motivated crew is an essential factor in reducing operational costs by increasing efficiency, safe operations and protecting the owner's investment in expensive vessels and equipment".

By taking all steps into consideration, one can easily obtain that there a lot of benefits of leisure time activities for both seafarers and maritime companies. Providing leisure facilities both on-board and onshore for seafarers ,and supporting and encouraging them to join leisure time activates as a serious participant can boost the emotional intelligence and life satisfaction by breaking social isolation, promote motivation and work performance as well as health and well-being, increase efficiency, safe operations and protect owner's investment by reducing operational costs.

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# UTILIZING E-LEARNING TOOLS TO FOSTER KNOWLEDGE MANAGEMENT PRACTICES IN MARITIME EDUCATION & TRAINING

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**Abstract.** Knowledge management is widely considered as a key driver for an organization's innovations. Indeed, better utilizing intellectual property and promoting expertise exchange is a topic that has been discussed extensively within the MET discipline. With the fast advancement in information communication technology, there are opportunities for an organization in the maritime industry, includes MET institutions, to tackle some traditional barriers to knowledge management practices in an effective manner. However, depending on various situations, there are a number of factors that might affect the processes of managing knowledge within an organization. The causes of these failures range from lack of management support; improper planning, design, coordination and evaluation; inadequate skill of knowledge manager and worker; having problem with organizational cultural and structure; Disoriented implementation of supportive technology, budgeting and excessive cost.

This paper reviews, synthesises, and discusses some key factors that affect the knowledge management practices in relation to the maritime sector. Several challenges that can hinder the implementation process are identified and discussed. We suggest how a MET institution effectively can utilize modern technologies, including E-learning tools, other various existing web-based application and cloud-based application to foster knowledge management practices. We also introduce an knowledge management application framework that describe the possibilities of how these technologies can interact with each others and with the users of an organization.

**Key words:** knowledge management, knowledge management system, E-learning tool, organizational knowledge, MET training

# 1 INTRODUCTION

Knowledge management has become an increasingly popular notion since the late 90s (Frost, 2014). Studies show that the successful management of knowledge can improve organizational productivity, service quality, organizational innovation, and uniqueness (Nonaka, 1994; Grant, 1996). This is also true to organizations in the maritime sector. Specific issues of knowledge management in the maritime sector for example includes that knowledge resources are widely spread across various maritime-related organizations. The creation and retention of such knowledge are a challenge for the maritime sector.

This paper reviews, synthesises, and discusses some key factors of knowledge management in relation to the maritime sector. These factors will be positioned in contemporary Maritime Education and Training's (MET) challenges and how a MET institution effectively can utilize modern technologies, including E-learning tools to foster knowledge management practices both internally and externally. In this context, the expertise and capacity of MET institutions are also positioned as a knowledge provider. It is possible that MET institutions take the lead to create a supportive knowledge management environment to nurture knowledge sharing in the industry.

Of interest to this paper are developments in Information Communication Technology (ICT), which open up opportunities for MET as well as other maritime related industries to foster knowledge management practices in an effective manner in terms of cost, scalability, and shareability. It is however important to keep in mind that although knowledge management can be enhanced by technology, it is not itself a technology discipline, and too much reliance on an IT tool can lead to the expectation of a "silver bullet" solution. Knowledge management strategies should focus on determining the socio-technical function of the IT systems that are necessary for the specific activities and initiatives within an organization (Robertson, 2007).

This paper is structured as follows: (1) introduces a theoretical framework to knowledge management and knowledge management systems; (2) is about contemporary issues in the maritime sector in relation to knowledge management; and (3) discusses how several contemporary ICT development can improve knowledge management practices within MET and the Maritime industry.

# 2 BACKGROUND

## 2.1 Data, Information, and Knowledge

Knowledge is not information and information is not data, before heading into discussing knowledge and knowledge management, it is important to clarify what constitutes knowledge and what falls under the category of information or data

**Data** can be considered as facts or figures which describe something specific, but they are not organized in any way and basically do not provide any further information regarding patterns, context, inferring, or descriptions (Frost, 2014)

**Information:** For data to become information, it must be contextualized, categorized, calculated and

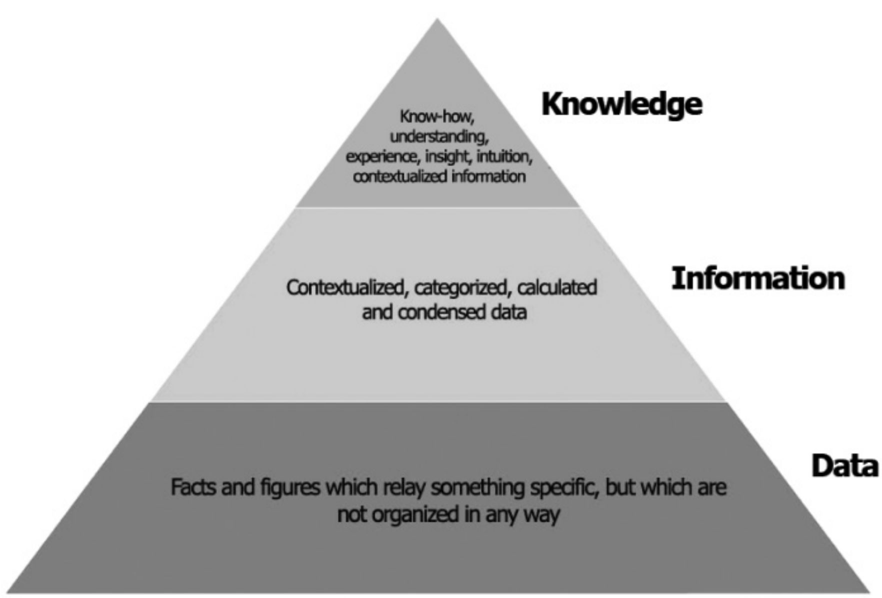


**Figure 1** Knowledge pyramid

Source: Frost, 2014 (http://www.knowledge-management-tools.net) condensed (Davenport & Prusak 2000). In other words, information paints a bigger picture from available data and makes it more relevant and purposeful (Bali, Wickramasinghe, & Lehaney, 2009).

**Knowledge** is "a fluid mix of framed experiences, values, contextual information, expert insight, and grounded intuition that provides an environment and framework for evaluating and incorporating new experiences and information. Knowledge originates and is applied in the mind of the knowers. In organizations it often becomes embedded not only in documents or repositories, but also in organizational routines, practices and norms." (Davenport & Prusak 2000). Knowledge implies know-how, understanding and experience of individual. Two types of knowledge can be distinguished, explicit and tacit knowledge.

### 2.2 Explicit knowledge and Tacit Knowledge.

**Explicit knowledge** can be transmitted to others. It is knowledge that is possible to codify and transmit in formal systematic language (Nonaka & Takeuchi, 1995) and can be readily articulated, accessed, and verbalized. Most forms of explicit knowledge can be stored in certain media (Wikipedia), It is sometimes referred to as know-what (Brown & Duguid 1998). Explicit knowledge is found in: databases, memos, notes, documents, etc. (Botha et al. 2008)

**Tacit Knowledge**, on the other hand, is harder to define knowledge and can be related to as for example experience and intuition. Tacit knowledge is personal and context-specific, and therefore hard to fully formalize and communicate. This type of knowledge is deeply rooted in action, commitment, and involvement (Nonaka & Takeuchi, 1995). Sometimes it is referred to as know-how (Brown & Duguid 1998) and it includes cultural beliefs, values, attitudes, mental models, etc. as well as skills, capabilities and expertise (Botha et al 2008).

### 2.3 Knowledge Management

Knowledge management can be defined as *"the systematic management of an organization's knowledge assets for the purpose of creating value and meeting tactical & strategic requirements. It consists of the initiatives, processes, strategies, and systems that sustain and enhance the storage, assessment, sharing, refinement, and creation of knowledge"* (Frost, 2014).

The view of knowledge as an actual asset rather than some something intangible enables an organization to better manage and utilize its intellectual resources. For an organization to successfully manage its knowledge assets, there must be the right tools, at the right time, for the right people to create, store, share and reuse the knowledge. From that point of view, knowledge management can be seen as continuous processes and comprise of (1) Knowledge Discovery & Detection, (2) Knowledge Organization, Assessment and Storing, (3) Knowledge Sharing, (4) Knowledge Reuse, (5) Knowledge Creation, (6) Knowledge Acquisition (Botha et al, 2008).

Organizational knowledge exists in many different forms as tacit, explicit and embedded within individual, group, intra and inter-organization. Concerning organizational knowledge management, the work of Nonaka and Takeuchi (1995) around concept of tacit knowledge and explicit knowledge with their theory

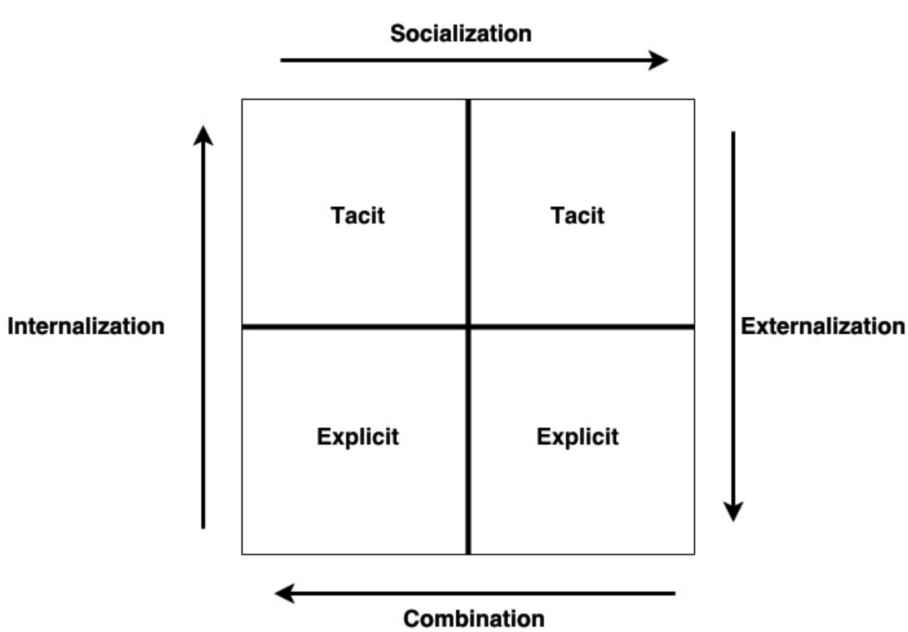


**Figure 2** SECI Model (Nonaka & Takeuchi, 1995)

about knowledge creation process has established a cornerstone within knowledge management. These authors describe individual tacit knowledge as a source of the knowledge creation process within an organization. Knowledge is managed through four processes of knowledge conversion that includes socialization, externalization, combination and internalization. This knowledge management process amplifies from the individual to the group and the organization as described below:

*"knowledge is created only by individuals. An organization cannot create knowledge without individuals. The organization supports creative individuals or provides contexts for them to create knowledge. Organizational knowledge creation, therefore, should be understood as a process that 'organizationally' amplifies the knowledge created by individuals and crystallizes it as part of the knowledge network of the organization."* (Nonaka & Takeuchi, 1995, p. 59)

- **Socialization**: Tacit to tacit. Knowledge is passed on through practice, mentoring, imitation, and observation. The key to acquiring tacit knowledge is experience.
- **Externalization**: Tacit to explicit. This is quintessential to the knowledge creation process. Tacit knowledge is converted and codified into documents, manuals. Writing is an example of such transformation. Externalization holds the key to knowledge creation process as it create new explicit concepts from tacit knowledge.
- **Combination**: Explicit to explicit. This process involve combining different bodies of explicit knowledge (documents, meeting, database). Codified knowledge resources (e.g. documents) are combined to create new knowledge.
- **Internalization**: Explicit to tacit. As explicit knowledge are now mostly tangible asset, they are used and learned, then that knowledge is internalized, modifying the user's existing tacit knowledge. It is closely like "What you have learned from reading a document.

## 2.4 Knowledge management system

Knowledge management systems can be defined as "a class of information systems applied to manage individual and organizational knowledge processes and flows. They include ICT-based systems that are developed and used to support and enhance organizational processes of knowledge creation, storage/retrieval, transfer, and application" (Carlsson, 2003). However, there is still not an universal definition that falls into consensus between scholars. Robertson (2007) argued that although an IT system assists, facilitate and enhanced the knowledge management process, but knowledge management is not an information technology discipline. It is suggested that an knowledge management system should be extended beyond the traditional information system. In this paper, we view the term knowledge management system as an abstract and generic system that includes IT-based information subsystems and non-IT-based subsystem. In other word, this referred generic system is composed of people, tools, technology, and knowledge asset that interact with each other to store, create new knowledge, and provide available knowledge to individuals in an organization who need it.

As previously mentioned, IT tools are only one important aspect of a knowledge management system. Human interaction and engagement is required to create a working solution for any knowledge management initiative and implementation. Botha, Kourie and Snyman (2008) suggest that functionalities of a complete knowledge management system should be capable of:

- **Supporting of Knowledge Detection, Sensing & discovery, organization:** Searching for existing knowledge. If knowledge exists within the organization, it must be properly recognized, externalized and categorized before it can be reused or shared within a system. With explicit knowledge, IT based systems can be used to search for knowledge by looking at the database, patterns and text.
- **Facilitating collaboration, socialization and communication:** Dealing with tacit knowledge is a lot more complex. It is perceived to include cultural beliefs, values, attitudes, mental models as well as skills, capabilities and expertise (Botha et al 2008). knowledge management processes that are related to tacit knowledge requires socialization, collaboration, communication, and such activities can take place under many different forms (Davenport & Prusak, 2000).
- **Enabling participants to create, distribute, share and reuse the knowledge easily:** Once the new knowledge has been detected or created, there should be an effective tool to store, organize, share, retrieve and reuse it. The user friendliness and the experience of the interaction with a system plays an important role to encourage users to participate in knowledge management processes.

However, depending on the situation, there are a number of factors that might affect the processes of managing knowledge within an organization. Some researchers indicate that the failures rate can be up to 50%, or even higher, if including all projects that did not live up to the expectations (Frost, 2014). The causes of these failures range from lack of management support; improper planning, design, coordination and evaluation; inadequate skill of knowledge manager and worker; having problem with organizational cultural and structure; Disoriented implementation of supportive technology, budgeting and excessive cost.

## 3 CHALLENGING IN KNOWLEDGE MANAGEMENT PRACTICES WITHIN MARITIME INDUSTRY

Common challenges that can be recognized in the maritime industry that implicates the management of knowledge includes a highly diversified workforce, remoteness of working environments, multicultural crew members or employees, and fatigue phenomena. While onshore, MET institutions also encounter difficulties to manage knowledge due to lacking incentives of engaging in a knowledge management initiative, inadequate ICT technical skills, and monetarily budget allocation.

The maritime industry by its nature is international and employs a high level of workforce diversity across nations and cultures (Fei, Chen & Chen, 2011). In some researches, it is estimated that two thirds of the workforce is working in multicultural environment (Kahveci & Sampson, 2001). Not only that, people from different countries speaks different languages. Even though english is now a common working language onboard the ship, the ability to communicate in english can significantly vary amongst seafarers (Fei, Chen & Chen, 2011). Apart from linguistic factor, a tight working schedule and fatigue phenomenon discourage seafarers from communication and their contribution to the knowledge management related activities. Whenever the ship is at sea, it becomes an isolated world spatially and socially. Most seafarers carry out their watch duty alone, where one group has a different schedule from the others. The manning trend is also to reduce the number of personnel on modern vessels, which makes the working environment even more isolated. Even with the help of modern ICT applications, the social connection with the rest of the world and with the onshore organization is still limited. It can be recognized that such working environment reduce the likelihood of encouraging the seafarer to be an active part of a professional network either for socialization or learning purposes (Goel 2003, Mazieres et al. 2002).

The above factors work in combination to make the daily communication difficult and consequently hinder the socialization and the sharing process of tacit knowledge. From a knowledge management perspective, the knowledge creation mechanism as described through the SECI model can be compromised and the effectiveness of learning and training efforts are reduced. The socialization plays an important role for transformation of tacit knowledge to happen. However, in order for new knowledge to be created and transferred, there should be interactions and conversions between tacit and explicit knowledge via the four processes of socialization, externalization, combination and internalization. Consequently, if a company invests in a knowledge management initiative, there is a challenge to get the active engagement of onboard participants, who are key for a successful implementation effort.

At shore, MET institutions also encounter challenges that can hinder knowledge management initiatives. Even though the importance of knowledge management has been acknowledged as a high level of priority, the implementation process is not always straightforward. Technically, some ICT skills and knowledge are often required in order for an instructor to successfully use a knowledge management system to codify, store, extract and share their knowledge. A MET institution itself is a non IT discipline, so when going beyond non-IT-based approaches (e.g. meeting, conference, socialization, etc.), most of the instructors and teachers need to be trained to use the IT-based tools properly. Difficulties in interaction with the technology discourage them to engage in any IT-based knowledge sharing activities.

Not only that, tight teaching schedules of teachers/instructors can also be seen as a barrier factor. The implementation of knowledge management involves many inter-related processes; creation, acceptance, adoption of values and procedures. It also requires strong guidance, support and cooperation across departments. Sometime teachers and instructors do not have time to participate actively in a knowledge management system or simply do not have time to manage the implementation of knowledge management or an effort of that kind in an institution.

Additionally, investing in a knowledge management solution is often expensive and there are limited effective assessment tools and mechanisms to evaluate the successfulness of knowledge management initiatives. The effectiveness of knowledge management has been recognized as notoriously difficult to evaluate, especially in monetary terms (Ahn & Change, 2004). The benefit that a well-working knowledge management implementation brings about is not something that is tangible. For some institutions, knowledge management must be linked to economics, and its value is expected to be readily apparent (Botha, et al 2008). In many cases, MET are from public sector with limited budget allocation which prevent them to invest excessively into such an fancy investment.

The factors mentioned above can weaken the knowledge management effectiveness. The activities of knowledge storage, sharing, and reuse can be hindered if the teacher and instructor have to deal with inappropriate tools or sophisticated technology. The process of externalization to convert what an instructor/teacher knows into a sharable system turn out to be a time consuming process. Weber (2007) warns that a knowledge management initiative risk failure when it is designed without input from stakeholders of an organization. Related work shows the correlation of employee contribution with the success knowledge management implementation (Frost, 2014). Having said that, providing a familiar application for knowledge management play critical role as it helps to encourage the user to participate in knowledge storing, organizing, retrieving, sharing and reusing activities.

## 4 SHOULD MET INSTITUTION START TO PLACE MORE EMPHASIS ON KNOWLEDGE MANAGEMENT?

Better utilizing intellectual property and promoting expertise exchange is a topic that has been discussed extensively within the MET discipline. Maritime industry has a very mobilized workforce, working in remote workplaces all over the world. In MET there is a shortage of experienced experts who have been involved extensively in real-world practice. Some experts work as instructors in an institution for a short period of time, then they leave for seagoing job. Such movement introduces challenges for knowledge management when it comes to manage the waste of intellectual property.

As previously mentioned, the importance of implementing ICT into educational activities has been widely recognized. There are also efforts in the knowledge management domain to encourage the contribution and facilitation of knowledge exchange within maritime knowledge community. There is a need to spark knowledge management initiatives by promoting collaboration, and expertise exchange between institutions, teachers and students. It is possible that MET institutions take the lead to create knowledge management supportive environment and nurturing knowledge sharing culture in the industry. A positive culture helps to encourage organizational member to share their knowledge as it strengthen trust (Davenport & Prusak, 2003), increase the willingness to accept knowledge and the ability to learn from their peers and group (Chua & Lam, 2005; Wu et al, 2010). A knowledge sharing culture also contributes to nurture informal communication, informal learning, openness to business process changes, and better reaction to external changes (Weber, 2007; Wu, Du, Li & Li, 2010). As a result, better knowledge management practices not just only benefit the METs themselves, it also helps to facilitate and nurture the knowledge sharing culture and knowledge sharing skills for a future workforce.

Secondly, future seafarers need to be equipped with contemporary skills and knowledge to handle dynamic change and uncertainty of working reality. At the same time, the faculty member of MET institutions should always find ways of upgrading and exchanging the knowledge and expertise with their students and their peers. Indeed, expertise exchange is crucial in MET. For example, it is important for a maritime expert, who is a maritime vocational instructor moving from shipboard operations to an academy simulation laboratory. It is also important for another "practice" faculty - a linguistic teacher who is moving from other university settings into the maritime education and training setting. There are always challenges of understanding and embracing the pedagogical and scholarly demands associated with a dynamic balance of theoretical and experiential education. In this case, an effective knowledge management help to better utilize intellectual assets, improving competitive advantage of a MET, and perhaps most importantly to help MET to keep up with the real-world practice. Studies show that that the successful management of knowledge resources can improve organizational productivity, service quality, promoting organizational innovation and uniqueness (Nonaka 1994, Grant 1996, Teece, 1998). A study of 443 company with more than 50 employee in New Zealand to examine the relationship between knowledge management implementation with the firm innovation and performance indicated that firms with knowledge management capabilities use resources more efficiently, more innovative and perform better than companies without a better developed knowledge management implementation (Pirkkalainen, Pawlowski 2013). Knowledge management via education and training should be no longer seen as an extravagance profit but as a necessities in order to keep up with changes and competitors (Wild, Griggs & Downing, 2002).

## 5 KNOWLEDGE MANAGEMENT AND ICT

With the fast advancement in ICT, including for example faster internet speed, the maturity of Web 2.0 platforms, online social networking, cloud-based technology, and their ecosystem applications, there are opportunities to tackle some traditional barriers to knowledge management practices. Throughout the literature, IT tools are being used and they play an important role in facilitating or enabling management practices (Alavi & Leidner, 2001; Wild et al, 2002). This paper proposes a framework which takes advantage of existing IT-tools and technologies. Its focus is around a core e-learning platform and its capability can be extended with the support of many other IT-based applications. These applications can be considered as being familiar with contemporary youth generation and with most of MET instructors and teachers.

### 5.1 Using E-learning platform to foster knowledge management practices.

Investing in a knowledge management can be expensive and take a lot of organizational effort. When it comes to knowledge management tools that are available on the market today, literally there are thousand of options to chose from (Frost 2014). We made an attempt to synthesize the capabilities of existing open-source e-learning platform to an MET/industry organization's operational procedures and processes in combination with the use of other available IT tools, e.g. Content Management System (CMS), WIKI, Cloud storage, etc. From that feasibility assessment, we propose a conceptual E-learning based knowledge management system model. The main goal is to utilize already established ICT facilities to improve and foster knowledge management practices in MET/industry organization in a cost-effective and scalable manner.

### 5.2 Why E-learning?

E-learning can be a way to empower a workforce with skills and knowledge (Wild et al, 2013). Taking advantage of E-learning systems in knowledge management is not a new occurrence. E-learning as a core platform of knowledge management systems has been used and deployed by many major corporations. CISCO System and McDonald's are just two examples of companies that promote and integrate E-learning as a core system for its knowledge management strategy (Cisco System, 2001; Wild et al, 2013). This coupling is due to the fact that E-learning and knowledge management processes have many attributes in common. Many basic knowledge management processes can be mapped onto an e-learning's basic courses, lesson units, and functions. The accessibility to internet and faster connection speed also make E-learning a viable solution that allow organizations to deploy learning and training to their workforce anytime, anywhere and enables an organization to share the knowledge across a distributed network. That also allows employees to take on learning activities in a flexible manner alongside with their daily work. This feature is important from a practical knowledge management perspective. When a real-world problem is successfully solved, its relevant know-whats and know-hows can be saved into a knowledge repository for later reference, sharing and reuse. At the same time, the processes of externalization and combination as described in SECI model occurs when one tries to convert knowledge from experience, skills and other relevant explicit knowledge (e.g. reference documents) into some tangible things as a learning objects. During such interacting processes, new knowledge can be created too. The point is, there should be a learning system available in place and in time that is easy and familiar to interact with. As with most educational and training institution, E-learning can be considered an essential and a familiar system.

The functionalities of an E-learning system permit the capture, storage and dissemination of learner's insight and expertise through rich media resources (audio, video, textual material, written guideline and documentation). Toward organizational knowledge creation, e-learning is a promising means to manage intellectual assets (Wild et al, 2002). For example, operational processes can be mapped into an e-learning course and lesson that help an organization to improve the skills of their workforce or creating a training portal for new workers as an internal training portal that store organizational knowledge (see Figure 4 and Figure 5).

If properly deployed, an e-learning system can become a growing-knowledge-repository that enables MET to continuously deliver the organizational knowledge to their employees with "what they need to know" at "when they need to know".

Additionally, there is a need for an MET institution to keep up with the industry with the ever changing real-world environment. An E-learning based knowledge management system that is accessible over the internet will enable an organization to train, educate and support their workforce, partners, customer and other stakeholder. In return, an institution can generate more knowledge through the use of that system as well as benefit from the information and knowledge gained from their knowledge partners.

Fortunately, the recent development of many web-based platforms and its applications, cloud technology, interoperability of databases, online social network have empowered an e-learning system with even more features. Figure 3 describes a framework of an e-learning based knowledge management system.

In the framework, the core is powered by an E-learning system which acts as intermediate interface that allows users to interact with the knowledge management process (knowledge discovery, detection, organization, assessment, and knowledge sharing reuse, creation, acquisition, sharing). For example, via its capability of creating an online training course, it can be used to support an effort from human resources of providing an internal training program to the employee. Surrounding that activities, existing explicit organizational knowledge (e.g procedures, policies, documents, etc.) can be made available and transferred to the people who need it. By interacting with the system (creating lessons, searching for available resources, etc.), the knowledge conversion processes (e.g. combination and

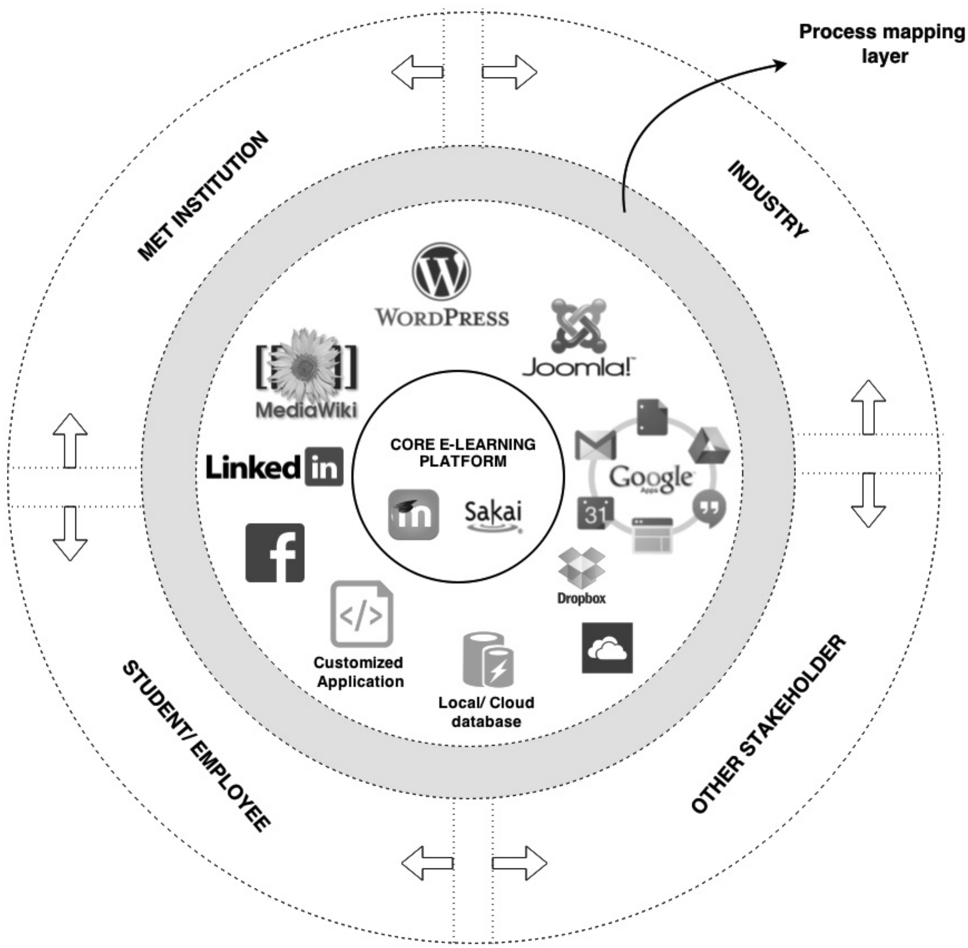


**Figure 3** Framework of E-learning based knowledge management

Source: Authors


**Figure 4** An internal training unit can be planed as structural lessons

Source: Authors


**Figure 5** Within each section, explicit knowledge such as documents, reference material can be linked from various locations and sources

Source: Authors

externalization) are taking place within an individual, and therefore facilitate the creation of the new knowledge.

A part from the core layer, other supportive applications such as Web 2.0 Content management system (CMS), cloud-based applications and online social networking are positioned as useful tools to assist knowledge management practices of an organization (Sultan, 2012). In-house content management and database access are often difficult and complicated to maintain, deploy, administer and inflexible to the rapid changing real world practice. Such technical limitations translates into significant planning, design, implementation challenges and increase operational cost that discourage many knowledge management project (Sultan, 2012). When acting in combination, the two inner layers can complement each other and contribute to addressing traditional barriers of knowledge management practices. Online social networking tools make it easier for anyone to feed information from their professional network, contribute to knowledge creation, sharing and forming an informal learning environment. It is easier than ever before to share a content of any kind from a website or from any CMS system over an online social network (see Figure 6).

Being web-native, these systems can work together and facilitate sharable mechanisms that extend the capability of an E-learning system. For example, within a lesson of an E-learning course, any reference and learning resources can be linked to any webpage that is located in cloud storage. For example, in figure 5, a cloud-based google document can be embedded inside an E-learning lesson unit and allow its authorized users to directly access, edit and collaborate without relating to the actual original location within the file repository. Figure 6 describes an inter-link capability that an E-learning system can benefit from these technologies. The web-native characteristic of these systems provide


**Figure 6** Information from a webpage or a CMS system can be easily embed in a social network (Facebook) post and shared across any interested group of people. Such post in a social network can also be linked back any other CMS or E-learning system.

any particular content an Uniform Resource Locator (URL) link that other systems easily can reach, reuse, and embedded. In other scenarios, the web-native social network feature enables an E-learning based knowledge management system to link directly to a social network page of an expert or an informal professional social network group. From there, the learners can contact, connect and seek support directly from that professional network. The created knowledge from that process can be updated back to the system for storage and reuse. In figure 6, any newly updated information from Facebook social network hosted by an institution or an informal professional network instantly are updated to author's personal feed. Each of these feeds, social page of an organization or group have an unique web-friendly URL that allow any web-based system to connect to and embedded in.

These sharable mechanisms allow any MET institution, industry, informal professional network and other stakeholder to share, contribute and collaborate on common knowledge artifacts and exchange expertise with ease. If it is successfully implemented, an organization from the industry can assist its project partners, workforce and contribute their applicable knowledge back to a MET by providing an access or a sharable training course. With other knowledge management scenarios, a MET community can take advantage of such technology leverage to promote and improve its internal and external knowledge management practices.

## 6 CONCLUSION

The importance of knowledge management for an organization to innovate and create a competitive advantages has been widely recognized. The capabilities of today's ICT and its potential applications provide MET opportunities to better cope with knowledge management practices internally and externally. E-learning is an important system to any educational and training institution, and can contribute to enhance the organizational knowledge management practices. In this paper, a framework has been proposed that positions an E-learning system at its core with the support of many other web 2.0 applications and cloud-based technology. It enables real-world processes to be mapped with E-learning courses and lesson units. The framework intends to lower the barrier of using an E-learning system for teachers and instructors and encourage them to engage into knowledge management initiatives. The successful of knowledge management solution require a systematic analysis and design, and the proposed framework needs to be taken into consideration and experiment in order to meet the complex need of particular setting.

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# ELECTRO-TECHNOLOGIES FOR ENERGY EFFICIENCY IMPROVEMENT AND LOW CARBON EMISSION IN MARITIME TRANSPORT

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**Abstract.** The global share of greenhouse gas (GHG) emissions from ships is on the rise which will become a significant portion leading to climate changes and other environmental issues unless reduction measures are taken. Therefore, the International Maritime Origination (IMO) and other regulatory bodies have set limits for emissions and defined emission controlled areas. As a result, alternative fuel such as Hydrogen and liquefied natural gas (LNG) that are low in greenhouse gas emission and competitive in cost are gradually being entered into the shipping industry. However, these alternative fuel technologies are still in the developing stage and the necessary infrastructure is not fully developed yet. Therefore, it is reasonable to assume that majority of the ships continue to burn fossil fuel for the foreseeable future.
A promising and viable solution for reducing the emissions is to reduce the fuel consumption through efficiency improvement. In this context, electro-technologies are shown to be capable of playing a vital role in improving fuel efficiency and thereby reducing emissions. The aim of this paper is to present a review on recent advancements of electro-technologies that help improve fuel efficiency of ships. A hybrid electric ship propulsion system is discussed as an example to show the potential of electro-technologies in improving the fuel efficiency.

**Key words**: electric ship propulsion, emissions, fuel efficiency improvement, high voltage shipboard power systems, hybrid ship propulsion, renewable energy sources

## 1 INTRODUCTION

Shipping is considered as the backbone of the global economy and it accounts for more than 90% of the goods transported locally as well as internationally [1]. With the steady growth of the shipping industry, more and more fossil fuel is burnt every year and as a result, the fuel price shows a long term increase. This, in turn, increases the operating cost of shipping. On the other hand, obnoxious emissions from the burning of fossil fuel causes long term damage to the environment [2]. According to the recent GHG study conducted by the IMO, the global share of GHG emission of the shipping industry accounts for 2.8% carbon dioxide ($CO_2$) equivalent of the global GHG emission [3]. Even though this is a relatively small number, the long term damage that it can cause to the environment and resultant climate change will be significant, especially if appropriate countermeasures are not taken to control the emissions. Therefore, certain countries and regions have imposed strict regulations on carbon emission and defined emission control areas (ECAs) around the coast [4, 5]. Ships that come to the ports in these areas or sailing in these regions should take measures to meet emission criteria.

As the international regulatory body for maritime transportation, IMO has taken strong initiatives to set emission reduction and efficiency improvement requirement targets that encourage the entire shipping industry to act on emission reduction. Amongst these initiatives, the energy efficiency design index (EEDI) requirement stipulates that newly built ships should meet agreed efficiency targets and 20%, 25% and 30% efficiency improvements targets in 2020, 2025 and 2030 respectively. This requirement plays a vital role in achieving 50% carbon reduction by 2050 [1-6]. In order to achieve these efficiency targets, a substantial change is required in every aspect of shipping. In this context, electro-technologies play a leading role as the bulk of ship power requirements can be efficiently supplied in the form of electrical energy. Therefore, the trend in the contemporary maritime transport sector is moving away from the predominantly mechanical based systems to a greater utilization of electrical and electronic systems. Electric ship propulsion is a good example that demonstrates this trend where traditional mechanically coupled propulsion mechanisms are increasingly being overlooked in favor of fully-electric or hybrid-electric drive systems [5]. The major advantages of fully-electric or hybrid-electric propulsion technologies are the improved efficiency, resultant reduction of GHG emissions, control flexibility and superior performance compared to traditional propulsion systems. In addition to propulsion, there are number of other areas where electro-technologies can contribute to the efficiency improvement in shipboard power systems. Section 2 of this paper presents a few electro-technologies that are currently used in ships to reduce fuel consumption. In addition, a few other promising technologies that are currently in the development stage are also discussed in section 2. A typical hybrid-electric ship propulsion system is taken as an example in Section 3 to illustrate the potential of modern electro-technologies in improving fuel efficiency and thereby reducing GHG emissions in maritime transport.

## 2 PREVAILING ELECTRO-TECHNOLOGIES AND EMERGING TRENDS IN SHIPS

### 2.1 Alternative energy technologies

The use of alternative energy technologies to supply the shipboard power demand is gaining attention as a way of reducing GHG emissions in ships. Three such technologies that are feasible for ships are photovoltaic power systems, fuel cell power systems and thermoelectric energy recovery.

#### 2.1.1 Photovoltaic (PV) power systems

In a clear day, one square meter area of the earth receives approximately 1kW of power from the direct sunlight [7]. This power can be converted into electrical form with the use of PV cells. This is a mature renewable energy technology widely used in land based power systems, accounting for more than 200GW worldwide [8]. At sea, ships receive sunlight without any obstacles or shading from the surrounding and therefore, an ideal place for erecting solar panels. However, as the amount of power that can be captured from sunlight depends on the available surface area there is a limitation on the amount of PV power generated in ships. Despite this space limitation PV power systems are becoming popular in cruise ships as a green energy source that supplies electricity to the ships' shopping districts [9]. In another implementation, PV panels are erected vertically which increases the effective surface area [10]. In these applications the power captured from solar panels are used to offset the power from fossil fuel and thereby reduce fuel consumption. Studies have shown that PV technologies have the potential to contribute up to 3% improvement of the fuel efficiency in ships [11, 12].

#### 2.1.2 Fuel Cells

In fuel cells, Hydrogen and Oxygen act as fuel which are combined inside a special membrane. The electrochemical reaction between Hydrogen and Oxygen produces electricity and $H_2O$ (water). Since the by product is water, this technology does not emit any obnoxious gasses. Apart from that, large scale production of Hydrogen and Oxygen is economically feasible. Therefore, the use of Hydrogen as an alternative fuel is considered as a promising solution [2]. However, safe and efficient hydrogen storage technologies are still at the development stage and therefore, large scale deployment of fuel cell power systems in ships are yet to come. Apart from that, response of fuel cells for changing power demands is slow and therefore they are more suitable to use as an auxiliary power source in ships for supplying slow changing loads [13]. Recently, the ship "Viking Lady" has been equipped with a Fuel cell system as a pilot project [14].

2.1.3 Thermoelectric energy recovery

Ships generate large amount of waste heat which is partly recovered as thermal energy through waste heat recovery systems. The conversion of waste heat into electricity is an alternative that can help further improve the fuel efficiency [11, 12]. Nevertheless, the conversion of waste heat into electrical energy is still at the development stage mainly due to the high cost, low efficiency (≈15%) and low voltage levels of the thermoelectric cells that are used to convert heat into electricity. In addition to the low voltage, the output voltage varies with the temperature and thus power electronic converters are required to interface thermoelectric modules into the power grid. New thermoelectric materials and high efficiency power electronic converter technologies are currently being researched to make thermoelectric generation efficient and cost competitive with the other technologies.

## 2.2 Energy storage

Energy storage has been identified as a key technology that can improve engine efficiency. For example, pulse loads or large power demands that last for short periods can effectively be supplied with energy storage elements such as batteries or supercapacitors without running the motor into non-optimal conditions. Recently, a vast amount of research has been carried out on the efficient use of energy storage technologies in ships. This growing interest and relevant technology development have made energy storage an essential part in future ships.

Lead acid is the most common, widely available and relatively cheap battery technology used in ships. Nevertheless, their efficiency and cycle life are low compared to the alternative battery technologies such as Lithium-ion, molten-salt and flow batteries. Out of these technologies, Lithium-ion batteries have the highest efficiency and cycle-life. Therefore, they have become the number one choice in consumer electronic and automobile industries. However, the cost of Lithium-ion batteries are still at the high side and therefore not a very popular choice for large scale shipboard applications. Flow battery technologies such as Zinc-Bromide, Vanadium- Redox and Iron-Chromium and molten-salt battery technologies such as Sodium-Sulfur and Sodium-Nickel are moderate in cost, efficiency and cycle-life. Therefore, these technologies are gaining attention as suitable energy storage technologies for ships.

## 2.3 Variable speed drives

Pumps and fans are widely used in ships which accounts for a reasonable share of shipboard electrical loads. The traditional approach is to connect the motors directly to the AC supply and run them closer to the synchronous sped. However, the required flow rate might be lower at certain conditions and therefore running closer to the synchronous speed is inefficient. In such cases variable speed operation can effectively reduce the power consumption. In order to realize variable speed operation frequency converters are used which is generally in the form of AC-DC-AC power conversion stages. In the past, diode and thyristor based power converters were used to build these converters. Nowadays, insulated gate bi-polar transistors (IGBTs) have become the popular choice to build frequency converters due to their high frequency switching and high power handling capabilities. In addition, advanced control technologies such as model predictive control and adaptive control are actively being researched to improve the performance of variable speed drives in steady state and transient conditions. Owing to these technological advancements and efficiency improvements, variable speed drives have become the industry norm for pumps and fans.

## 2.4 Electric propulsion

In simple terms, electric propulsion refers to the generation of propeller torque by means of an electric motor. In fully electric propulsion systems, motor is the only unit that generates the torque. In hybrid electric propulsion systems, an engine generates major portion of this torque and the motor assists it. Electrical power required for spinning the motor comes from a prime mover driven single generator or set of generators. The prime mover can be either a diesel engines or a gas turbine. When the power is transmitted in the electrical forms, the placement of generators and engines become flexible, whereas in traditional mechanical transmission based systems, engine is required to be placed at a particular location. Apart from that, the motor can be placed very close to the propeller so that mechanical transmission and associated problems such as tear, wear and fatigue can be minimized. This has been further extended in pod propulsion systems by putting the motor into a pod outside the ship and attaching the propeller directly into the rotor. This gives the flexibility to turn the entire pod and thereby change the direction of the thrust. This enables rudderless maneuvering. Since the response of electrical systems are faster than mechanical systems, ship maneuvering has become easier with electric propulsion.

Compared to the traditional mechanical driven propulsion system where a specific large engine has to be coupled to the propeller, in electrical propulsion systems, a number of small generators can be connected into the common electrical power bus and run them efficiently based on the power demand [15]. An extension of this technology is the integrated shipboard power system where the same set of generators are used to power the hotel loads as well [15, 16]. This enables engines to be used in an optimal manner based on the operating profile. Therefore, from the overall system point of view, introduction of electric propulsion and integrated power systems help improve fuel efficiency and control flexibility.

### 2.5 High voltage shipboard power systems

In the last few decades there has been a global trend to build a few number of bigger ships than building large number of small ships. This trend seems to be continuing in the future as well. Consequently, the power requirement of the ships also increases with the size. This in turn requires bigger power cables to transmit more current to the loads increasing the cost of the conductors and power loss within the conductors. The promising solution to reduce conductor size and power losses is increase of the system voltage. As a result, modern ships come with high voltages systems such as 11 kV and 6.6 kV compared to the traditional 690 V low voltage distribution systems. Power converters used to drive propellers and other motor loads such as tunnel thrusters should either be capable of operating at these high voltage levels or should use locally installed step down transformers. The latter is the most common approach while the former is currently being in the research, development and testing stages. The move from low voltage to high voltage in shipboard power systems is capable of reducing power losses and thereby improve the fuel efficiency. Nevertheless, it comes with certain challenges that have to be addressed with suitable supporting technologies such as high voltage power converters, high voltage motors, advanced control techniques protection mechanisms, and appropriate power system architecture [15].

In addition to the above mentioned applications and scenarios, dynamic positioning, slow speed maneuvering, and supplying pulse loads such as radar are other areas, where more electric technologies can make a significant contribution in terms of energy efficiency.

## 3 ENERGY EFFICIENCY IMPROVEMENTS IN HYBRID ELECTRIC SHIP PROPULSION

In hybrid electric propulsion systems, diesel engine is the main source of power for the propeller while the electric motor supports the main engine to drive the propeller especially at maneuvering or during peak power demand. This can effectively reduce the peak power requirement of the engine and thereby reduce the overall size of the engine. This assistance from the motor is known as power take-in (PTI). Similarly, it is possible to take some of the main engine power out through a shaft generator so that electrical loads in the ship can be supplied from the main engine. This is re-

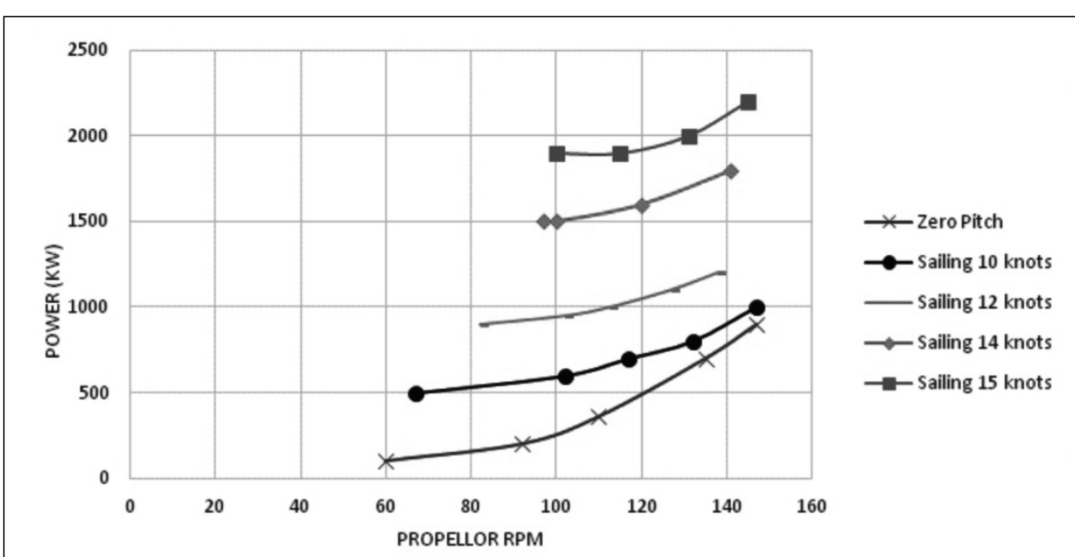


**Figure 1**
Propeller shaft input power requirement as a function of the propeller speed [16]

ferred to as power take-out (PTO). The shaft generator and the motor can be the same machine, where in the PTI mode generators coupled to the auxiliary engines provide electrical power to the machine to operate as a motor. In the PTO mode, power is taken out from the main engine and fed to the electrical system. In this situation, auxiliary engines can be turned off if the main engine is capable of supplying the propulsion load as well as the other electrical loads of the ship.

In traditional hybrid systems, the shaft generator is coupled to the main engine through a gear box and the output of the generator is directly connected to the power bus. Since the power bus requires a constant voltage at constant frequency, the engine runs at a constant speed. In order to get required thrust to propel the ship and maintain the ship speed, the pitch angle of the propeller blades are varied. When the ship is not moving, pitch angle is set to zero which results in zero thrust on the propeller. However, as shown in Figure 1, spinning a zero pitched propeller at a constant speed requires certain amount of power that increases rapidly with the increase of the required speed. This power is lost at the propeller without doing any useful work and thus reduces the overall efficiency. For example, if the required engine speed is 145 rpm, then the power loss, is about 900 kW. This power loss can be reduced if the engine speed can be reduced, e.g. 90 rpm where the loss is only 200 kW.

This variable speed operation can be realized by placing a frequency converter between the shaft generator and the power grid. This can effectively reduce the power loss by 700 kW and thereby reduce the fuel consumption and GHG emissions.

## 4 CONCLUSIONS

The rise of the fossil fuel price and emissions are the major motivations for exploring alternative fuel and fuel efficiency improvement technologies in maritime industry. PV power systems, fuel cells and thermo-electric generation are considered as promising alternative energy technologies that can help reduce greenhouse gas emissions. These emerging technologies heavily depend on development of associated electro-technologies. Apart from that, through efficiency improvement, by means of electrical technologies, fuel consumption can be reduced. Electric and hybrid electric propulsion technologies are found to be more efficient and flexible compared to traditional mechanical power transmission systems. With an example of a hybrid electric propulsion system, this paper has shown that power losses can be greatly reduced with the appropriate use of modern electro-technologies. Therefore, in conclusion, it can be envisaged that electro-technologies will play a significant role in fuel efficiency improvement and greenhouse gas emission reduction in future ships.

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# TALENT MANAGEMENT AT SIMAC
# Which future skills are of largest strategic importance for the Danish maritime industry as well as shipping businesses in general?

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**Abstract.** The maritime industry and shipping companies in general, have worked with talent management from a specializing point of view i.e. if you are a navigator, you will become even better, if you train and enhance your navigating skills every day.
Recent research focuses on identifying personal skills rather that professional ones, and thus training these skills in different and challenging surroundings. But before you start preparing a "Start-up Talent Program", you must identify what talent skills are required within your business field, and which skills will be sought after in the future by the maritime industry. It is estimated that 10 per cent of the students have talent, and they possess a special gift [1]. The question is now, how to define it.
"Measuring talent is a straightforward enterprise: it simply correspondents to outstanding performance in the use of specific skills of any occupational field" [1] . But what is talent, and how do we identify talent in such correlation, and what are the specific skills?
**How do we define talent within the Danish maritime industry, and what skills must be spotted and developed?** Having this in mind, two lecturers at SIMAC have made individual interviews and focal group interviews with HR managers and other decision makers from different businesses within the maritime industry, as well as students at SIMAC.
Based on semi-structured interviews, the main purpose of the interviews was to stress out and define, *what is talent?* – a definition is given from shipping companies', industries within the maritime industry and from the students' perspective.
**Which future skills are of largest strategic importance for the Danish maritime industry as well as shipping businesses in general?** The respondents agreed on the fact that: A talent is a person, who possesses a certain skill, and delivers top-performance. Defined in a business correlation it is a skill or skills of strategic importance, and they can support, underpin and promote a company's competitiveness. Based on the interviews, the respondents defined talent as specific prerequisite i.e. unique qualifications. Some people possess these unique qualifications more than others, they are hard and complicated to achieve, and they are difficult to develop, as they need more than just normal training [2].
**How do we define talent in the Danish maritime industry – what skills are required in order to possess talent?** Based on the interviews, the primary markers in a talent definition: is a person, who possesses *spirit*, he or she is *engaged* in his or her work, by nature they are *curious* , *social competent*, and *innovative*, and he always possesses a *holistic approach* of every situation he or she engage in [2].

**Conclusion.** Our analysis shows that the definition of talent is a person, who possesses a certain skill, or skills. Hence, we have been able to classify, that the required skills within the maritime business, are skills like spirit, engagement, curiosity, social competence; innovativeness and they have a holistic approach.

**Key words:** talent management, skills, training, effectual entrepreneurship

## 1 INTRODUCTION

According to a global survey performed by Mckinsey, today more than ever, companies rely on talented employees and the way their talent is managed to gain competitive advantage [3].

This dissertation starts by acknowledging that in order to attain efficient talent management the organization must understand what talent means in relation to human performance, and how to incorporate talent management at a strategic level [3].

The research focuses on identifying - how the Danish maritime industry can successfully manage talent strategically within the organization. In order to conclude on this question, we have to ask ourselves 2 underlying questions:

– How do we define talent within the Danish maritime industry, and what skills must be spotted and developed?

– Which future skills are of largest strategic importance for the Danish maritime industry as well as shipping businesses in general?

## 2 METHODS

In this research, we will use semi-structured interviews, as it consists of several key questions that help to define the areas/the field questions to be explored. Furthermore, by using semi-structured interviews, it is thus possible to diverge in order to pursue a statement/response in more detail [4]. The flexibility of this approach, allows for the discovery or elaboration of information that is important to participants but may not have previously been thought of by the interviewer.

To determine what talent skills are important, the research is based on qualitative methods i.e. interviews, as it provides a more thorough and a deeper understanding of what talent really is. As this research focuses on finding a new way of exploring and defining talent within the maritime industry, it is not possible to find relevant literature on this subject. Therefore, qualitative research interviews are of most importance as it explores the views, experiences, beliefs and/or motivations of individuals on talent management.

The interviews studied this phenomenon, where detailed insights are required from individual participants. Second, personal interviews are also particularly appropriate for exploring sensitive topics, where participants may not want to share certain issues in a larger group environment.

Focus group interviews were used in order to explore this phenomenon. Students from SIMAC are selected, and it is important for us to set up groups that are already familiar with each other i.e. they enjoy a comfort and familiarity which facilitates discussion or the ability of challenging each other comfortably. Two focus groups are identified one representing junior officers and another one representing senior officers.

By this, we are interested in finding new perspectives on talent, and to see if there is a different perception on this issue. However, we decided on working with small focus groups, hence to ensure an interaction which is the key to a successful focus group.

The main purpose of the interviews is to stress out and define, *what is talent?* – a definition is given from shipping companies', industries within the maritime industry and from the students' perspective.

The length of interviews varies depending on the time available from the respondent. However, on average, talent interviews last 20-60 minutes.

## 3 HOW DO WE DEFINE TALENT WITHIN THE DANISH MARITIME INDUSTRY?

What is talent and how is it expressed? Talented persons are not afraid of trying something new; they seek challenges i.e. in their profession or their personal life's. They dare go upstream and try something new, even if there is a chance of failure. They are first-movers, as they commence new things, just to see if they will gain further knowledge of something new. One of the focus groups classified these people, as geeks, but in a positive way of interpreting their fundamental behavior [2].

Talented people show immense surplus in regards to their business field as well as in their everyday life. This makes them cable of helping other's e.g. if one has difficulty in understanding new theory, or students that have difficulty in finding their own learning cycle, they help! The students stated that these people will become good mentors and advisors for the new students entering SIMAC. One of the students did notice that: "These people do have a very good memory, as they tend to draw different theory from other subjects, and use these different theories when relevant" [2].

Talented persons are innovative. When looking at a new product they like to add new features into the product i.e. they are able to identify new demands and needs. They are cable of innovating and developing new product solutions based on marked needs.

> *"If you have a look at COOL4SEA, they had a fantastic idea, they look at a problem at sea, and thought, what can we do in order to help them, and they were eager to find a new approach to a cooling system"* [2].

When looking at developing new processes, talented persons are able to make a 360 turn around process. They commit themselves 100% to the assignment, and look out for a new approach [2]. Bringing talented people into a project has several advantages.

> *"It helps organizations identify problems before they even begin the brainstorming sessions. You can put them in any position and they will fulfill that position successfully finishing that task with success"* [2].

Today, you will see a talented person as a person who possesses discipline – they like to work hard, they are very ambitious, they like to make a difference and they possess a certain drive. This means, that they are able to carry out any assignment within shorter time, than a normal employee [2]. Also you see them moving up the career latter really quickly. If they are not challenged on the job, they move on to another organization, where they can find new and challenging assignments. Some of respondents even claim that the talented are very competitive, – and they like to compete – especially with themselves, and they constantly focus on their performance.

The respondents generally expressed positive feelings about being identified as a talent by their professors. However some of the respondents mentioned there might be increased pressure or anxiety around talents, as there might be high expectations around that person and on their performance [2].

## 4 WHICH FUTURE SKILLS ARE OF LARGEST STRATEGIC IMPORTANCE FOR THE DANISH MARITIME INDUSTRY?

To sum it up, it is now possible to identify 6 core personal values:

- Commitment and Engagement
- Curiosity
- Spirit
- Social competence
- Innovative
- Holistic approach

They will become tomorrow's new leaders, taking action on things; they are skilled leaders as they understand the basic needs of their employees. Talent management is often referred to as the leadership pipeline [5].

Providing education to build expertise—and thereby boost performance—is fundamental to an effective talent program and to any dynamic organization.

## 5 WHICH PRINCIPLES ARE DEFINING THE WORK ON TALENTS AT SIMAC?

The theories of effectual reasoning advanced by Sarasvathy and Read (2001) proposes a decision making process that differs from traditional views of decision making used in the management sciences. The main differences being the disparity between the "Causation" and "Effectuation" point of view [6].

- **Causation:** The focus is on achieving a desired goal through a specific set of given means. Causation invokes search and select tactics and underlies most good management theories.
- **Effectuation:** The focus is on using a set of evolving means to achieve new and different goals. Effectuation evokes creative and transformative tactics. Effectual logic is the name given to heuristics used by expert entrepreneurs in new venture creation.

Traditionally the future is predicted through plans and knowledge without interaction with stakeholders. Objective data is analyzed with the purpose of decision making on strategies, plans and resources – this is known as the causational approach to problem solving.

"Effectuation" is a methodical approach enabling a talent to turn professional competences into action and achievement. The "effectuation" approach creates solutions by interacting with processes and stakeholders. The "effectuation" approach works from the thinking that innovative processes are less rational and linear than the causal approach.

Learning processes are filled with unpredictable incidents, actions and initiatives. Corporation and successive amendments creates a more heuristic path. The road to success is not given and according to Sarasvathy (2001) these unpredictable processes are the key to entrepreneurial success and can also be related to talent management [6].

The "Talent Programme" at SIMAC is based on the 6 talent characteristics stated earlier. Furthermore the content of the programme is developed and designed on the 5 principles of "Effectuation" [6]:

1. The bird-in-the-hand : means : who I am ? – What I am ? – whom I know ?
2. The affordable loss principle : risk : what can I afford to lose ?
3. The crazy quilt principle : partnerships : pre-commitment from partners and stakeholders
4. The lemonade principle : contingencies : ability to act on surprises

5. The captain-on-the ship : control : focus on activities within own control

The talent programme will embrace these 5 principles in all modules with the purpose of creating a theme of a pragmatic and activity based learning platform with the outcome of realizing new ideas and opportunities. Given different scenarios and operational challenges the students will define which principles have the most relevance and evidence in the given situation. The students are grouped in random teams making it essential to act upon resources, means and professional competences in hand. This approach will create a belief in the student that he is able to solve and be part of complex and value creating processes within his own project or in an existing company. According to Bandura (1995) this is related to as "*Self Efficacy"* [6].

The different aspects of the talent programme aims to operationalize – not "examinize" - the learning process in order to create value for the student. The student is exposed to different businesses enabling them to create partnerships and relations – learning to respect professional as well as personal competences within other people.

## 6 CONCLUSION

Based on qualitative research and empiricism within the maritime industry and qualified students, our analysis shows that the definition of talent is a person, who possesses a certain skill, or skills. Hence, we have been able to classify, that the required skills within the maritime business, are skills like spirit, engagement, curiosity, social competence; innovativeness and they have holistic view.

The Talent Management Programme at SIMAC is based on a methodical approach "Effectuation" enabling a talent to convert professional competences into action and achievement.

By focusing on talent management and the core values identified – it is our belief that the maritime industry in Denmark will be able to secure and develop their current market position with the philosophy : *"A mile Ahead"*

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# ASPECTS OF HUMAN ELEMENT MANAGEMENT IN SHIPPING

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During the last several years special attention has been paid to the role of the human element in shipping. The question "How to make the ship crew management more effective and efficient" is in the very centre of the discussions. The most popular answer is to make this small group, the crew, behave as a team. Not disparaging this approach, the paper aims to present some good management tools that can help to improve the ships' crew performance. The paper is focused on the specific area of reducing the negative effects of the cultural shock in multicultural environment. The general thesis is that there are some management tools that work and bring for predetermined results in the specific sphere of crew management.

Currently, there is an indisputably imposed thesis that the ship is a complex technical facility which is a "*man-machine system*", generally determined as an "*aggregate of operators and technical means used in labour activity*" (Topalov, 2015). The correct implementation of the systemic approach requires consideration of the environment for functioning of that system. Assuming that the environment is not purely physical and expanding the approach, we shall inevitably reach the model representing the system as an inter-related aggregate of:

– Technology;
– Individual;
– Group;
– Organizational environment;
– Society and culture;
– Practice;
– Physical environment.

This multi-component model is known as the "*Septigon Model*" (Koester, 2007). That model is useful because "it captures most of the human factors elements that form part of the maritime system)" (Michelle, 2008)[1].

Disregarding the "Septigon Model", the components of the system can be re-defined in three groups:

- Human factor related components;
- Technology;
- Physical environment.

The optimization of the functioning of those three groups of components is important from the point of view of safety.

As far as the opportunity for our influences over the Physical environment are strongly limited and currently reduced to prognostication, then the Human factor related components and Technology shall be definitely subjected to optimization.

In the recent 2-3 decades, technologies marked an exclusively quick progress. It is unlikely to be forcedly to say that the reliability of their trouble-free functioning had reached high values close to the marginal possible values. Unfortunately, this is not the same for the question of Human factor related components. Presently, different sources present the share of human errors as a reason for about ¾ of the accidents at sea (U.K. P&IClub, 1997) (U.S. CoastGuard, 1995). In response to the outlined negative trend, several concepts emerged which are closely directed to optimization of the Human factor related components. Classically, these concepts are related with organizational behavior, leadership, human errors.

Studying the factors influencing the performance of the ship crew members, the Nikola Vaptsarov Naval Academy carried out several polls with representatives of all categories of the ship crew. Almost unanimously, the performed polls imposed the opinion that the problem with the cultural stress falls among the main factors influencing the emotional satisfaction of the crew. It is appropriate to present briefly the processes accompanying cultural adaptation before suggesting a certain approach to overcome the problem.

Upon falling among a foreign cultural environment, every individual passes through a process of cultural adaptation. Scientific literature describes that process with the so-called Lysgaards' U-curve hypothesis, which follows the processes of adaptation to a new culture. Later on, that model is further developed by Gullahorn and presented as a "W-model" of social adaptation (Gullahorn & Gullahorns (1963) W-curve hypothesis) (Gullahorn, 1963). Insofar as the "W-model" of social adaptation also discusses the processes of reverse adaptation at return, it is more appropriate for discussion. Insofar as the Gullahorn model is too schematic, then it is presented in the way implemented in the site DepartSmart, available at http://web.viu.ca/studyabroad/DepartSmart/.

The graphic presents the degree of emotional satisfaction during the different stages of the stay on board.

Assuming a normal level of emotional satisfaction, presented with a horizontal dashed line in the graphic, we can project the deviations to that level with the purpose to differentiate the stages of cultural adaptation. More specifically, those stages include:

- Emotional fluctuations before departure;
- The "Honeymoon" stage;
- The stage of cultural shock;
- The adaptation stage;
- Emotional fluctuations before return;
- Satisfaction after return;
- Nostalgia for the foreign culture;
- Adaptation to life at home.

Emotional fluctuations before departure are seen during the first stage. The individual has an increased feeling of anxiety. There are strong fits of nostalgia and concern from the forthcoming separation with the relatives. These feelings intensify because while recognizing the forthcoming separation, people become more tolerant, the problems are suppressed and everything seems to be put in order. There is a sensation of quickly running time. With a sufficiently big length of experience, that condition is born easier. Classically, it passes with the fact of beginning of the trip. The individuals with healthy psyche who had a longer practice of the profession adjust exclusively quickly to the new task even in the early dynamics of travelling to the new workplace.

Upon arrival, and even earlier, during the trip, there is a transfer to a state of increased emotional satisfaction, the "Honeymoon" stage. There is eagerness to enter the new environment and a positive emotional adjustment. Things are interesting, contacts are friendly, communication is well-intentioned and there is an increased working capacity as a whole. The condition may last between few days and several weeks, depending on the environment and the emotional adjustment of the individual.

However, soon the cultural differences happen to contradict our traditional understandings, a nuance of irritation appears. The more known is the new environment, the more irritating the cultural differences become. The individual limits their contacts and falls in a state of a cultural shock. Emotional fatigue appears.

[1] For further information about the maritime metasystem, the authors recommend "(Michelle, 2008)".

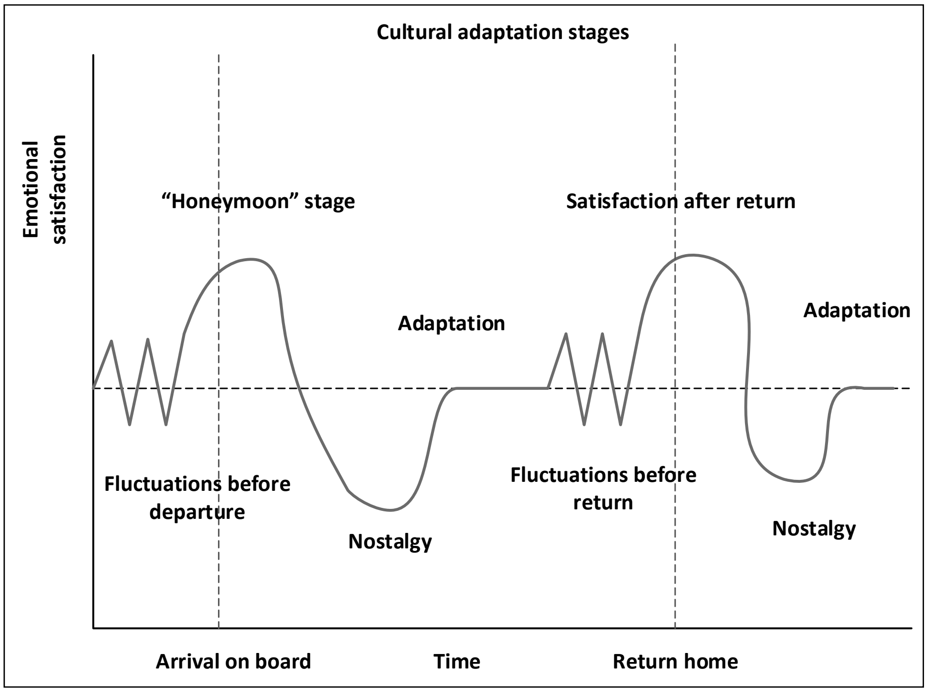


**Figure 1** Cultural adaptation stages. The graphic is borrowed from the site DepartSmart available at http://web.viu.ca/studyabroad/DepartSmart/

The popular name of the final manifestation of such behavior among sailors is "to act inappropriately (crazy behavior) because of homesickness", and scientific literature calls it "homesickness". At that stage, the behavior of the individuals is annoying and is not tolerated by the crew, especially by that part of the crew who arrived with an earlier shift. The individuals with long working experience are acquainted with the stage of cultural shock and can suppress it to a great extent.

We need to outline several factors that cause a cultural shock and deepen its symptoms:

- Stress;
- Cognitive fatigue (difficult thinking). The syndrome of professional exhaustion (burnout) appears;
- Role changes;
- Personal shock.

It is appropriate to point out in general the techniques for coping with the cultural shock. The first group of techniques is related with the individual training.

In the first place, it is appropriate to learn more about the cultures of the nations that are expected to form the crew. Nowadays, Internet offers many sources of advices for the specificity of culture of different nations along with recommendations for behavior.

It is also appropriate for the individual to compile a plan for personal building during the stay at a different culture. In all cases, it is appropriate to make sense of the free time not only with entertainments but also with activities like learning a foreign language, mastering a new profession, development of specific new knowledge.

In addition, we need to be prepared also for coping with any ethnical and religious prejudices.

If the individual belongs to a nation or race that often becomes subject to such prejudices, then a little humor and prior preparation with jokes on this subject will not be redundant.

Next, the individual should be aware of the manifestations of cultural shock and their consequences.

The choice of behavioral style and self-education in tolerance are very suitable techniques. The positive perception of reality is strongly recommended. Mastering of rules of communication and reliance on standards of behavior are very important.

We should add that communication within a friendly circle is the best anti-stress factor. Making friends and maintenance of amicable relationships is a strongly recommended technique. Considering that communication is always based on a sign of community, then searching for such a sign should be made continuously but not obtrusively. The appropriate signs for a community for communication include common experience, artistic interests, hobby, sport and arts. In such communication, avoid deepening in such topics to an extent that can cause boredom in the interlocutor, or suppose exposition of an opinion opposite to the one of the interlocutor. The skill to listen is of paramount importance.

The instruments of social interaction should not be underestimated as well. In all cases, the participation in the life of the work group shall be tolerated. Generally, adherence to established traditions and respect to national and religious holidays is well accepted. The registration of attention for a certain occasion and in a way adopted in the foreign culture is a good approach for integration within the work group. It is also appropriate to generate traditions and holidays in an unostentatious way. For instance, to celebrate somebody's national holiday with a menu that is traditional for the country, to present a symbolic gift, etc. are appropriate models for social interaction. Showing interest and registration of knowledge about the national traditions and history of the interlocutor is also very important, to the extent that the topic is not subjected to excessive comments and comparisons.

Other approaches to overcome the cultural shock are known as well. Without going into details, we are interested in the existence of other control models acting irrespectively of the will of the individual.

Going back to the graphic in figure 1, we need to say that as a minimum, the idea for control of the cultural adaptation is to decrease the amplitude of deviation from the normal condition of emotional satisfaction, combined with decrease of the duration of those deviations.

It is appropriate to assess the role of control considering that background. As a whole, there are different models of control but for the current study, it is appropriate to follow the model presenting the following styles of control (Williams, 2011):

- Bureaucratic;
- Objective;
- Normative;
- Concertive;
- Self-Control.

Bureaucratic controls are top-down, management-based, and measurement-based. It is based on organizational policies, rules, and procedures. This type of control uses rewards and punishments to influence employee behavior and uses policies and rules to control behavior.

Objective controls are also top-down, management-based, and measurement-based. It is based on reliable measures of behavior or outputs. It uses observable methods. There are two types of objective control:

- Behavior control, that regulates actions and behaviors of employees;
- Output control that measures employee outputs and is coupled with use of rewards and incentives.

Normative and concertive controls represent shared forms of control because they evolve from company-wide or team-based beliefs and values.

Normative control is based on strong corporate beliefs and careful hiring practices. Company values and beliefs guide employee behavior and decisions. This control is supported by careful selection of employees and role-modeling and retelling of stories.

Concertive control is based on the development of values, beliefs, and rules in autonomous work groups. Employees are guided by beliefs that are shaped and negotiated by work groups. It is applied by autonomous work groups that operate without managers and have members responsible for controlling work group process, outputs, and behavior.

Self-control, or self-management, is a control system in which managers turn much, but not all, control over to the individuals themselves. Self-control is based on individuals' setting their own goals, monitoring themselves, and rewarding or punishing themselves with respect to goal achievement. The particularities of this type of control are:

- Employees control their own behavior;
- Employees make decisions within clear boundaries;
- Managers and employees set goals and monitor their own progress.

The hints for applying these control methods are of significant importance (Williams, 2011):

1. Use bureaucratic control when standard operating procedures are needed and it is necessary to establish limits.
2. Use behavior control when it is easier to measure activities than outputs, "cause-effect" relationships are clear and good measures of behavior are available.
3. Use output control when it is easier to measure outputs than behaviors, good measures of output are available, clear goals and standards are available and "cause-effect" relationships are unclear.
4. Use normative control when culture is strong, it is difficult to create behavior measures and it is difficult to create output measures
5. Use concertive control when there are group responsible for task accomplishment, workers take "ownership" of behavior and outputs and strong worker-based control is needed.
6. Use self-control when workers are intrinsically motivated, it is difficult to create behavior measures, it is difficult to create output measures and workers have self-control and self-leadership.

Comparing, on one side, the problems arising from the cultural stress and cultural adaptation, and the models of control, on the other side, imposes the idea that it is possible to overcome the cultural shock through establishment of clear standards originating from the policy of the company and the rules for work, imposing a strict system of incentives and sanctions and maintenance of the desired level of operability.

The inference that the bureaucratic style is the suitable model for control in the process of cultural adaptation is inevitably imposed.

This is due to the following advantages of that model:

- This style does not rely on voluntary adherence to standards but imposes them, in case of need forcibly as well;
- It is appropriate for the hierarchical systems;
- It introduces clear relationships in the hierarchy of the organization;
- It suggests that each of the participants in the process will strictly adhere to a certain role;
- It relies on preservation of a rational degree of effectiveness and efficiency in the process of functioning;
- It contributes for a short or almost no change of performance during the change of leaders or workers.

The bureaucratic model is apparently feasible. Moreover, this method is imposed as a recommended method for coping with the negative consequences of stress among the crew.

On the other side, we should not neglect the opportunities of the models such as the objective and normative ones, and even the concertive model, considering that the concertive method is strongly corresponding with the concept of leadership. This imposes the apparent inference that the style of control should be selective and evolving.

Considering selectivity, there is a concept that the higher is the hierarchy on the ship, the better is the staff selection, and the higher are the self-consciousness and self-discipline. In such conditions, in respect with the higher units of the ship's hierarchy, there should be a gradual transition from bureaucratic through objective and normative to concertive control.

As far as evolution is concerned, then in the initial stage of staff formation (after change of the crew) and with the development and fitting of the team, there should be a gradual transition from bureaucratic to objective, and even to normative control. In that aspect, it should be noted that concertive control remains a good but hardly achievable wish.

In all cases, the leader is recommended to apply bureaucratic control in the beginning of their mandate (the shift), at least until the leader becomes oriented in the settings and convinced that the standards are followed and the processes run according to the established procedures.

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# CHALLENGES OF CROWD MANAGEMENT ON PASSENGER SHIPS

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**Abstract.** There are big differences between the emergency situations happening onboard the same type of ships and of course between different types of passenger ship.
However, when accident investigation reports of passenger ships have been reviewed, some of these accidents have had impressive consequences regarding saving lives and minimizing the number of causalities. On the other hands, some of such accidents have had disastrous consequences.
According to STCW convention and HSC code, all crewmembers of passenger ships shall have special training on passenger safety and crowd management. These special vocational courses are designed to provide passenger ship`s crew with necessary information that supposed to be sufficient to provide them with adequate proficiencies and experiences and required to be acquainted with the techniques of controlling and management of passengers during emergency situations.
STCW requirement only considering how ship`s crew can handle passengers but not how crew can handle and control their emotions and feelings which of course affects their response as human during emergency situations.
This paper aims to emphasize the challenges facing passenger crew during emergency situations and how to control the crewmembers' emotional and behavioral responses by training, these will be accomplished through:
– Investigate the most famous passenger ships accidents.
– Analyzing the consequences of each accident and the behavior of crew
– Compare between such successful and failed cases
– Studying the human emotional and behavioral
– Review the minimum training standards provided responses during emergency.

**Key words:** passenger ships, crowd management, maritime safety, crew qualifications

## 1 INTRODUCTION

Emergencies can occur on even the most modern passenger ship. Only a well-trained crew can mitigate the effects of such an emergency and take care of passengers through good organization. Crew qualifications and proficiencies shall not depend only on theoretical training on how to manage crowd deal with different emergencies, as required by STCW convention and HSC code. However, crew of passenger ship especially those in command shall have special psychological training and mental strain control training to control themselves first before controlling others behavior.

Carrying passengers at sea is considered as one of the hardest tasks assigned to merchant ships to carry and that require special trained crew supported with very special competencies in particular decision-making. However, when passengers were considered as a kind of cargo carried seaborne, crew and passengers as human has the ability to think and accordingly, they will be able to react to the frequent changing events around them.

On this basis, they have different responses and attitudes to the developing events, these reactions are vary significantly according to persons' culture, knowledge, age, gender, purpose of the trip and whether alone or with their families.

Recently, passengers sea transportation has dramatically evolved, the sizes of ships and number of passenger carried on board has been significantly increased. Accordingly, the number of crewmembers increased and their responsibilities strongly differed and varied.

**Crowd Management (During Emergencies)**

The crowd is seen as a large group of individuals in the same physical environment, sharing a common goal (e.g. transport from place to place or to have fun and pleasure).

In short, Crowd Management is the task to assist passengers in an emergency situation, to lead passengers in staircases, corridors and passages; to use procedures for preventing panic and other irrational behavior and to communicate with passengers. The crewmembers shall perform all the above mentioned tasks with high proficiency and discipline.

Bengt Schanger (2012), defined Crowd Management as "the systematic planning for, and the supervision of, orderly movement and assembly of people during emergency. Crowd management involves the assessment of people and handling capabilities of the ship. It includes evaluation, based on information available. It includes projected levels of occupancy, adequacy of means of ingress and egress, processing procedures such as evacuation, and expected types of human behavior".

**Crowd Control (During normal situations)**

Crowd Control is the controlling of a crowd during normal situations, to prevent the outbreak of disorder and prevention of possible riot. Examples are during passengers` embarkation and disembarkation in normal conditions.

**Crowd Management means on board Passenger Ships**

There are two basis for managing crowd on board ships as follows:

**a) The Passive Crowd Management (indirect)**

Passive Crowd Management methods means the proactive actions and measures taken to ensure smooth flow of passengers onboard and prevent any misunderstanding and ambiguity regarding correct directions of flow, preventing congestions and providing good communication channels. These requirements are regulated by safety standards and requirements regarding safety construction like SOLAS Conventions and training standards as STCW Convention; including the following:

- **Management of the Hardware:**

- The structure and design specifications of scape roots, alleyways, and muster stations
- Alarm systems
- Markings of escape routes
- Low Location Lighting systems
- On-board communications and alarm systems
- Public address systems on passenger ships
- Arrangement of Means of Escape
- Emergency source of electrical power
- Emergency lightening system
- Survival craft muster and embarkation arrangements
- Marking of escape routes

- **Management of the Software:**

- According to IMO, (2007) Conduct evacuation analysis for new and existing passenger ships, including:
  a. Typical population- male, female, young, old, mobility impaired
  b. Some parts of escape routes may be unavailable
  c. Cognitions availability due to passenger behavior
  d. No dead-end corridors no lock doors in direction of scape
  e. Two escape routes from every space- one fire protected

- According to IMO, (2005), the evaluation of evacuation analysis of the High speed passenger craft are as follows:
  a. Description of the system
  b. Identification of assembly stations.
  c. Identification of embarkation stations, MES and survival craft.
  d. Description of the evacuation procedure including the role of the crew.
  e. Identification of groups and their escape route.
- Decks are sequentially numbered
- The cabin numbers increase from the aft to the forward end of the ship to provide horizontal awareness
- Simple mimic plans showing the "You are Here" position
- Escape routes marked by arrow prominently displayed on the inside of each cabin door and in public spaces
- Written instructions informing passengers what to do in case of emergency
- Instruction for safe escape
- Muster list and emergency instructions
- Decision support system for masters of passenger ships
- Information on passengers

- **Management of Human-Ware:**
  - Emergency and abandon ship drills

From the first of January 2015 passengers shall undergo safety drills, including mustering at the lifeboat stations, before the ship departs or immediately on departure, and makes mandatory on emergency training and drills the carrying out of enclosed-space entry and rescue drills, which will require crewmembers with enclosed-space entry or rescue responsibilities to participate in an enclosed-space entry and rescue drill at least once every two months.

- Crew Training – STCW requirements

As required by the STCW convention, masters, officers and other personnel who are designated on Muster Lists to assist passengers in emergency situations on passenger vessels have to complete approved training on crowd management and these include very common subjects. The required training course has duplications with survival techniques course on the following subjects: life-saving appliances and control plans: Muster lists and muster stations, emergency alarms (general emergency, man overboard, abandon ship), launching of survival crafts and the proper donning of life jackets. Also, mustering procedures: Preparation and launching of equipment, staff assignments, custody and use of communication equipment, manning of fire teams, etc. Operational limits: Ship's layout (exits, stairwells, elevators, etc.), power failures, emergency lighting. Emergency procedures.

However, the course only include guidelines for assembling passengers, conducting a vessel search, keeping order and discipline, leadership skills.

Communications: Alarms, language barriers, clear and reassuring orders, rumor control, anxiety, special assistance for the disabled, communicating with the bridge. From the above demonstration, it is obviously indicated that items included in crowd management training are very much shallow and need much more modifications to include how to prepare candidates to psychotically manage their behavior first before managing passenger behavior and others.

### b) Positive crowd Management (Direct) Way

This means the Crowd Management Techniques, Behavioral Management and Time Management.

### Experience from previous passenger ships accidents

The following table indicates the most famous passenger ships` accidents and analysis of the crew behaviour and the resulted causalities:

| Ship's name | Accident description | Crew behaviour | Learned Lessons |
|---|---|---|---|
| Titanic (1912) | Weather was clear Ice warning received hit iceberg and sank | Prior to the Titanic disaster people were led to believe that the ship was unsinkable, conditioned to this belief, many people react accordingly and denied that the ship was in danger of sinking. | "Prior conditioning will affect how people may react during emergency |
| MS Estonia (1994) | Ship sank due to bad weather | The general emergency alarm not given until about five minutes after the list developed, nor was any information given to passengers over the public address system. By the time the alarm given, the list made escaping from inside the vessel very difficult. This, together with problems in using life-saving equipment contributed to the tragic outcome. | The delay of sounding emergency alarms may result in disastrous situations |

| Ship's name | Accident description | Crew behaviour | Learned Lessons |
|---|---|---|---|
| Al Salam 98 (2006) | Sank due to fire and free surface effect | Survivors said that the ship's captain, had insisted on continuing on to Egypt, 110 miles away, after a fire had broken when the ship was just 20 miles off the coast of Saudi Arabia. He and his crew had reportedly not merely ignored the appeals of passengers to turn around, but had locked some in their cabins.<br>Some passengers apparently remained asleep. Some said that crewmembers had prevented them from wearing lifejackets.<br>Survivors said many of the passengers were trapped in lower levels of the ship and would not have made it out before it disappeared into the water. | Loss of crew control gives passengers the right to start control themselves, give orders and deny crew instructions |
| Explorer (2007) | MS/ Explorer hit an iceberg off Antarctic | Ppassenger from cabin 314 said that while at the muster station, Expedition Group were telling jokes to keep the passengers calm. He said he felt the situation was more serious than they being told and did not appreciate jokes. | Crew appearance and mod will be copied to passengers |
| Costa Concordia (2012) | Extreme list | Witnesses reported that the crew left it until the very last moment to begin boarding passengers onto lifeboats. As a result, precious time was lost, and in the panic people began jumping into the water. The longer they left it to launch the lifeboats, the worse the ship was lifting in the water. People seemed to be trapped in the decks on the side of the ship that was under water.<br>"While we were still in the dining room, the crew basically disappeared, and it was left to a few Thai waiters who didn't speak English to try to keep us calm. | If the crewmembers haven't proper training and not skilled enough, the first thing to do is to disappear |

**Source:** Information are extracted from the accident investigation reports

## Difficulties facing crewmembers during managing crowd on passenger ships

When a person finds himself in a crowd during unknown emergency he or she will behave on one of the following types of Crowd behavior:

- Passive crowds (spectator crowds)
- Active crowds,
- Hostile crowds ("mobs"),
- Escape crowds ("panic"),
- Acquisitive crowds ("crazes") and
- Expressive crowds ("mass hysteria").

Crowd behavior in ship accidents will be dependent on:

- The nature of the accident and the circumstances it produces for escape (visibility, smoke, list, flooding etc.),
- The level of information given by those in command,
- The perceived risk,
- The family context and the time available for escape.

The following are brief description of some difficulties facing crew in handling crowd onboard passer ships, these mainly extracted out of the most famous accidents:

### a) Psychological impacts on passengers and crewmembers

We always try to Manage Situations not passenger Behavior so we failed to Manage Emotions then Responses. Many of the actions taken by those responsible for the safety of passengers on a ship are based on incorrect assumptions about how passengers will behave in an emergency.

Harbst and Madsen (1995) indicated that, when an emergency arises, passenger bbehavior will be similar to the following model:

- 10% of people will accept that there is danger
- 30% of people will look for further evidence of danger
- 60% of people will initially ignore the signs of danger

However they illustrate the likely actions of people once they have accepted that a dangerrous situation exists:

- 10% will attempt to evacuate
- 5% will attempt corective action
- 10% will attempt to worn others
- 60% will wait for instructions or look for other intiatives
- 12%-14% will become baralysed and take no action
- 1%-3% will panic.

During emergency number of people onboard (passengers and crewmembers) will tend to ignore an unexpected event in the hope that it will go away itself. This reaction appears to be particular strong upon involved in risky situation and then lead to panic.

Patient (2014) defined panic attack as a severe attack of anxiety and fear which occurs suddenly, often without warning, and for no apparent reason. In addition to the anxiety, various other symptoms may also occur during a panic attack. These include one or more of the following:

- A thumping heart (palpitations).
- Sweating and trembling.
- Dry mouth.
- Hot flushes or chills.
- Feeling short of breath, sometimes with choking sensations.
- Chest pains.
- Feeling sick (nauseated), dizzy, or faint.
- Fear of dying or going crazy.
- Numbness, or pins and needles.
- Feelings of unreality, or being detached from yourself.

George S. Everly (2008) also added that there are many of body reactions designed to enhance physical survival when confronted by a life-threating situation for prolonged periods. Problem can arise in a host of bodily systems yielding results such as increasing the serum lipids, irregular heart rhythms, headaches and impulsiveness.

**Causes factors of panic**

There are many reasons might leading to panic such as:

- Lack of training/understanding
- Level of panic is directly proportional to the level of danger and behavior of the leader and his followers.
- Failure to issue reasonable orders.
- Conflicted orders and decisions.
- Ignorance of what is currently happened.

Roberts (2000) explained that when People caught in a disaster or extreme mess appear to follow a set pattern of psychological responses. The pattern is similar irrespective of the disaster. There are several characteristics of individuals currently going through a crisis or traumatic event:

- People first begin to recognize that there is a threat.
- Next, these individuals discover that the stress and trauma of the event cannot be dealt with using existing coping skills.
- People then begin to experience fear, confusion, and stress.
- Those facing a crisis begin to exhibit symptoms of distress and discomfort.
- Finally, people enter a state of imbalance where the crisis situation seems insurmountable.

To assist in differentiating between panic and stress Peter Ockerby (2001) categorized behavior into two categories: coping and non-coping. Panic is associated with non-coping behavior while stress is associated with coping behavior.

| Coping behavior | Non-coping behavior |
|---|---|
| Attempt to solve problem | Makes no attempt to solve problem |
| For examples:<br>– Raise the alarm<br>– Remove the threat<br>– Move rationally<br>– Consider others | For examples:<br>– React emotionally<br>– Become hostile<br>– Withdraws |

**b) "group-binding"**

Svein Kristiansen, (2013) "defined the concept of group-binding" as people both rationally and emotionally have an interest in finding their relatives before being evacuated. As a consequence of group binding some passengers will break away from the crowd, and they can subsequently be subject to way-finding errors. In the event of an accident on a passenger ship that results in a decision to muster the passengers, group binding will initially be encountered by the crew in the form of noncompliance with instructions.

Some passengers will refuse to leave a particular place, where they had an agreement to meet again with relatives, and other passengers will refuse to go directly to the assembly station because they want to search the ship for their relatives

If people enter the ship as a group then they will want to evacuate as a group. People will often spend time assembling before evacuating, and then they will only move as fast as the lowest member of the group. In a real accident parents cannot be trusted to comply with instructions from the crew, if they are separated from their children (or elderly family members).

**c) High turnover of seafarers**

The ITF (2015) indicated in its "cruise ship safety" policy that one of the current problems within the cruise ship industry is the high turnover of seafarers. It is not uncommon for the average turnover rate to be between 25% and 35% per year and this has considerable implications for the implementation of the ISM Code and the safety of the vessel. Consideration should therefore be given to measures which will make the industry more attractive and thereby reduce such unacceptably high turnover rates. One such measure would undoubtedly be to professionalize many of the positions and functions through the adoption of formal qualifications and certification requirements.

**d) Most of passengers on cruise ships are elders and need special care**

For assisting passengers with special needs in an emergency, an adequate number of seafarers should be specially trained and provided with suitable documentary evidence to attest to the fact that they have been adequately trained in the evacuation of passengers with special needs.  As the ITF considers all the personnel employed or engaged on cruise ships as seafarers, it goes without saying that they should receive appropriate training.

**e) Selfish behaviours – pushing, trampling**

During emergency situation everyone including crewmembers needs to survive and save his or her life. Despite the crewmembers main roll on board is to lead passengers out of their cabins through stairways to the embarkation deck, but in many situation we find crews were in front of passengers racing to survive and embark the survival crafts. During emergency, if there was only one device could help in rescue one person of two, both of them think that he or she has the right to have it and survive.

**f) Inconvenient surrounding atmosphere**

During emergency situations it is probable to have the ship out of main source of electrical power and only emergency lightening system in operation which is normally faint light and not enough for passengers specially elders to find their way out of their cabins. Normally fire emergencies were accompanied with smoke which reduce visibly or enforce passenger to close theirs  eyes and knee down to the ground. In addition, during emergencies which involves inrush of water into the ship and flooding, the ship will sustain a list to one side which will prevent  many of passengers to move freely.

**g) Bad weather and ship movement**

During emergency accompanied with bad weather the situation always become worse because of ship movement and all operations have to be carried out performed in a harry. Passenger always have got seasickness and cannot even stand up or move.

**h) Security of passengers**

It may be the case of instability that comes with emergencies on ships a well-suited environment for, evils to revenge, theft or to get rid of their enemies and might leads to violence and Disobedience.

**i) Different nationalities and cultures**

Passengers transported to different places always have different languages and cultures as well. They always carry heavy luggage and may be cargo as personal items. During emergency, they might need to carry their luggage with them when evacuated to the survival craft or need to go to luggage store room or the garage to chick their belongings.

In fact the problem of multinational not only with regard to passengers but also concerning crewmembers, multinational crew always have no interest and intention to lost their lives to save others life so, they always evade any danger and behave the same way as passengers. In facts, they only need to serve passengers and earn money out of these.

**j) Wrong decision making**

Despite the fact that, the ship master is the only one who can take crucial decisions on board, but his/her decisions depends mainly on his/her long experience in this field, which of course differ significantly from master to another. Therefore, in the case of passenger ships which carry large number of persons and the ship` captain of course is confronted with very stressful situations, there is a need to train masters of passenger ships on decision making under mental stress techniques, Strategic Leadership: The Essential Skills and Emotional Intelligence and Self-Management.

**k) Passengers always have no faith on crewmembers**

Passengers must have faith in the crewmember on the basis of their uniform and their respectable behavior. However, during emergency situations, some of passengers look at crewmembers as they are the reasons behind their sufferings and torments because of their faulty decisions and reactions. If crewmembers lost their authority due to bad management, lack of communication with stakeholders, showing lack of proficiency or being psychotically affected by the situation, passengers will refuse to obey their instructions and start to search for alternative leader among them and start following him instead.

**m) Bad arrangement and distribution of cabins**

Hundreds of cabins are located at the seaside of the ship, but thousands of them already located internally within a sophisticated network of cabins. For a normal passenger, during emergency, it will be impossible for him to leave his cabin and find his way out to the wright direction leading to the correct muster station, because it is very difficult for passengers to do this the wright way during normal conditions of lightening, good visibility and stable ship.

**n) Insufficient number of the crew**

It is not unusual for vessels carrying three or four thousand passengers to only have a crew of between two and three hundred and for fast ferries carrying close to one thousand passengers to have less than fifty crew to handle an emergency and a possible evacuation. Coping with any emergency situation, with all its inherent possibilities for chaos, naturally calls for very intelligent, effective, knowledgeable and trained behavior by the crew.

**o) Loss of communication channels**

Crewmembers might lose their channels of communication with the bridge, if they are late in understanding or hearing instructions and information or standing in blind sectors out of rang. On the other hand, crewmembers might lose their channels of communications with passengers because of languages difficulties. Under stressful situations, everyone starts to talk his own native language and express his intentions accordingly.

## CONCLUSION AND RECOMMENDATIONS

Carrying passengers at sea considered one of the hardest tasks assigned to merchant ships to carry and that require special trained crew supported with very special competencies in particular decision-making.

During emergency situation everyone including crewmembers needs to survive and save his or her life. Despite the crewmembers main roll on board is to lead passengers out of their cabins through stairways to the embarkation deck, but in many situation, crews were in front of passengers racing to survive and embark the survival crafts.

If crewmembers lost their authority on the passengers due to bad management, lack of communication with different parties, showing lack of proficiency or being psychotically affected by the situation, passengers will refuse to obey their instructions and start to search for alternative leader among them and start following him instead. Therefore, in the case of passenger ships which carry large number of persons and the ship` captain is confronted with very stressful situations, there is a need to train masters of such passenger ships on decision making under mental stress techniques, Strategic Leadership: The Essential Skills and Emotional Intelligence and Self-Management.

For the above considerations, it is recommended that:

a. Those people who have responsibility for the safety of passengers in an emergency on a passenger ship should have appropriate proficiency and competences on how to behave and control their emotions.
b. Responsible persons on board passenger ships should have practical training on handling crowd situations under the influence of abnormal working environment like ship under extensive list of trim, smoke, and restricted visibility.
c. People with the responsibility for notifying passengers that an emergency or potential emergency exists must consider that the use of an alarm in isolation is unlikely to ensure an effective evacuation. Passengers need more than one cue before they will take the situation seriously so alarms must be supported by public address announcements and directions from uniformed ship`s crew.
d. Where there is any doubt about the seriousness of an emergency, or when all facts are not well-known, preparations for evacuation should begin. This does not have to mean a full scale evacuation of the ship but it should at least include notifying passengers and have them start to make their way to the easily stages of an evacuation could lead to a massive loss of life during the later stages.
e. Training of ship`s crew "Crowd management" according to IMO model course (1.28) should give much more strength to train crewmembers on handling stressful situations and avoiding panic and mental strain.
f. Evacuation demonstrations should be carried out with due concern for the problems of mass movement or panic acceleration likely to arise in an emergency situation when rapid evacuation is necessary. The evacuation demonstrations should be dry shod with the survival craft initially in their stowed positions.
g. Captains of passenger ships shall have mandatory special training in decision making under mental stress techniques, Strategic Leadership: The Essential Skills and Emotional Intelligence and Self-Management.
h. The worst situation a passenger ship can be confronted with, if there is a need to abandon ship during very bad weather. Therefore, researchers are asked to find alternative solutions for safe means of evacuation.

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# PERSPECTIVES OF FORMING MARITIME LOGISTIC CLUSTERS IN GEORGIA

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**Abstract.** The purpose of this research is to estimate the prospects and possibilities of establishing maritime logistics clusters in Georgia. Cluster forms of activities, particularly maritime logistic clusters, have been the object of the study in this article. The main method of the research is a comparative analysis of the advantages and limitations of cluster forming and functioning of maritime logistics.

Development of maritime logistics clusters, in the article, is considered as using of transport industry potential through the development of logistics processes for the creation of additional value. Sea ports are considered as important links in the logistics chain. Creation of maritime cluster was studied in the article on the basis of Batumi and Poti Sea Ports, what should increase the competitiveness of both the port and other companies – cluster members. Creating a cluster provides synergies and new opportunities for innovative handling of technological operations in port logistics. The implementation of the logistics cluster business model based on the Batumi Sea Port should facilitate the involvement of industry, transport and logistics companies in the impact zone of the port logistics.

The result of the maritime logistics cluster operation should strengthen the position of Batumi Sea Port in Georgia, both in the terms of transit goods maintenance and in the economic development of country as well.

The paper contains the main prerequisites for the forming and functioning of maritime logistics cluster in Batumi and Poti Sea Ports: significant untapped potential in marine, cargo storage and air cargo logistics; completion of Georgia-Turkey railway will open new possibilities in efficient transportation.

In the article was concluded that marine and railway development will stimulate road transport and logistics centers development. Development of transport system will significantly improve competitiveness of Georgian products in prise.

**Key words**: seaport, logistics, maritime logistics cluster

## 1 INTRODUCTION

Advantageous geographical location of Georgia on the Caucasus Transit Corridor (CTC) has highlighted the importance of national transport and logistics sector as a stimulating factor of growth for other economy sectors. Taking into account the strategic nature of the sector, the Government of Georgia has identified it as one of the priorities to develop and explore the ways of regional hub creation. The objectives of modernization and development of Georgian transport potential actualize the need to improve the competitiveness of the regions by strengthening their infrastructure and innovative development. Regional transport and logistics clusters formation and development are the most effective tools in this direction.

Being the only access to the Black Sea for the Caucasus, Georgia's sea ports have to be the centers of logistic clusters.

## 2 MAIN TEXT

Georgian ports functions as logistics centers are investigated on the basis of a number of reasons, the main ones are:

– By the end of the 20th century the world leading ports evolved into logistics centers and their work shows that: by the years of operation they have achieved competitive advantages;
– In case the ports are not logistics centers, small logistics companies, which do not have their own oil and container terminals, assume this function and perform the role of intermediaries. Then the length of logistics chain increases at least per one unit, that influences on the cost of turnover.
– It is profitable for cargo owner to deal directly with the seaport as a logistical partner, because the port is a major constituent supply chain node.

Seaports are concentrated on the traffic flows and are important supply links in the transport and logistics chain, thereby they representing a cluster, the core of which is the port. The purpose of port cluster creation is to increase the competitiveness of the transport hub. It has economies of scale and more opportunities to improve handling of technological operations. Obtaining the free economic zone status is a catalyst for the formation of port clusters.

Strengthening Georgian port functions and their transformation into a logistics center will improve competitiveness, both from the standpoint of transit goods maintenance and for the development of the Georgian economy.

Logistics cluster is considered as a group of competitive companies and enterprises (industrial, commercial, transport, logistics), that are linked geographically and cooperate on a voluntary basis to improve the overall efficiency of the logistics process. Clusters are recognized as one of the most efficient production systems of the globalization era and Knowledge Economy.

The literature review on the formation of the transport and logistics clusters research allowes to determine the main synergies from their creation (Fig. 1). [1-5]

World experience of transport and logistics clusters operation shows that their activity is effective in the areas with high transit potential. Taking into account the favorable geographical position of Georgia, increasing its transit potential is a key task, which was defined on the government level as one of the priorities in the economic development strategy "Georgia – 2020".

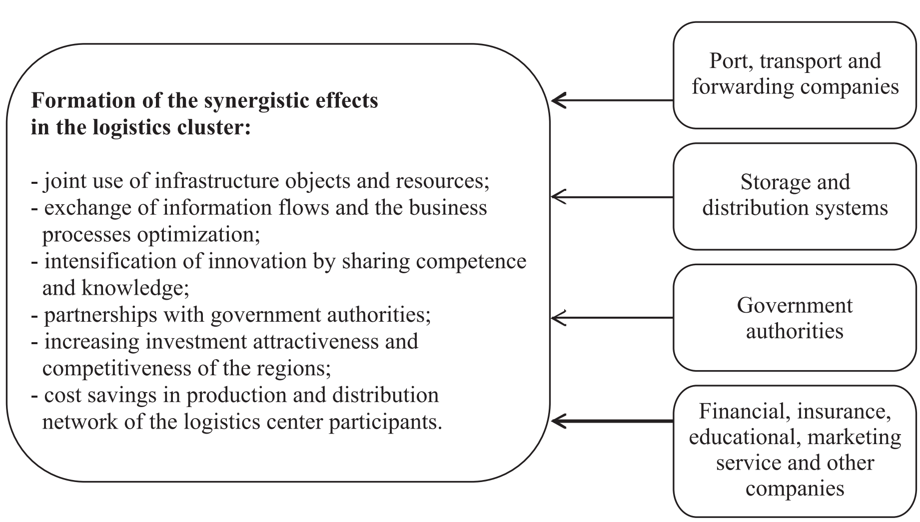


**Figure 1** Types of synergistic effects in the logistics cluster
(adopted from http://www.rusnauka.com/36_PVMN_2013/Economics/11_152118.doc.htm)

The completion of the expressway, railway route Baku-Tbilisi-Kars, construction of a new cargo terminal and the extension of Kutaisi airport runway, as well as the completion of the deep-sea transport in Anaklia are priorities to enhance the transit function of Georgia.

The development of Georgian transit potential is seen as a revival of the new "Silk Road". Thus, according to experts' opinion, the opening of a new railway line will reduce the time required for transportation of Chinese goods to Europe to 20 – 25 days. Kazakhstan also intends to join the project – an agreement on the establishment of a coordinating committee of the Transcaucasia route was signed in Astana. According to the draft, cargo from China will go on Kazakhstan railway, then through Aktau port (Caspian Sea) to Baku, where by railway to the Georgian Black Sea ports – and from there to Europe. China, which is strongly investing in the development of transport routes, is working on two directions – the first – through Russia, the second – on the new "Silk Road", through Kazakhstan, Azerbaijan, and Georgia. According to preliminary calculations, trade between Turkey and China in 2023 will increase from 24 to 100 billion dollars; significantly the transport corridor will play an important role.

Taking into account Georgia's existing transit prospects it is important to assess the dynamics of cargo transportation in the country (Figure 2).

These data are indicated a positive trend of increasing turnover by main modes of transport in Georgia. Reduced traffic on railway can be compensated by increasing transit opportunities, in particular, by the developing transportation of goods from the Caspian region to Turkey and Europe.

On the other side, obtaining the effect of the railway development is not possible without involving of Georgian seaports resources and the using of Georgia's access to the Black Sea. In this aspect the creation of logistics clusters based on the existing infrastructure of the Batumi and Poti ports is very perspective (Figure 3). [7,8]

As it is vivid from the chart, the volume of cargo processed in the Batumi Sea Port in 2014 in comparison with 2013 year decreased to 6.3 million tons, while in the port of Poti increased on 16%. With regard to marine terminals, the volume of cargo processed in the Supsa terminal in 2014 compared to the same period of the previous year increased by 5%. Despite the fact that the Kulevi terminal is characterized by a decrease

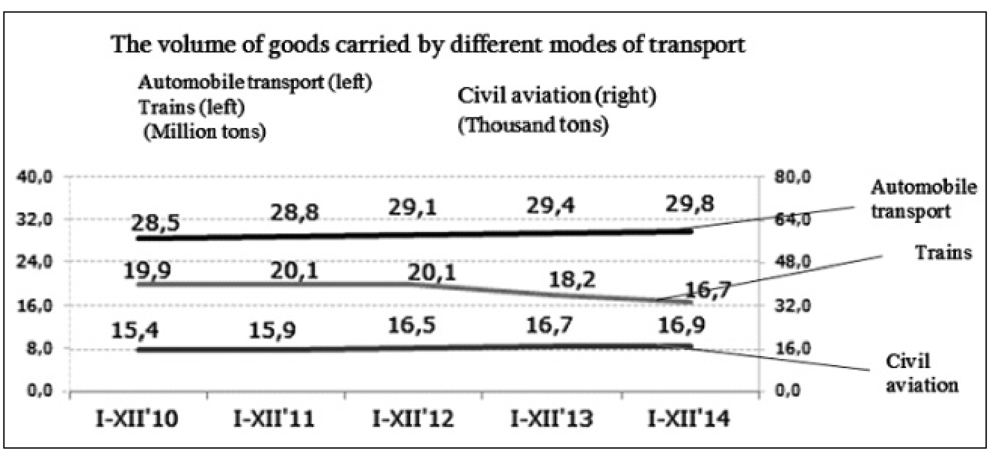


**Figure 2** The volume of goods carried by different modes of transport [6]

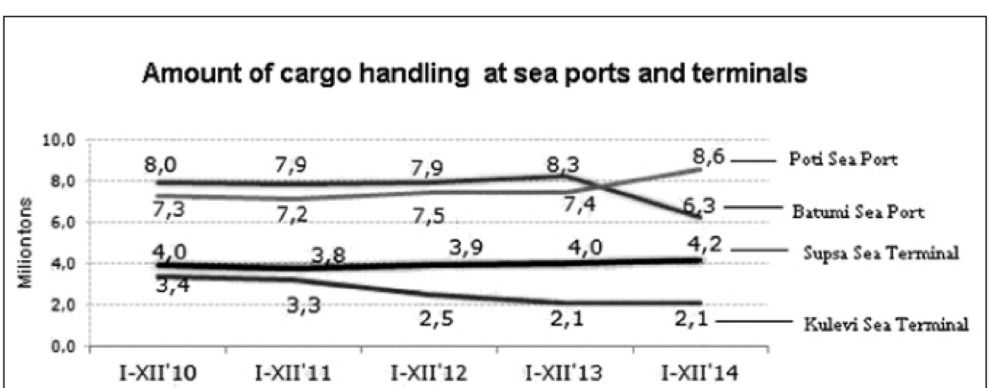


**Figure 3** The volume of cargo handling at Georgian sea ports and terminals [6]

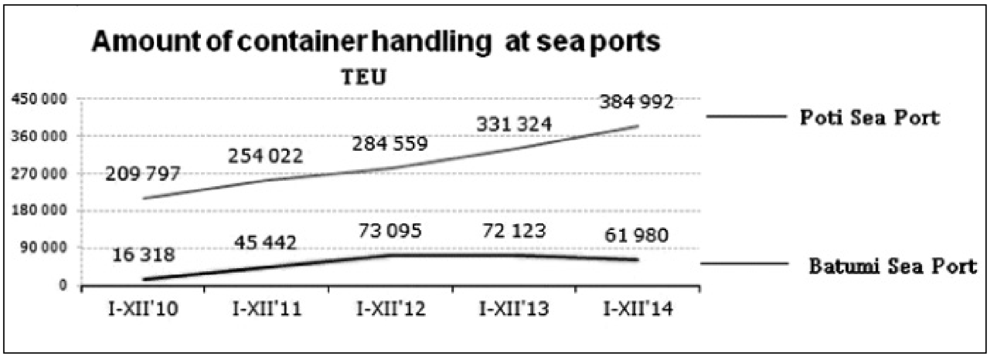


**Figure 4** The volume of container handling at Georgian sea ports [6]

**Table 1** Forecast indicators of oil production (million barrels per day)

| County/year | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| Azerbaijan | 1.0 | 1.0 | 1.1 | 1.1 |
| Kazakhstan | 2.7 | 3.1 | 3.4 | 3.7 |
| Turkmenistan | 0.3 | 0.3 | 0.3 | 0.3 |
| Uzbekistan | 0.3 | 0.3 | 0.5 | 0.6 |
| Total | 4.3 | 4.8 | 5.3 | 5.7 |

**Source:** International Energy Outlook, Energy Information Administration (EIA)

in this indicator, it has not caused a significant reduction of cargo volume in the industry.

Poti Sea Port for several years has been a leader in the processing of container cargoes. In 2014, there were processed on 83% more containers than in 2010 and on 16% more than in 2013. Batumi Sea Port has reached the highest growth in 2012, although in 2014 compared with 2013 it decreased slightly and amounted to 61,980 TEU.

The important role of ports as the central objects of the logistics center is explained by their specialization in the transshipment of oil. Expanding of transit routes passing through the territory of Georgia, is also a requirement of the global world economy, due to large reserves of carbon raw materials in the Caspian Sea.

The forecasted growth of oil production in the Caspian Sea region will increase demand for its transportation by tankers (Table 1).

The table data shows that the forecasted indicators of oil production in the Caspian Sea region is growing rapidly, and by 2030 will reach a total of 5.7 million barrels per day. Such amount of oil can't be passed through the currently existing oil pipelines and it is expected that part of it will be exported from the Georgian Ports passing through the railway. If Georgian maritime infrastructure by that time will not be ready for the above mentioned processes, the loads will be redistributed to other alternative ways.

For this purpose the Turkish Government intends to increase the capacity of the Bosporus Strait. New channel called "Istanbul Channel" will be more the Suez and Panama canals. Channel length will be near 40-45 kilometers width – 140-150 meters, depth – 25 meters. The capacity of Channel planned near 160 ships daily, including oil tankers.

## 3 CONCLUSION

Development of maritime logistics clusters is the implementation of transport industry potential through the development of processes that bring added value in the field of logistics.

Georgian sea ports concentrated traffic flows and are important links in the supply of transport and logistics chain and should be the core of logistics cluster. Creation of a maritime cluster on the basis of Batumi and Poti sea ports should increase the competitiveness of both the port and other companies – cluster members. Creating a cluster provides synergies and new opportunities for innovative handling of technological operations in port logistics.

The implementation of the business model of maritime logistics cluster based on the Georgian sea ports should facilitate the involvement of industry, transport and logistics companies in the impact zone of the port logistics.

The result of maritime logistics cluster operation should strengthen Batumi and Poti Sea ports position not only in Georgia, but also in Caucasus region. It should be implemented both in terms of goods and raw materials transit maintenance and in the economic development of country as well.

The main prerequisites for Georgian maritime logistics cluster forming and functioning are:

– availability of significant untapped potential in marine, cargo storage and air cargo logistics;
– completion of Georgia-Turkey railway that will open new efficient transportation possibilities;
– port and railway logistics development that will stimulate road transport and development of innovative logistics centers;
– development of transport system will significantly improve the cost of Georgia's products competitiveness.

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# A CONTEMPORARY OUTLOOK ON HUMAN ELEMENT IN ENERGY EFFICIENT SEABORNE TRANSPORTATION

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**Abstract.** This paper addresses human element issues in the current discussions on energy efficiency in the maritime transport. Shipping is generally known as the most environmentally friendly mode of transport (Boon, 2007) in terms of $CO_2$ produced per ton nautical mile. Nevertheless, there is still immense potential in various technical and operational areas remained for improving energy efficiency in the sector. These measures, not limited to, include ship design, hull and propeller efficiency, alternative fuels, renewable energy, weather routing, fleet management and so forth. Despite an extensive amount of research available to improve energy efficiency in shipping, the implementation of such measures has not been progressed by the industry as expected (Johnson and Andersson, 2014). In addition, the area of human element when operationalising the concept of energy management in practice is under-researched. This paper draws attention to barriers, human behaviour, and change management theory in the process of integrating energy management measures into the workplace from the organisational to personal level. For example, how does the organisational change influence human behaviour in the context of energy management? How do the personnel in a maritime organization or on board a vessel take on energy management in their routines of work? What leads to cultivate a mindset of energy efficiency among workers in the organisations? This paper revisits the contemporary discussions related to energy efficiency in shipping and focuses on human element to support the process of implementing energy management for a sustainable maritime transport system (IMO, 2013). It can be concluded that more emphasis on human element in the area of energy management will help the development of an implementation mechanism for the sustainable shipping, and thereby human element should be focused both in education and research on energy management. Such academic efforts will make a substantial contribution to the contemporary debates in interdisciplinary science and technology.

**Key words**: human element, energy efficiency, shipping, sustainability, energy management

# 1 INTRODUCTION

There has been a growing attention to "green shipping" or eco-friendly operation of ships in the last couple of decades. In 1992, The United Nations Conference on Environment and Development (UNCED) was held at Rio de Janeiro and the discussions included alternative energy sources to replace the use of fossil fuels in relation to global climate change. This led to an effort to make an international agreement, called Kyoto Protocol, within the United Nations (UN) Framework Convention on Climate Change, setting internationally binding emission reduction targets. Shipping was not an exception in this discussion. According to the Third IMO GHG Study (IMO, 2014), the average green house gas (GHG) emission from shipping accounted for approximately 3.1% of annual global $CO_2$ during the period of 2007–2012 on average.

Similar to car industry, shipping industry is also expected to contribute to energy efficiency in the design of ships as well as the use of alternative fuels. Undoubtedly, technology in future shipping cannot escape from the political and economic demand of energy efficient seaborne trade and is expected to drive this trend of "green shipping" in even more operational and feasible manners.

While technological development foresees the future landscape of modern green shipping, the element of human should not be forgotten. Even if unmanned ships become realistic, there is still a need of human-beings to operate such ships from the shore. In the event of introducing new technology, there is always a chance of re-define the role of human-beings in a new work scene. This paper thereby aims at discussing the human element in energy management in the pursuit of efficient and environmentally sound shipping operations.

# 2 WHY GAPS EXIST?

The idea of energy efficient shipping has been welcome both politically and economically since 1990s. The climate change became a serious concern for people around the world and UNCED in 1992 confirmed that it is a global challenge for the earth. Various UN organisations have discussed this global threat from their perspectives. Food and Agriculture Organization (FAO) calls for a strong and collective effort to reduce the risk of intensified food insecurity for many of the world's most vulnerable people (FAO, 2015). World Health Organization (WHO) warns that climate change is expected to cause approximately 250,000 additional deaths per year between 2030 and 2050, from malnutrition, malaria, diarrhoea and heat stress (WHO, 2015). While voices from global and local political arenas were raised, the industry also became aware of its economic incentives for sustainable operations. In the context of energy efficiency in shipping, various measures were developed to reduce $CO_2$ emission. These measures include, for example, ship design, hull and propeller efficiency, alternative fuels, renewable energy, weather routing, fleet management and a number of new innovative technologies have been investigated for application.

The question is how these energy efficiency measures are implemented in practice. Thollander and Palm (2013:35) employ the term, 'energy efficiency gap', to describe 'the existence of a "gap" between potentially cost-effective energy efficiency measures and the measures actually implemented.' It is evident from numerous research that not all the energy efficiency measures may be implemented despite their financial benefits (Thollander and Palm, 2013). This problem, acknowledged as 'energy efficiency gap', refers to policy decision-making, market factors, social barrier, and so forth. Public policy intervention requires certain justification for implementation by balancing cost and benefit. Policy decision-making could, therefore, cause a barrier of adopting certain measures in a given situation. In addition, market factors can be a challenge for certain energy efficiency measure. For example, when oil prices are sufficiently low, it would become difficult to argue that all the energy efficiency measures are cost-effective and therefore they are less likely to be implemented.

Among those gaps, social barrier is somewhat similar to the notion of human element which is the main focus of this paper. It considers the perspectives of workers who exercise energy efficient operations and how the people behave and react to the implementation of energy efficiency measures in their routine work.

# 3 HUMAN ELEMENT AS SOCIAL BARRIER

The role of human element has been a concern since human beings started to interact with modern technology. 'We are an inseparable part of the entire technological, social and decision-making machine, and of the learning process itself (Duffey and Saull, 2008:xv).' When human beings meet new technology and try to work around it, there would be the area of human element which could help to understand how we tend to behave and react to certain situations.

Human element in the maritime sector has been highlighted by a number of accidents which the shipping industry experienced. For example, the tanker, Torrey Canyon, made the first major oil spill in the

English Channel in 1967 as a consequence of psychological pressure and time demand factor. Today's shipping is even more complicated as the crew is often multi-national and communication issues between seafarers with different cultural backgrounds has been seriously observed as human element in modern shipping (Kitada, 2011, 2015). Human performance factors or behaviours are frequently referred to accident causation. These factors and behaviours include fatigue, stress, health, non-technical skills, situation awareness, decision making and cognitive demands, communication, language and cultural diversity, and teamwork (Hetherington et al, 2006). It should not be under-estimated that industry-driven motivations to push workers to an extremely stressful work environment may incur a danger to human-beings, cargos, and environment.

In terms of energy efficiency in shipping, it was also driven by the industry where they were striving for cost-effective business models. A number of studies have focused on the development of new technology and innovation in maritime energy sector. For example, a ship can be equipped with a device which can lively transmit all the ship operating parameters and weather conditions to the shore-based ship management office via satellite systems. This new technology enables shore-based managers to monitor and analyse the ship data from a distance and to provide effective support, such as an advice for the optimal energy-saving operation (see also Bazari and Longva, 2011). Despite such technological innovation in energy efficiency in shipping, the literature on human elements in the context of maritime energy, including barriers, human behaviours, change management, is rather scarce.

## 4 AN INQUIRY TO BARRIERS TO ENERGY EFFICIENCY IN SHIPPING

Energy efficiency is becoming one of the mandates for many shipowners as well as policy-makers. Corporate social responsibility (CSR) has been introduced in private sectors, and the reductions of energy consumption and $CO_2$ emissions became a shared responsibility across various industries. Shipping industries have come to the new phase which their commercial activities were proved to be the most environmentally friendly mode of transport (Boon, 2007) in terms of $CO_2$ produced per ton nautical mile. Thus, their commitment to the globe is very important and should be sustainable.

While technological development has enabled to find various solutions to energy efficient shipping, the industry has been experiencing a gap between its potential and action. Johnson and Andersson (2014) pointed out that the implementation of energy efficient measures has not been progressed by the industry as expected. Why is it so?

An inquiry to barriers to energy efficiency in shipping is a starting point for such a discussion. Economic barriers are well-known as both market and non-market failures. Market failures include, for example, imperfect or asymmetric information problems, split incentives, principal-agent problems, adverse selection, and moral hazard whilst non-market failures are such as market heterogeneity, hidden costs, access to capital, and risk (Rehmatulla et al., 2013). On the other hand, barriers related to organisation and human behaviour have not been studied as much in shipping. Instead of focusing on technical and economic barriers, this paper draws an attention to socio-economic barriers for the purpose of mitigating a human element gap between energy efficiency expectation and implementation.

One of the socio-economic barriers to be highlighted is a limited extent of information dissemination in smaller firms. Compared to large shipping companies, small firms do not have as much resources as large ones, including human and capital. Banks et al. (2012) argue that larger shipping companies may be able to invest in new technologies, innovations and training regarding energy efficiency than smaller companies. The evidences from their research on energy efficient operation of ships do not seem to successfully motivate those small ship operators and owners to exercise energy efficient practices as expected (Banks et al., 2012). If collective efforts as an industry to save energy are not made because of the lack of consensus, the impact would be smaller than potential. It is, therefore, important to increase the awareness of energy efficiency through the dissemination and sharing the research-based information and the shipping industry could work for more effective implementation.

Another consideration in the socio-economic barriers arises from organisational theories. Max Weber understands organisations as hierarchy which admits the relationship between superiors and subordinates (Weber 1968). In such organisations, decisions to implement energy efficiency measures are not necessarily made by practitioners and there may be a gap between the leaders and followers in terms of the lack of understanding of human element. On the other hand, systems theory explains that the organisation is an open system, which interacts with the environment and is continually adapting and improving. If the organisation implements energy efficiency, it needs to be systematic in adapting such changes which may bring a larger impact than anticipated. The research reveals that 'many shipping companies appear to lack the ability to systematically address energy efficiency within their organisations' (Johnson and Andersson, 2014). From the neo-classical perspective, human behaviour in organisations is further emphasised and concerns about social and psychological aspects of human behaviour. In the context of energy efficiency in shipping, such social and psychological impact of human behaviour should not be under-estimated and it needs to be a central of the discussions in examining the energy efficiency gap in shipping.

## 5 ENERGY MANAGEMENT FROM INDIVIDUAL TO ORGANISATIONAL LEVEL

The area of human element in energy efficiency in shipping is not a single dimension but rather multi-layered and intertwined with other technical, political, social and cultural aspects of the industry. Bearing in mind a limitation of developing a comprehensive understanding of human element issues in this short paper, the attempt is made to discuss three sub-set questions in order to facilitate some important human element considerations in energy management from individual to organisational level.

The first question is posed as how the organisational change influences human behaviour in the context of energy management? Today's organisations are exposed to various changes from both external and internal factors. External changes include, for example, the effect of globalisation, technological development, legal forces, market change, and political tensions with neighbouring countries. Internal changes can be structural, cultural, and new directions and processes resulted from leadership and management changes. Organisational changes may occur at various stages of organisational development. When energy efficiency is first introduced in the organisation, how would the visions and strategies of energy management be shared and promoted among the workers? Human behaviour deeply rooted in the organisation for a long time may be challenged if the energy management requires the workers to change their behaviour. Therefore, from the management point of view, it is crucial that organisational change would bring new and pragmatic framework (By, 2005) in which workers can understand the meaning of change both at organisational and individual levels. Moreover, such an examination of organisational change impacting individual workers can be further discussed in other situations, for example, in their routines of work.

Routine work where various policies and procedures take place is something difficult to understand from the top-down approach. Without organisational change, ordinary patterns of work are heavily involved in human behaviour where workers' knowledge and experiences are pervaded. The second question comes, therefore, as how the personnel in a maritime organisation or on board a vessel take on energy management in their routines of work. It is widely acknowledged that the Master and the crew tend to experience a gap in their perceptions of routine work on board when the managers in shore-based offices try to enforce new policies and procedures into the ship. Johnson and Andersson (2014) also observe such organisational barriers that the ship crew who directly influence actual energy use may be organisationally far from those responsible for implementing energy efficiency improvements and hardly be included in the decision-making process. In this context, energy management should not be introduced as an additional burden for seafarers and considered to employ a bottom-up approach. This standpoint is actually answering to the next question relating to human element in energy management.

The third question concerns about a sustainable issue of workers' education and training: what leads to cultivate a mindset of energy efficiency among workers in the organisations? As discussed earlier, a top-down approach would face a limitation to encourage and motivate workers, especially seafarers, to understand the meaning of energy efficiency on board and proactively contribute to a sustainable development of ship operations. Banks et al. (2012) conducted a study on seafarers' awareness, knowledge, motivation and ideas in energy efficient operation by using a questionnaire and received 317 responses from more than 20 countries. The research highlights that seafarers tend to feel uncertain or a lack of sufficient knowledge or motivation about how they can contribute to carbon reductions. It also reveals that the current education and training for seafarers does not focus on energy efficient operation. Meanwhile, cultivation of seafarers' mindset of energy efficiency may also result in modifying their behaviour and routine work if necessary. 'Energy management is not an immediate fit to existing organizational structures, but may require new organizational forms and new infrastructure for performance monitoring (Johnson, 2013)'. In order to successfully implement energy efficiency in organisations, a dialogue between managers and workers is necessary, including a possibility of incentives, such as a bonus resulted from saved fuel costs by implementing the company's energy efficient policies and procedures. Without such consultations, psychological barriers would not be removed. For the better sake of healthy management and operation of ships, unnecessary tensions between managers and workers should be avoided.

## 6 SUSTAINABLE SHIPPING: THE ROLES OF HUMAN AND TECHNOLOGY

According to the IMO concept document on a sustainable maritime transportation system (IMO 2013), the IMO Secretary-General, Mr. Koji Sekimizu emphasises the role of shipping industry to serve sustainability in a wider context under the UN visions. Seaborne trade is crucial in terms of supporting countless of wealth-creating and poverty-alleviating activities in both developed and developing countries. In addition, shipping offers job opportunities to people around the world and it is worth noting that over 1.5 million seafarers are employed largely from developing countries. In this document, energy efficiency and ship-port interface as well as energy supply for ships are highlighted as the key components of the IMO's sustainable development approach.

Technology in energy efficiency will continue to provide wide options and solutions for different stakeholders to implement energy management in their organisations. From all available measures for energy efficiency, companies have to make a decision of which solution is suitable and appropriate and explain their employees why a particular solution is chosen in their work environment. If the workers are given an opportunity to address their concerns and preferences when choosing a solution for energy management, it would help the organisation to learn the process of adopting a new system and a potential gap related to human element could be reduced. Otherwise, it is suggested that managers should explain how the chosen-measure for energy efficiency will influence the employee's patterns of work. Managers are also expected to be flexible in designing the implementation process by discussing with workers, hence both managers and workers can learn from each other.

The role of human element in the energy management, therefore, needs to be more emphasised in both education and research. The lack of human element would cause a gap in the implementation mechanism for the sustainable shipping. In the past decade, the shipping industry failed to address human element issues in the implementation process of energy efficiency. Under the IMO's effort as well as the United Nations Decade of Sustainable Energy for All 2014–2024 (SE4All) (UN 2014), all the stakeholders in the maritime sector are invited to promote such advocacy campaigns and develop a strategy for action. In response to this call, the shipping industry should be fully aware of the importance of human element in energy efficiency and contribute to the establishment of an implementation mechanism, namely, 'a sustainable maritime transport system' (IMO, 2013).

## 7 CONCLUSION

Energy is an essential engine for growth, and thereby energy management is vital for human beings, within their capacity, to keep our environment, including oceans, sustainable. The paper highlighted that a focus made by the shipping industry in energy efficiency has been based on technological, economic and political debates without linking to human element issues, such as barriers. It draws a conclusion that more emphasis on human element in the area of energy management should be facilitated to develop an implementation mechanism for the sustainable shipping.

Awareness of human element issues in energy management can be effectively raised via education and research on energy efficiency in shipping. More and more interdisciplinary research which connects technology to socio-economic approaches is expected to increase, and such discourses would help filling in the current gap observed in energy efficiency implementations. While shipping is committing to continuously operate the most environmentally friendly mode of transport around the world, socially responsible attitude of the industry would picture a positive image of the industry itself. Thus, the shipping industry will be more attractive to people and adaptable to change.

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# NECESSITY OF MECHATRONICS KNOWLEDGE IN MARINE ENGINEERING EDUCATION

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**Abstract**. Improvements in the electronics and sensing technologies show its influence on industry and ship systems. The more recent ships are built with newer electronic technology and automation systems which reduce the necessity of man power while increasing the reliability of the system. However, these ships are manned with the marine engineers and officers who have very limited knowledge of electronics and electronic control systems which are generally called mechatronics systems. It is clearly foreseen that the mechatronics education will be a must for the new generation of marine engineers. The curriculum of the marine engineering education should be updated considering this deficiency. In this paper, the new mechatronics laboratory of ITU Maritime Faculty will be introduced. The hands on education and training capabilities of the laboratory, the equipment and instruments, and the experimental facilities will be explained. Its effect on marine engineering education and its benefits to marine engineers will be discussed.

**Key words**: marine engineering, education, mechatronics, mechatronics laboratory

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## 1 INTRODUCTION

Recently, multidisciplinary studies have become more important for technological and scientific improvements. Most of the universities and institutions try to initiate new organizations for collaborative and multidisciplinary studies and bring the scholars together. One of the most outshining multidisciplinary areas is mechatronics.

The term "mechatronics" was first introduced by a Japanese company in 1969 [1]. One of the definition for mechatronics is; "Mechatronics is the synergetic integration of mechanical engineering with electronics and intelligent computer control in the designed manufacturing of industrial products and processes" [2].

The improvements of electronic equipment and systems make many applications feasible which were possible only in theory. For example, common rail system for internal combustion engines is actually a very old system. However, it is very popular these days because it became feasible with the electronic control systems. The improvement in sensing technologies has also very important role. Today it is possible to find various sensors which are very accurate and precise. Besides they are endurable to very rough conditions.

The mechatronic systems are everywhere in our world. Most of the systems are integrated with sensors, actuators and electronic control systems. The mechatronics is established as a new discipline named "Mechatronics Engineering". In this department, basics of mechanical engineering, electrical/electronic engineering and computer science are taught. However, it is also a problem for other engineering disciplines to learn mechatronics knowledge. Therefore, the engineers of other disciplines like civil engineering and mechanical engineering also need to know about these systems. This results in the necessity of updating the curriculum of these disciplines including mechatronics knowledge.

## 2 MARINE MECHATRONIC SYSTEMS

Mechatronics is very important also for the marine engineering department. Marine engineering is very close to the mechanical engineering. However, marine engineers are focused more on operation of complex mechanical systems. The new build merchant ships are equipped with more mechatronic systems. These systems on board ship are not as complicated as robotic systems. It doesn't include very complex sensing systems, rigid body dynamics etc. These mechatronic systems are mostly based on electronic control systems using simple sensors. Electric motor controls, tank level controls, pressure and temperature controls, and fuel control of engines are some of the instances of mechatronics systems on board ship.

Selection of the sensors and electronic control systems suitable for the marine systems has vital importance. The environmental conditions of ship should be taken into consideration. The ship is navigating in a very dynamic environment. The parameters such as ship movements (rolling, pitching, yawing), high vibration, humid, sea salt, oil mist, and high temperature should be considered and suitable sensors and electronic control units should be chosen. There are mainly two types of control units for industrial systems: Microcontroller systems and PLC (Programmable Logic Control) control systems. PLC control systems are more preferable for ships due to their suitability to above mentioned ship environment.

Another part of mechatronics for maritime sector is marine robotics. This is more complex and more specialization is needed. In this case, the integration and synergy of different disciplines is needed. Another point is that in this case mechatronic system design is carried out and it is not only operation of existing systems. Most of the marine robotics studies are focused on remote controlled and autonomous vehicles such as autonomous underwater vehicles, autonomous surface vehicles and remotely controlled underwater and surface vehicles.

## 3 MECHATRONICS EDUCATION FOR MARINE ENGINEERS

The electronics, computers, and information technologies are growing very fast and they take place in our everyday life. Therefore there is a gap between the knowledge of engineers educated with classical curriculum and the expected skills at the related sector.

This problem can be considered in two different perspectives: the curriculum of mechatronics engineers and the curriculum of other disciplines. There are many studies investigating the mechatronics and developing a curriculum for mechatronic engineers [3, 4, 5, 6, 7]. Study [3] investigated the mechatronics education in Nordic and Baltic Countries. They concluded that the mechatronics education in these countries is focused on local industry and they educate the engineers to work for offshore oil industry. In other words, they narrowed the wide area of mechatronics education and made it easier and more applicable.

There are also studies which investigate about the integration of mechatronics courses to other disciplines such as mechanical engineering [8, 9, 10]. In the study [9] the authors proposed a microcontroller system laboratory for supporting mechanical engineering course. In [10] development of supporting mechatron-

**Table 1** The courses supporting mechatronics knowledge at ITUMF

| Course Code | Course Name | Credit | Theory | App | Lab |
|---|---|---|---|---|---|
| BIL 106 E | Intr. to Scientific and Engineering Computing | 3 | 2 | 2 | 0 |
| GMI 201 | Marine Electro-technology | 2,5 | 2 | 0 | 1 |
| GMI 222 | Marine Electronics | 1,5 | 1 | 0 | 1 |
| GMI 341 E | Automatic Control Systems | 2,5 | 2 | 0 | 1 |
| GMI 427 E | Mechatronics | 2 | 2 | 0 | 0 |
| GMI 412 E | Hydraulic and Pneumatic Control of Systems | 2 | 2 | 0 | 0 |

**Table 2** Proposed courses related to mechatronics

| Proposed Courses | Credit | Theory | App | Lab |
|---|---|---|---|---|
| Digital Control Systems and Signal Processing | 3 | 3 | 0 | 0 |
| Digital Electronics | 2 | 1 | 1 | 0 |
| Programmable Logic Control (PLC) | 2 | 1 | 0 | 2 |
| Microprocessors | 2 | 1 | 0 | 2 |

ics courses for mechanical engineering students is presented. They proposed two additional classes which are “Introduction to Mechatronics” and “Mechatronics System Design”.

The curriculum of marine engineering education is very close to the mechanical engineering. Almost all of the engineering courses such as thermodynamics, heat transfer, mechanics, material science, fluid mechanics, strength of materials etc. are identical. Therefore, marine engineering curriculum already has a strong background of mechanical side. There are also courses which are related or supporting mechatronics such as: automatic control, programming languages (C++, Matlab) etc. However, it is not sufficient for marine engineers due to increase of mechatronics systems on board ship. The marine engineers should have technical skills and expertise in these systems. Therefore, it is necessary to improve the marine engineering course by developing some courses which will support the mechatronics knowledge and skills. In the study [11], the importance of mechatronics for marine engineers is discussed and some new courses are proposed.

The marine engineering education at ITU Maritime Faculty is discussed here and the necessary courses which will be more suitable for supporting marine engineers’ mechatronics knowledge are proposed. The existing courses which are related to mechatronics at ITUMF are shown is Table 1.

In BIL106E course, one of the programming languages such as C++, Matlab and Fortran is being taught. Marine Electro-technology course is based on the basic electrical engineering knowledge, electromagnetism, and basics of electrical machines and classical control of electrical machines. Marine Electronics course includes basic electronics knowledge as semiconductors, diodes, transistors etc. Control theory is the main topic of Automatic Control Systems course. Hydraulic and pneumatic control systems are also very important part of mechatronics systems and it is the topic of GMI 412E course. In the Mechatronics course the basics of mechatronics systems, sensors and actuators are being taught. Another important point is the credits of the courses. It sufficiency of the number of hours for theory and laboratory and total number of hours should be considered, too.

As we can see there are many courses related to mechatronics but there are still some deficiencies which should be included in the curriculum. The missing parts are mainly electronic control systems, integration of hydraulic and pneumatic systems with electronic systems (electro-hydraulic, electro-pneumatic), signal processing, PLC and microcontroller systems. In Table 2 the proposed courses are listed. These courses are planned to be selective courses.

## 4 THE NEW MECHATRONICS LABORATORY AT ITUMF

There are various laboratories at ITUMF related to mechatronics. These are:

- Electro-technology/Electronics Laboratory
- Automatic Control Laboratory
- Hydraulic/Pneumatic Laboratory

These laboratories are sufficient for classical control of electrical machines, basics of electricity and electronics and classical hydraulic/pneumatic courses. However, the electronic control of these systems can-

**Figure 1** PLC Training Set at ITUMF Mechatronics Laboratory

not be carried out. Therefore a new mechatronics laboratory is developed. In this laboratory mainly PLC control systems are preferred because mostly these systems are used on board ship as explained in Section 2. Besides, also a microcontroller training set is included due to its importance.

The PLC Training set is shown in Figure 1. It consists of a PLC controller and application modules. The PLC controller can be used alone or with application modules. A Siemens S7-1200 series CPU 1214C model PLC is used in the set. There are 8 digital inputs and 6 digital outputs. There are 6 pieces of relay outputs for

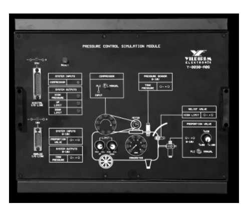
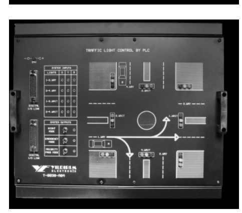
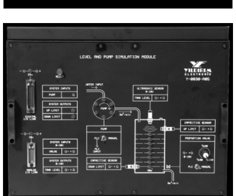
| **Image of Module** | **Name of Module/ Applications** | **Image of Module** | **Name of Module/ Applications** |
|---|---|---|---|
|  | Asynchronous Motor Application Module/ Speed and control applications of Asynchronous Motor with PLC |  | Pressure Control Simulation Model/A compressed tank's pressure measurement and control applications, PLC applications for real analog and digital signal simulations |
|  | DC Motor Application Module/ Speed and control applications of DC Motor with PLC |  | Traffic Signalization Simulation Module/ Traffic signalization applications |
|  | Sensor Applications Module/ PLC applications with sensors |  | Graphic Based Touch-Screen Operator Panel Module/ Input/output applications with operator panel and PLC |
|  | Level and Pump Simulation Module/The pump and tank's fluid level measurement/control, PLC applications for real analog and digital signal simulations | | |

**Figure 2** Application Modules of PLC Training Set

**Figure 3** Microprocessor Training Set and Application Modules

digital outputs. The digital outputs can be selected – PLC output or relay output- via a selector switch. For analog applications, there is potentiometer and adjustable frequency oscillator in the PLC Training Set.

The application modules of the PLC training set are shown in Figure 2.

In Figure 3 the microprocessor training set with PIC16F877 microcontroller and application modules are displayed. The application modules are:

1) Step Motor Experiment Module
2) Display and LED Experiment Module
3) Heat Control Experiment Module
4) Elevator Experiment Module
5) BreadBoard Experiment Module
6) I2C-PWM-LCD – UTLRASONIC Experiment Module
7) DIP-DAC Experiment Module

## 5 CONCLUSIONS

Most of the control systems on board ship are being replaced with mechatronics systems very rapidly. The necessity of mechatronics knowledge is clear. The marine engineers should have the mechatronics knowledge and skills to be able to carry out their jobs. Therefore, the curriculum of marine engineering education should be updated including courses related to mechatronics. The laboratory environment is also very important for better understanding of the systems by hands on experiments. In this paper we introduced the new mechatronics laboratory at ITU Maritime Faculty. This laboratory is equipped for education of marine engineers and equipment is chosen suitable for this purpose.

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# DEFINING AND DESIGNING A COMPREHENSIVE LEADERSHIP EDUCATION PROGRAM USING THE MARITIME MODEL OF LEADERSHIP

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**Abstract.** The maritime industry professional, whether at sea or on shore, must possess certain leadership skills, abilities and attributes that will allow him or her to be successful in a variety of professional environments. Our industry is demanding in many ways and has the right to expect that graduates of MET institutions will be competent to assume leadership roles upon graduation and well into the future. Because of this, it is likely that every MET institution claims Leadership Development in its institutional outcomes or objectives for its graduates. However, the term Leadership can, and often is, defined in many different ways by those giving speeches, writing textbooks and articles, and representing the industry, and this can complicate the design of an effective leadership development program.

The California Maritime Academy is in the midst of a 3-year review and redesign of its leadership development training program. The first question raised was not "How should one define Leadership?" but rather "What are the needs and expectations of the maritime industry, both shore-side and at sea, of its future maritime leaders?" After a review of modern leadership paradigms, educational leadership programs throughout the United States, including military and maritime academies as well as universities well recognized for their leadership programs, and conversations with industry professionals, a model for Maritime Leadership was developed.

This paper will present the Maritime Model of Leadership as a standard definition of leadership development for any MET institution. It will focus on why the Maritime Model is important to understand when designing or re-defining a leadership development program for the next generation of Maritime Leaders and Professionals in a Global Profession. It will also follow the development of a new Comprehensive Leadership Development Program at Cal Maritime using the Maritime Model including the inclusion of the entire Maritime Academy in the leadership development of its cadets.

**Key words:** leadership, leadership development, leadership education, maritime leadership, leadership models

In May 2013, The President of the California State University Maritime Academy (Cal Maritime) formulated a task force to "create a comprehensive, four-year, co-curricular continuum of leadership development and training programs, events and activities for Cal Maritime cadets that integrates with and complements academic studies" to the incoming freshman class. This 17 person task force, consisting of faculty, staff, administrators, ship's officers, and cadets was given 15 months to implement a program to the incoming freshmen class, and three years to have the program fully developed. The program should ultimately be nationally recognized for its leading edge, comprehensive and integrated multi-dimensional approach to delivering powerful, and relevant student leadership development.

Part of the rationale for developing such a program is that while virtually all maritime academies and universities claim to teach and train leaders for shipboard and portside leadership roles, there was little evidence that existing programs were effective in delivering a comprehensive program, and less evidence that programming was reaching all students regardless of their interest or ability to participate.

## DECISION MAKING PROCESS

To accomplish the goal of designing the program, the task force used a decision making process similar to the Scientific Method, or an Engineering Design Process, which is called the Six Step Decision Making Process.

A brief description of the process follows here:

### Step 1 – Assess the environment

Assessing the environment meant understanding what was already being done on and off campus, inside and outside the classroom. It included reviewing the resources that were available on campus and those that were had available to use off campus as well. The team reviewed federal and state maritime and service academy leadership development programs and looked at the programs listed in a national review of the 25 best leadership programs in the country. Theories of leadership development education and pedagogy were studied. But it was most important to understand what the Maritime Industry at large meant when it was looking for leaders for that industry.

### Step 2 – Analyze the task

The second step is to ensure that everyone completely understand the task at hand, the timelines, the budget (if appropriate), and the expectation of the deliverables. It was during this step that it was determined that it was not required define leadership or what it means to be a leader, but rather to understand and deliver a program that ensured graduates knew what it takes to be a leader, and were ready to do so. It was during this step that the definition of the Maritime Model was developed from which came the evaluation criteria and the programming models.

### Step 3 – Develop and weight criteria for evaluation

During this critical step the criteria that would help determine the best plan of action was determined. It is important that this be done prior to the development of options so that the options do not drive the criteria, but that the criteria are used to evaluate the options. For this program, criteria included twelve guiding principles that included principles such as flexibility, content, affordability and ease of assessment. Of course, some of these principles were deemed more important that others, and so were weighted more heavily during the evaluation process.

### Step 4 – Determine options, evaluate against criteria, select option or model

After the preparatory work during the first three steps, the task force was ready to start with developing options for the program. Preliminary free-flowing conversations, included brainstorming, talking with constituents, discussing ideas with industry leaders and educational professionals, and then working in teams to design four separate and distinct options as potential leadership development program models. The teams developed the conceptual framework for the models, and presented them to the task force for critique and comment, and then continued development based on feedback.

Each of the four options was then evaluated against the previously developed and weighted criteria. It is important to note that the options were not evaluated against one another, but only against a common set of criteria. This evaluation was completed privately by each task force member and the results were tabulated using raw scores, average scores and scores with standard deviations. In all scenarios, the preferred option was the same. However, by looking at the rating sheets, there were elements of the other options that received high scores in certain aspects of the evaluating criteria. These areas were reviewed and identified for possible inclusion in the chosen option model.

### Step 5 – Develop program model

The remainder of the first 15 months of the task force effort was to design the program based on the conceptual model and ensure it met the overall objectives laid out in the very beginning of the effort. In this step the specific programming needs were identified and designed as part of the four year curriculum. As this program is intended for every student, it was critical to identify a process for ensuring that all cadets were full participants in the program, and that the programming lessons and opportunities were being delivered to each and every student.

**Step 6 – Implement, assess, improve**

The final step of the decision or design process is implementation. Cal Maritime is currently in this phase which was intended to take the final 21 months of the 36 month process. The program was implemented for the freshman class, and has gone through its first academic year. During that year, the task force worked with the students, faculty and staff to monitor and control the program, as well as continue to design it for students in other years. During this step there will be adjusting, adding to, and assessing of the program with an eye toward continuous improvement and growth. It is during this phase that the program will be presented to audiences such as IAMU to gather feedback and comment as part of the assessment program.

## FOUR YEAR CONTINUUM OF LEADERSHIP DEVELOPMENT

The leadership program has many components and opportunities for the cadets to complete. While some of these opportunities will occur at the student's own pace, much of the programing is geared toward a four year continuum with a particular plan. While not all opportunities are in strict adherence with this practice, the *general strategy* is for the learning opportunities to focus in this manner:

- 4th class (first year): developing self-discipline and freshman success
- 3rd class (second year): developing accountability of self and one other person
- 2nd class (third year): developing diverse group leadership competencies
- 1st class (final year): developing life skills necessary to thrive as a new graduate

## I TEACH LEADERSHIP

It was important to the task force that this program be a comprehensive part of the campus environment. To help ensure all campus constituents knew what was to be accomplished with the program, all employees regardless of position were included in the program. In a President's address to the campus wide community, he handed out buttons for everyone to wear that read: *"I teach Leadership at Cal Maritime, ask me how!"* As the buttons were handed out, he read some of the "answers" to *ask me how*, ensuring that everyone knew they were part of the program, as well as showing some of the expected outcomes of the leadership program. Here are some of the ways that all Cal Maritime faculty and staff teach leadership in their everyday work habits:

- I make ethical decisions
- I hold myself to an outstanding work ethic
- I hold myself and my team accountable for my/our actions
- I treat others with respect; my superiors, my subordinates, my peers, and our Cadets
- I collaborate on important tasks
- I dress in appropriate attire for my profession
- I am respectful of other's time, so I am on time
- I give credit where credit is due
- I understand that my actions, my words, and my work product are seen and heard by all, and are important to the quality of the learning environment of our students

## THE MARITIME MODEL

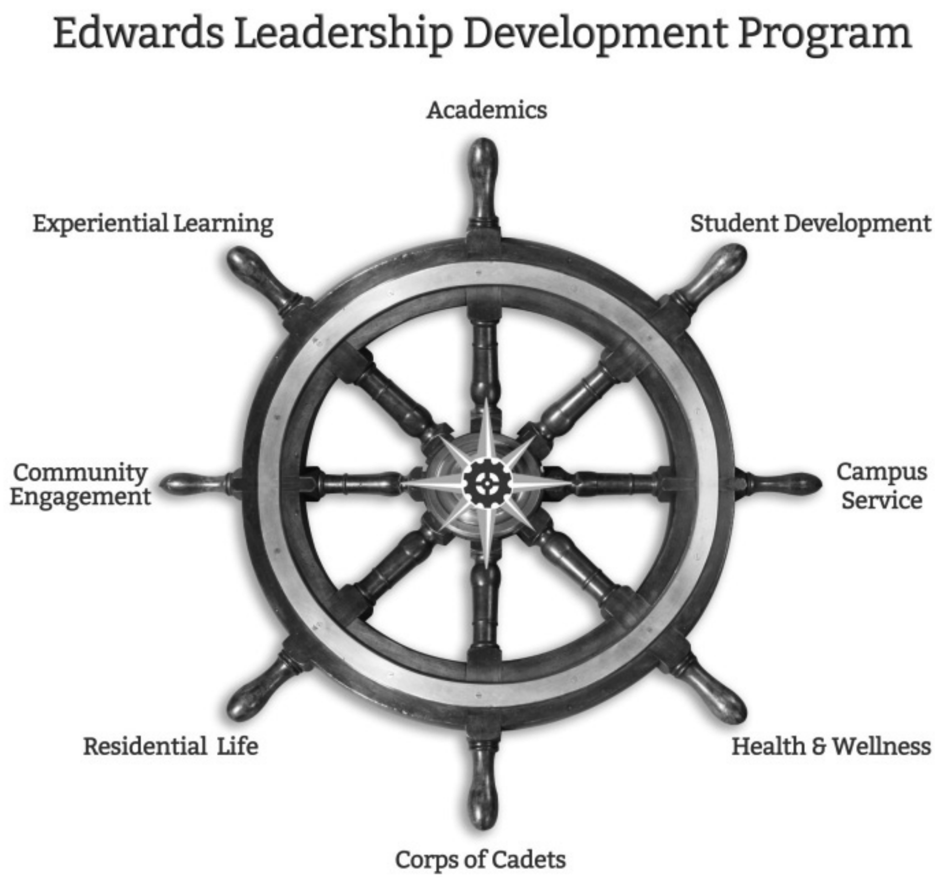
As mentioned above, the task force, in conversation with maritime industry professionals determined the need for defining the maritime model of leadership. What does it mean to be a leader in the Maritime Industry? And how are students prepared for this challenge? The task force based its programming and leadership development programming around this definition.

> *The "Maritime Model" of Leadership is one which embraces the history, importance, and tradition of the seafaring chain of command while promoting active participation and engagement in modern team management best practices.*
>
> *The Maritime Leader is a "loyal shipmate," who is ethical, responsive and goal-oriented, who strives for excellence, demonstrates integrity, and is confident, ever-learning and adaptive.*

Based on this definition, the challenge was to create a leadership development program that develops graduates ready for sea-going or shore-side professions in which they are competent to understand and contribute to the situation, confident to articulate their opinions, and respectful enough to understand their position in the ultimate line of authority.

## THE SHIP'S WHEEL

A traditional ship's wheel is the graphical representation of the Cadet Leadership Development Program.




The wheel is comprised of eight spokes, or handles, each representing an important component of each cadet's living and learning experience while attending Cal Maritime. Each cadet will reach a fundamental or foundational level of leadership training, education and experience through each of the eight areas. During their tenure at the Academy, additional leadership opportunities will be available for the cadets to pursue higher levels of leadership experiences through one or more of these areas, depending on the student's personal interests, strengths and abilities. As the students progress though the program, they may earn certificates in Leadership at the honors, high honors, and highest honors levels, in a manner similar to academic achievements of cum laude, magna cum laude and summa cum laude.

Required and optional programming in each of the areas will be delivered in unique and specialized manners appropriate to the distinct function of the educational experience. These methods will include lectures, labs, seminars, team building, retreats, one-on-one sessions, international travel, experience in real-world situations, simulations, and involvement in the governance of the campus, as well as community engagement opportunities. These opportunities will be assessed for effectiveness and relevance on a regular basis.

The eight spokes of the wheel, as shown in the graphic above are briefly described here going clockwise around the wheel from the top.

**Academics**

The leadership program is designed to integrate with and complement the academic programs at Cal Maritime. As such, the academic programs will provide practical, experiential and theoretical learning opportunities within and across majors at the lower and upper-division course levels. Academic Programs outside the traditional classroom such as Student Exchange Programs provide additional areas of leadership development.

**Student Development**

The area of student development and career services will provide training and leadership education opportunities in the areas of conduct and judicial affairs as well as career placement and enhancement. Examples of these will be preparing cadets to run and determine responsibility in student conduct issues, preparation for company co-ops and commercial cruise experiences, and job searching and interviewing techniques.

**Campus Service**

Leadership opportunities in this area will focus on student and campus governance and stewardship. Students will learn and perform business and management skills while working with the ASCMA (Associated Students), campus clubs and organizations, campus governance committees and the campus stewardship program.

**Health and Wellness**

In this area, students will be introduced to, and develop peer teaching opportunities of, the positive effects of a healthy life-style. Subject matter will be varied and include topics regarding choices, alcohol and other drug use and abuse, relationships, physical and emotional balance in professional and personal life.

**Corps of Cadets**

All students are members of, and active participants in, the Corps of Cadets, the most obvious and unique aspect of campus life relative to any other California State University campus. The Corps of Cadets is an all-embracing lifestyle at Cal Maritime with strict guidelines regarding accountability, punctuality, uniform and grooming standards, and conduct and disciplinary regulations. The Corps offers practical leadership and training opportunities at many levels during the typical four year cycle of Academy life and is clearly the common shared experience of all cadets.

**Residential Life**

Programs in Residential Life add to the success of our students in knowing themselves and bringing out self-discipline qualities needed to be a leader. Programs include many aspects of college life and personal growth, including living within a community successfully, managing time and stress, and separate programs specifically catered to first year and returning students. More advanced leadership opportunities exist in the residence halls for Residence Hall Officers commonly referred to as Resident Assistants. Additional programing is available for students meeting special requirements for living off campus which include subjects such as off-campus citizenship and programing with landlords and neighbors.

**Community Engagement**

Cal Maritime Cadets are ambassadors to and throughout the community in many ways. Whether it is through intercollegiate athletics, community service learning, military training programs or representing the Academy at local state and national organizations and government offices, cadets have opportunities to gain leadership skills working alongside leaders and organizations both on and off campus.

**Experiential Learning**

Cal Maritime cadets must all participate in academic and extra-curricular experiential learning opportunities throughout their careers on campus. This area will focus primarily on the leadership and learning opportunities for the cadets through their practical business (Co-op) experiences both domestic and abroad through cruises on the Golden Bear, commercial merchant vessels and faculty led international experience.

## CONCLUSION

As of the time of this paper, the task force is completing its second year of a three year design stage. The program has been designed and undergone initial implementation and is being further developed as well as being in the early stages of assessment for effectiveness. Feedback on the program has been positive and is being actively sought after and appreciated.

One of the most gratifying results of actively seeking input and feedback on the program has resulted in the naming of the program. The program is named the Edwards Leadership Development Program and is supported by the Tom & Libby Edwards Leadership Development Endowment.

**Acknowledgements**

The author would like to acknowledge the IAMU AGA paper selection committee for selecting this topic for presentation at the conference. Additionally, the author would like to acknowledge the President of the California Maritime Academy for his leadership in establishing the task force, and to the faculty and staff, industry advisors, and alumni of Cal Maritime for their interest and support, and the 17 original members of the task force and those who joined later for their significant effort to the development of the program. And finally, on behalf of Cal Maritime, the author expresses gratitude to Tom and Libby Edwards for their recognition and financial support of this effort.

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# STUDY ON THE TRAINING EFFECT OF THE SAIL TRAINING

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**Abstract.** Sail training involves the acquisition of the knowledge and skills related to vessel operations. It has is believed that sail training can enhance leadership, teamwork, and communication capabilities, all of which are related to EQ (emotional intelligence quotient). Allison et al. researched the characteristics and values of sail training and reported that young trainees who participated in off-shore sail training programs exhibited measurable improvements in social confidence and their ability to work with others. Kunieda et al. also demonstrated that the effects of the sailing vessel training improved a trainee's EQ, especially in communication skills, positive-thinking, and self-control. In this paper, we examined each EQ factor related to improvements in competency using a case study. It was found that seven EQ competency items had significantly improved for some participants. Further, our study revealed that sail training could not just assist participants control their own feelings but also encouraged active and positive-thinking and improved cooperativeness. In the case study trainee's essay regarding the sail training, it was described how the team cooperated and overcame difficult situations during the voyage. The trainee also emphasized communication and teamwork. If trainees do not pull together as a team, they are unable to achieve their ultimate purpose. The trainee's essay on the sail training was further analyzed using text mining, and we were able to extract the frequently occurring words, such as "precious experience," "learning" and "significant." Using the grounded theory approach (GTA), which is a qualitative analytical approach, coding and categorization were performed and a hypothetical construction was attempted. As an example, we were able to apply label names, such as "the powerfulness of a wind," "powerless in front of nature," and "hardship of the calm." We summarized these label names under the category "natural experience in sail training." Categories, such as "humane growth" "bilateral work and community life," and "goal achievement," were similarly obtained. We developed the following hypotheses from these relations. "Working together with a friend, overcoming many difficulties during the sailing voyage, and arriving at the destination improves confidence, cooperativeness, teamwork, and communication skills."

**Key words**: sail training, EQ, text mining, grounded theory approach

## 1 INTRODUCTION

The effectiveness of sail training has been widely accepted and researched. Kunieda et al. conducted a creativity test before and after a voyage and demonstrated that there was a remarkable improvement in the “frequency” and “originality”. Kunieda et al. further investigated using a questionnaire and found that the effect of the sail training improved the trainee’s EQ across nine EQ competencies, with significant improvements shown in “communication skills,” “positive-thinking,” and “self-control.”

Using a case study analysis, we examined EQ competency improvement in detail. We also analyzed the trainee’s sail training essay using text mining and then further analyzed the essay using the grounded theory approach (hereinafter “GTA”).

## 2 CASE STUDY

We conducted an investigation into a change in the consciousness among trainee merchant marine university students before and after going on an ocean voyage aboard the sail training vessel Kaiwo Maru. From the EQ competency questionnaire, improvements in communication skills, positive thinking, and self-control were observed.

### 2.1 Growth in EQ competency

Each EQ competency improved notably, as indicated in Fig. 1. Remarkable improvements were found in self-control and positive thinking, and there were some improvements in teamwork, activeness, and situation awareness. When the contents of each question were investigated in detail, the following replies indicated significant improvements in self-control.

1. “When being suppressed, taking suitable action is possible”
2. “Being able to have the presence of mind, even when things do not progress satisfactorily.”

This trainee indicated the following in his essay. “Since a present-day vessel completely differs in operation, it may be that it is meaningless in itself. However, for this training, I think that all the things to become a navigational officer are condensing.” Therefore, over time, the sail training became meaningful. Further, in the trainee’s essay, he twice described his team as “the highest team”; thus, we surmised from this that he had a successful experience and overcame many difficult situations as a part of the team.

### 2.2 Growth with sociability

Hospitality, teamwork, and positive thinking all significantly improved, as shown in Fig. 2. When the replies to the question content were investigated in detail, all questions relevant to sociability showed improvement.

The following content were found in this trainee’s essay. “There was no useless day. Mental growth was the largest, although many things including technical skills were learned. I can be gazing at the future and acting calmly, and I can work while caring about friends.” While learning teamwork and cooperating with friends, hospitality regarding work-sharing and caring about friends was cultivated. Furthermore, the trainees thought, “There was no useless day.” He positively analyzed his personal growth as “mental growth” and felt that this was his greatest achievement, even though they were studying many other things.

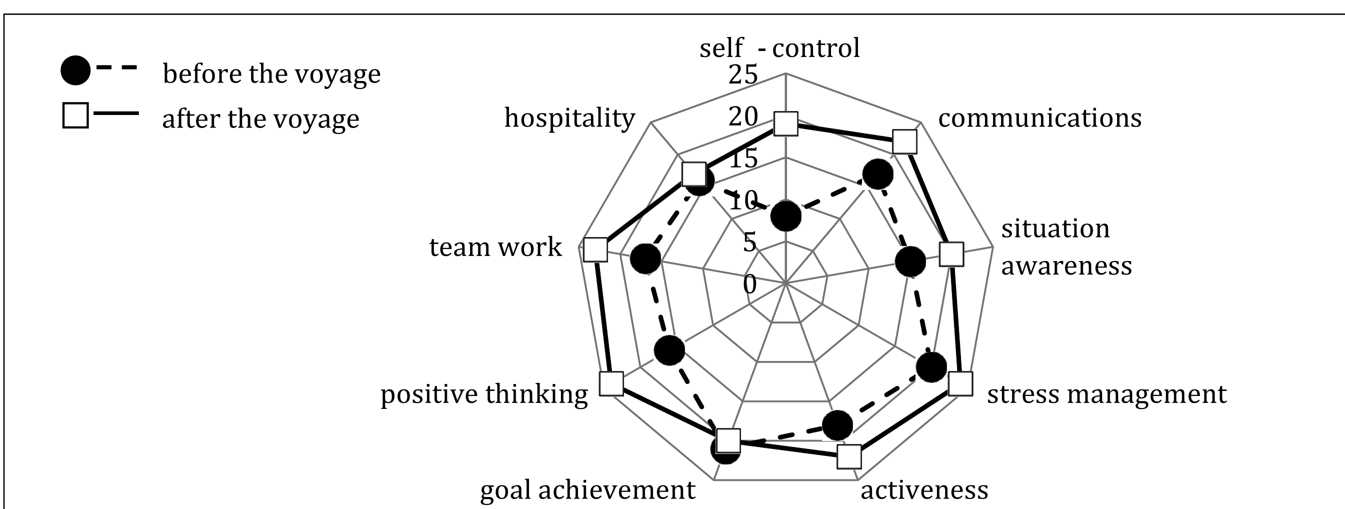


**Figure 1** Growth in EQ competency

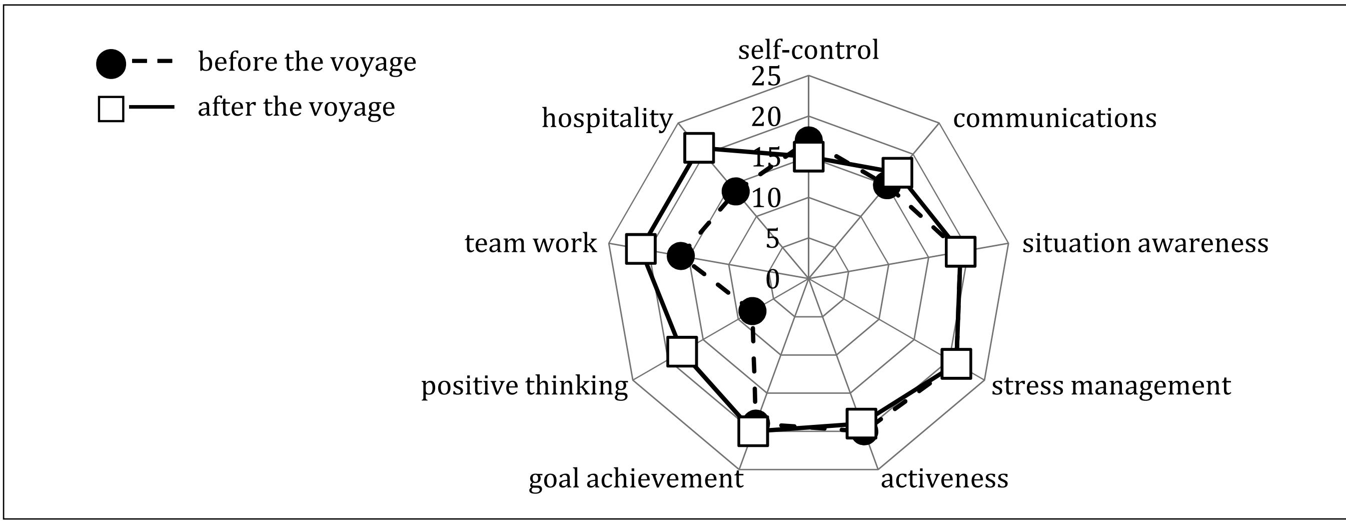


**Figure 2** Growth in sociability

## 3 ANALYSIS OF ESSAY

### 3.1 Text mining

Text mining divides words or phrases in a text using natural language analysis techniques, and then analyzes the frequency of appearance of certain words and the correlation. We analyzed the essays from the Kaiwo Maru's training using text mining. The participants were 77 merchant marine university students (including six women), and the essays were written in the final stage of the training.

The fundamental information about the texts was as follows; 6,952 words and 993 sentences, from which 2,297 word classifications were obtained. The most frequent words (Top 20) are shown in Fig. 3. Many of the words referred to "training" and since it was an essay about training, this was to be expected. The description of the training was given, with most referring to "sailing under wind," and "training to climb the mast." Further, there were also references to "ship handling training (Training of lowering and raising the anchor)" and "voyage plan presentation."

The descriptions which included "experience" were generally affirmative with the descriptions of a good and wonderful experience. The word "fear," was found to be associated with a fear of heights when training to climb the mast. Many affirmative sail training descriptions were associated with the words "growth" and "significant." Eighty-two references were found related to cooperativeness and teamwork, such as "cooperation," "community life," "the people of the room," "group member," and "each other."

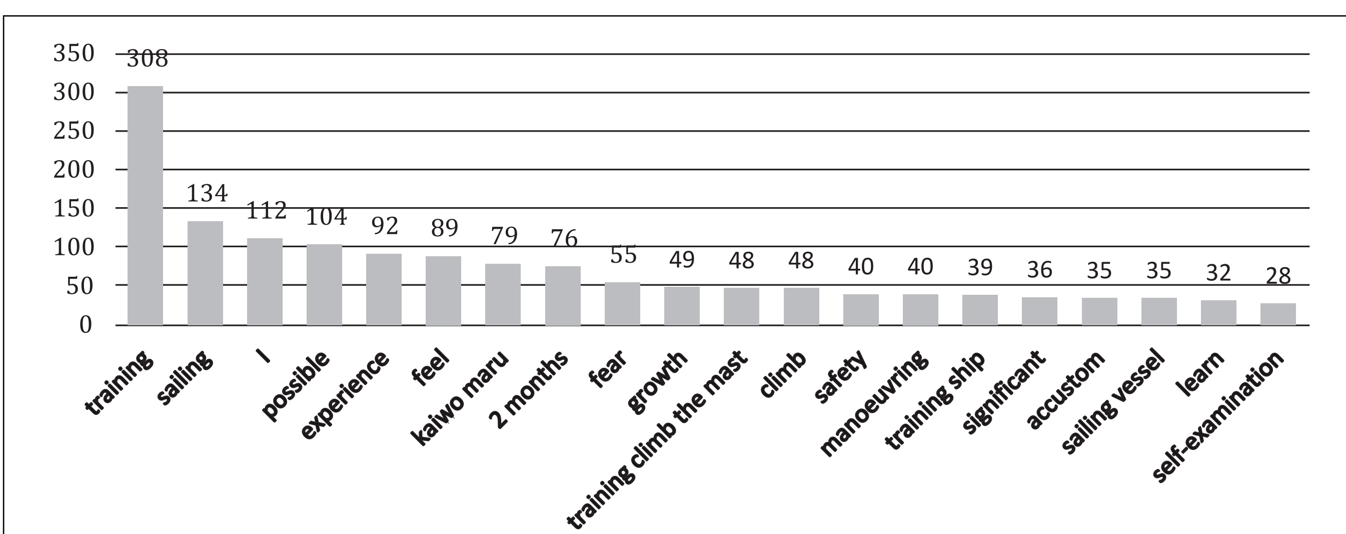


**Figure 3** Frequently appearing words (Top 20)

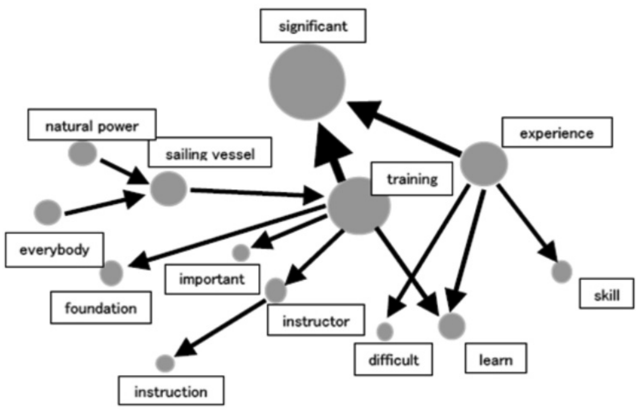


**Figure 4** Attention analysis (significant)

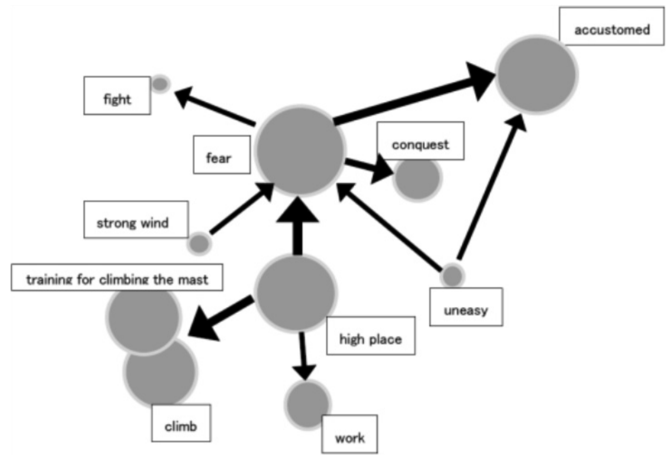


**Figure 5** Attention analysis (fear)

Next, the analysis examined the use of the word “significant,” as shown in Fig. 4. The size of a circle shows the frequency of its appearance in the figure. That is, as can be observed, there were more words related to “significant,” “training” and “experience” than other words. There were words describing “training,” and “experience” separately, as well as words drawn from both. The word “significant” was found to be generally used in the affirmative when related to “training” and “experience.” Therefore, the trainees who felt the voyage was significant for their training considered the training and experience in the affirmative.

A further analysis was conducted on the word “fear,” which is considered to be comparatively negative, as shown in Fig. 5. The main word related to the cause of fear was “high place,” with a few instances of “strong wind.” A related word “accustomed” and “conquest” were also drawn from the word “fear.” “Fear” was found to be related to climbing to a high place and working on a high place and having conquered the fear, the trainees become accustomed to it. Both “significant” and the “fear” from the trainees’ essays were considered to be positively associated with the training.

### 3.2 Grounded theory approach (GTA)

GTA is the qualitative analysis of a text and is used to extract the applicable contents from a text, divide them as objectively as possible, and then label them, the results from which are then used for target theory establishment.

**Table 1** The example of data coding

| No. | Data | Property | Dimension | Label name |
|---|---|---|---|---|
| 1 | Navigational skills with a sailing vessel was able to be accomplished by pulling together. | The feature of the sailing vessel’s navigational skill<br>incubating cooperativeness | ・An understanding of the sailing vessel’s navigational skill<br>An education in emotional behavior | (1) The features of sail training<br>(2) The effects of sail training |
| 2 | The group members who overcame the rough sea together were able to have the strongest united power. | Improvements in united power | The effect of the rough seas | (3) The educational power of nature |
| 3 | Felt the training confronted the grandeur of nature, especially the wind. | the characteristics of nature, such as the wind | Own feelings | (4) Training from nature |
| 4 | The head target was missed repeatedly and it was grasped only by hearing the ship’s position from an officer or other trainees.<br>-From this experience, I keenly realized that I had little knowledge. | Difficulty of practical training<br>Experience of practical training | An understanding of the trainee’s own ability<br>A self-examination from training | (5) The effect of practical training<br>(6) An understanding of reality and oneself |
| 5 | Man the yards was judged most impressive. | Confidence and pride through impression | The impression of man the yards | (7) The effect of man the yards |
| 6 | I would like to think positively and to use this in my life in the future. | message of the training | a self-examination of the training | (8) The effect of training, and usefulness of the training |

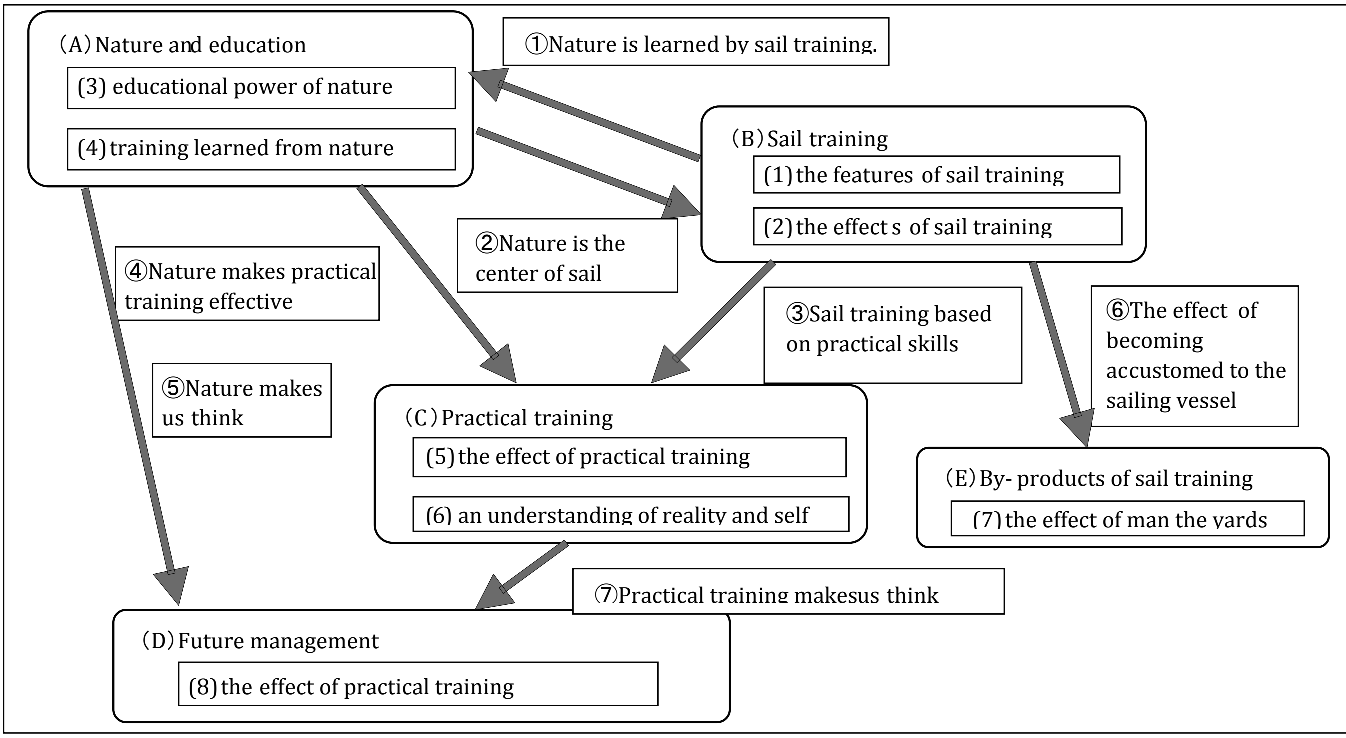


**Figure 6** Categories identified by the GTA

The Kaiwo Maru trainees' essays were analyzed using GTA, which highlighted the hypothesis about the sail training effect. Texts about training were extracted from the trainees' essays, and this was processed using a procedure called "coding." Coding consists of two steps; "sectioning of data," and "labeling." Sectioning divides the data so that those who analyze the data objectively can understand the context. Next, a label name, which expresses a property and a dimension, is given to the data that was sectioned using GTA and are specifically attached to the sectioned data and then the coding is complete. An example of the data coding is shown in Table 1. In the data column of Table 1, the content regarding training was extracted.

"Category extraction" is a procedure in which the coded data and items that are similar based on the label name are collected and extracted, as shown in Fig. 6. By performing a series of category extractions and category relationships using the GTA, a hypothesis regarding the evaluation of the sail training was identified.

"By coming into close contact with nature, such as the wind and a wave, the power of nature was learned and this was one of the training effects of the sailing vessel voyage."

"Pulling together with a friend, overcoming many difficulties in the sailing voyage, and arriving at the destination improves confidence, cooperativeness, teamwork, and communication skills."

## 4 CONCLUSION

The effect of sail training was measured using an EQ competency questionnaire. One example showed a remarkable improvement in seven of the nine EQ competency items. This EQ competency improvement in the trainee was observed in the training essay. It was also found that hospitality improved and the text analysis from the essays uncovered competency improvements. The sail training essays were analyzed using text mining and a frequency word analysis was conducted. Then attention analysis, which focused on a certain word, was conducted, and it was found that the trainees considered the training to be a positive experience. A hypothesis about the effect of sail training was developed as a result of the GTA qualitative analysis of the sail training essays.

As a result of the various analyses, a fixed result was obtained. Although there was further data in the essays about the training on the training ship, it was not completely used in this paper. As text mining can process a lot of text data easily, we plan on continuing this analysis and as GTA, which is qualitative analysis, is also considered effective, we plan to further analyze the data using this technique.

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# ANALYSIS OF EFFECTIVENESS OF 18,300 TEU ULCC SERVICE ON THE FAR EAST – BALTIC ROUTE

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**Abstract.** Paper contains analyze of dynamic market of ULCC, new shipping lines, new services, destinations and partners and port technologies. Statistics, information and statements for December 2014. In 2014 around 15,4 million TeU was transported on Far East – Europe route. EVERGREEN ordered 11 ULCC vessels apr. 20,000 TeU each. Actually the biggest container vessel in the world is MSC OSCAR, which can carry 19,224 TeU. Strategic goals of Port of Gdansk is to gain the rank of distribution port and Baltic container hub. The port's full potential was duly recognized as the Trans-European Transport Corridor No.6 was delineated to provide a connection between the Nordic countries and Southern Europe (Adriatic), with the Gdansk port ranking among its major links. The existing potential of its two container terminals (i.e. Gdansk Container Terminal in the Inner Port and Deepwater Container Terminal Gdansk DCT) currently ensures the throughput capacity of 1,200,000 TeU's and will be further expanded over the coming years. The expansion potential at DCT Gdansk is estimated to reach up to 4 million TeU's. Service of 18300 TeU Maersk's vessel in weekly service with ports of Far East.Plan of developing of port and building DCT2 (650 meters of berth, 16.5 meters draft and new Superpostpanamax Cranes STS produced by Liebherr Container Cranes Ltd, as well as 16 RTG gantries. ). New investments value 290€ billion give to new terminal possibility of developing to 4 million TeU a year. New terminal will be ready to mooring first ULCC in October 2016.

**Key words**: ULCC, container terminal, TeU, DCT

# 1 INTRODUCTION

In Gdansk Bay are located 2 big ports: Gdansk and Gdynia in which there are 4 container terminals:

1. BCT – Baltic Container Terminal
2. GCT – Gdynia Container Terminal
3. GTK – Gdansk Container Terminal

and

4. DCT – Deepwater Container Terminal

DCT is the newest and having practically unlimited potential for expansion up to 4 million TeU capacity in next 2 years. In August 2013 new Maersk 18270 TeU container carreer (Maersk Mc-Kinley Moller) opened regular weekly service from Far East to Poland. Diagram 1 shows tendention of develop of DCT from first year of existing up to moment of Maersk Service establishing from 2013.

# 2 CHARACTERISTIC OF DEEPWATER CONTAINER TERMINAL

DCT handles import, export and transhipment containers to/from mainline and feeder vessels, trains, CFS and road transport. Even though DCT is not an automated terminal all the machinery that is available in the terminal is really new due to the short life of it. The distribution of the yard is not random and every place is assigned to different containers to fully optimize the stevedores and yard workers Job (Figure 1).

The terminal equipment is listed in Table 1 .

**Table 1** DCT data information

| | |
|---|---|
| Terminal area | 44 ha |
| Operating quay length | 650 m |
| Berth depth | 16.5 m |
| Warehouse with mobile reloading ramps | 7,200 m$^2$ |
| Storage capacity | 26,000 TEU |
| Post-Panamax ship-to-shore (STS) cranes | 5 x 58 t |
| Rubber-tyred gantry (RTG) cranes | 17 x 40.6 t |
| Terminal tractors | 35 |
| Reach-stackers | 4 x 32 t |
| Empty container stackers | 2 |
| Rail siding | 4 rails track of combined length of 4 km |
| Stations for refrigerated containers | 336 |
| Pre-gate parking area | 100 lorries |
| Annual throughput capacity | 1,250,000 TEU |
| Annual train capacity | 760,000 TEU |
| Terminal Operating System | Navis |

Terminal operating system called *Navis* connects all computers in the office, cranes, in short, all the devices and machinery. DCT Gdansk has a yield of 30 movements per hour. DCT Gdansk has its own stevedores working for 24 hours with 2 supervisors and 2 teams with different number of person.

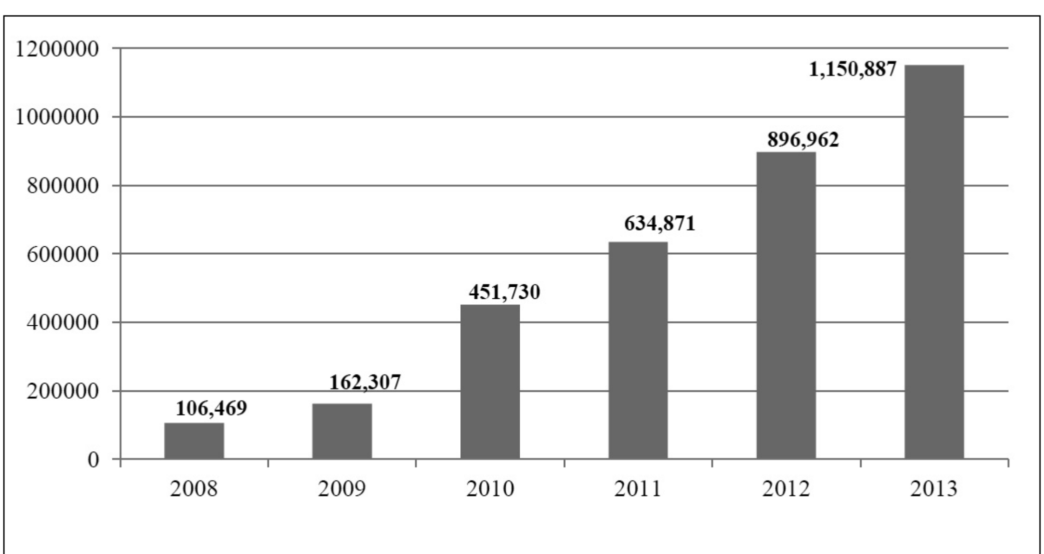


**Diagram 1** Annual container throughput growth at DCT, from 2008 to 2013 in TeU's (source: inner publication of DCT Gdansk)

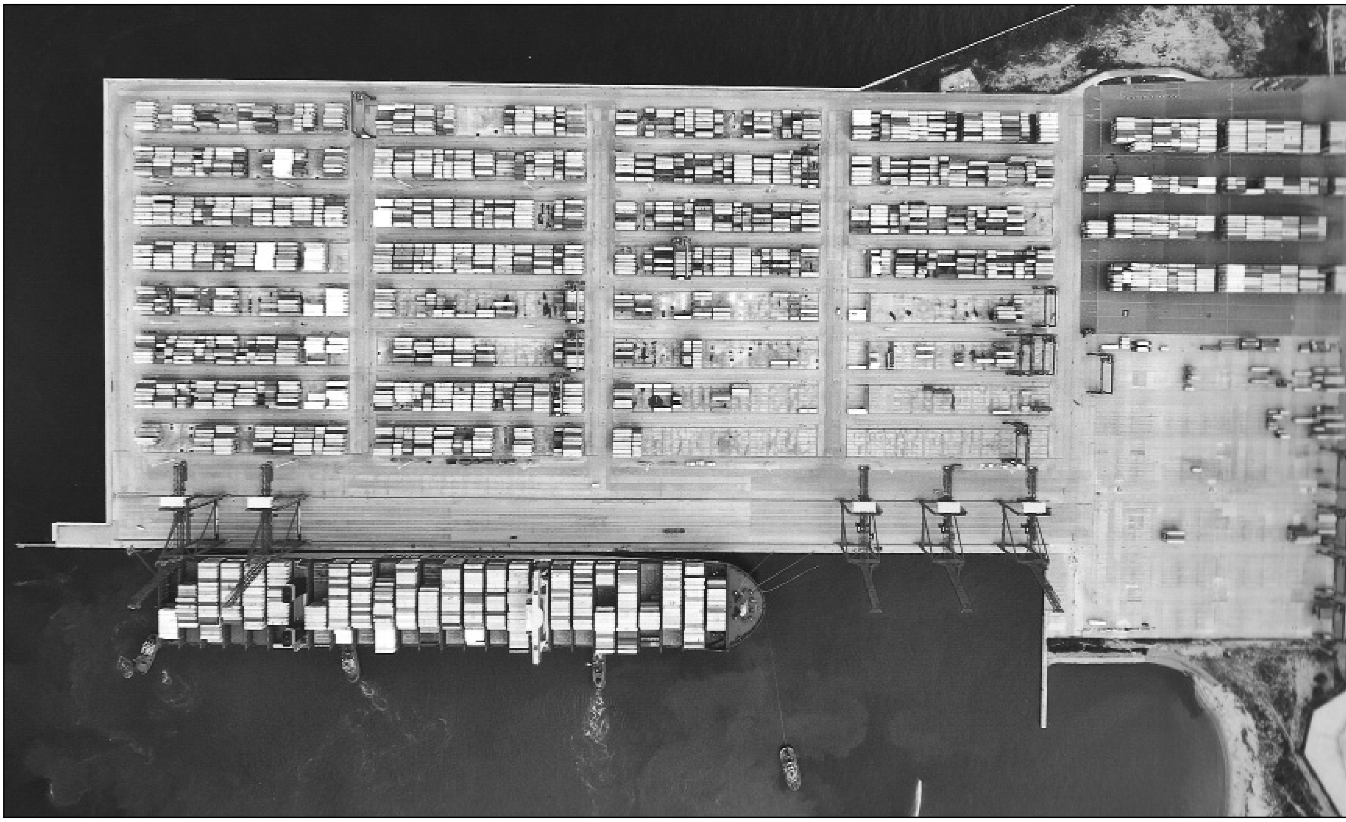

**Figure 1** Maersk ULCC mooring in DCT (Dec. 2014)

## 3 WHY GDANSK ?

The following picture (Figure 2) shows the ports that have enough depth in the North European Cost, from France to Poland, to harbor the largest container vessels that have around 14-15 meters draft or even more. It is important to remember the UKL concept, under keel clearance, that must be 10% of the draft. It is not a nonsense because even all the information that we have nowadays, hundreds of groundings are registered every year some of which have finished with duties. First of all, Maersk is always looking for increase its own business. As already cited before, Maersk is operating AE 10 route with the largest container vessels in the world. For example, the largest vessels, EEE class, have a length of 400 m, 59 meter breadth and a draft of 15 meters, that means that these kind of vessels are limited by their dimensions. Not all the ports can hostage these enormous ships. The most typical limitation is the draft, ports are not deep enough.

Even if we follow searching a port capable to handle these enormous vessels on the south Baltic Sea coast is impossible to find one. DCT Gdansk is the only terminal that can do it along the coastline. It is important to say that Baltic Sea has a maximum draught permitted of 15 meters because there are zones with 16.5 meter deep and the UKL, under keel clearance has to be 10%. This zone is the entrance to the Baltic Sea between

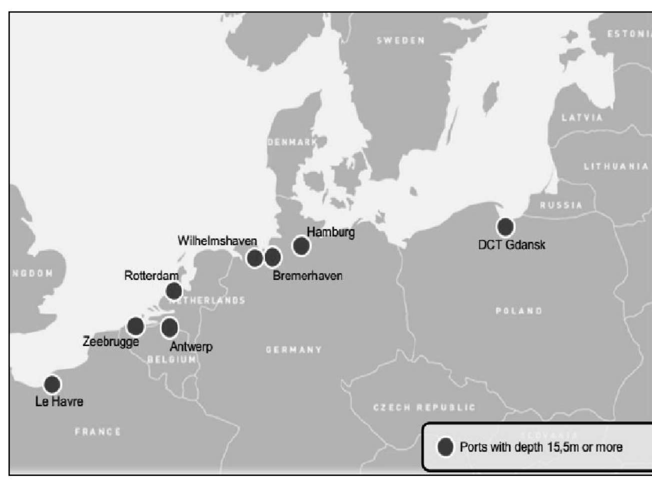


**Figure 2** The Gdansk – Le Havre Range and the ULCV Ultra-Large Container Vessels Map. Source: Google images

Denmark and Sweden in the Great Belt (Figure 3). As a curiosity we can mentioned that apart from the limited draft in the Great Belt, vessels have to cross down the Great Belt Bridge that hat 65 meters clearance below. EEE *Maersk* class vessels are around 58 meters high from the waterline, of course depending on the quantity of load. That means that clearance between the bridge and the top of the vessel are only 7 meters. (Figure 4) Secondly, DCT Gdansk is an easy accessible port facility that connects Asia with the emerging mar-

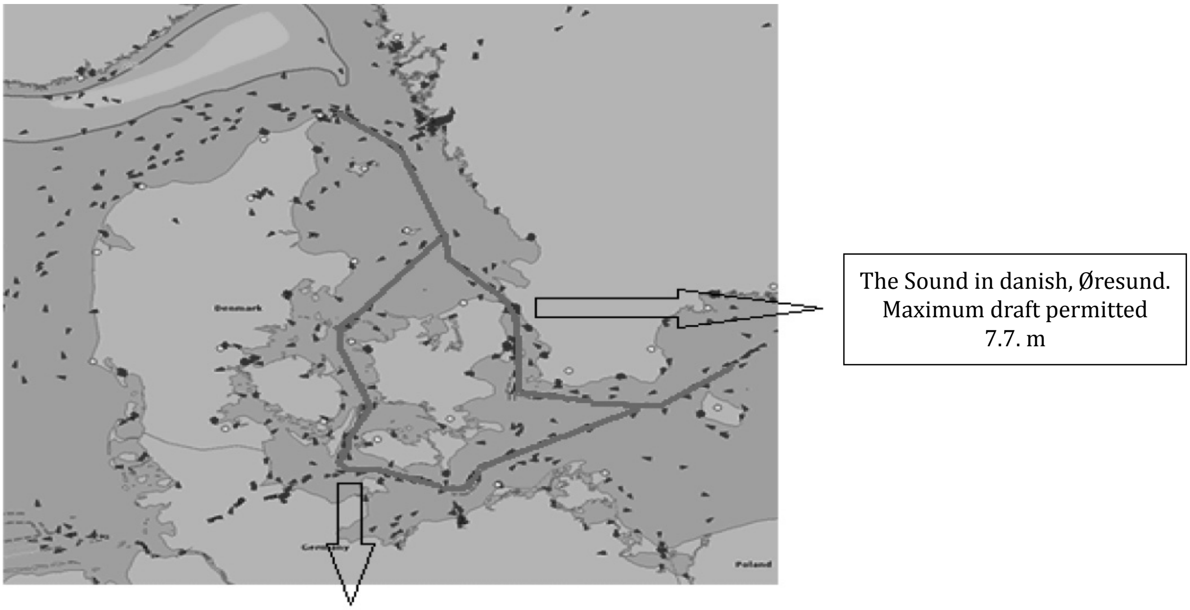


**Figure 3** Denmark channel map. Source: Mutual concerns of oil transporters and a coastal state presentation by Andreas Nordseth, Director, Danish maritime Authority

**Figure 4** Maersk vessel under GBB. Source: Google images

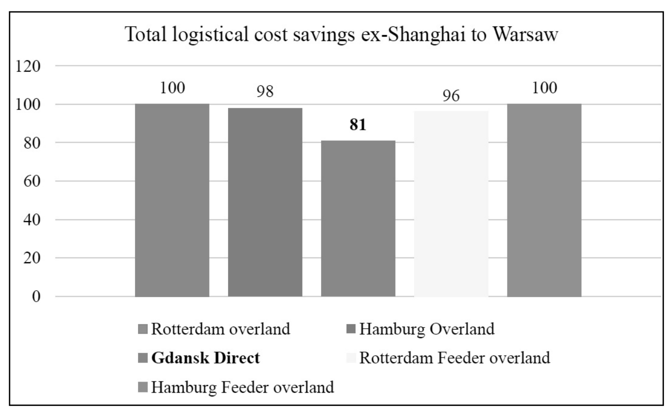


**Diagram 2** Saving graphic. Source: Ocean Shipping Consultants Ltd "Shipping Cost Study" September 2011

kets of Central and Eastern Europe. We checked that the closer by sea the cheaper. The graphics above show economic aspects of container traffic between the Far East and Poland, By way of example, in this case was chosen Shanghai, China to Warsaw central Poland.

The first graphic (Diagram 2) shows us the cost per FEU. While transport via Rotterdam or Hamburg costs are around 1800 €, via Gdansk costs are less than 1400 € per FEU. Stevedoring/Port duties and deepsea shipping costs are more or less the same for all routes but, we find the savings in the inland delivery, confirming the closer the cheaper.

In the second (Diagram 3) graphic we can see that the most expensive methods are the ones that more use land transport. Saving less than 5% using feeder services and saving around 20% going directly via Gdansk.

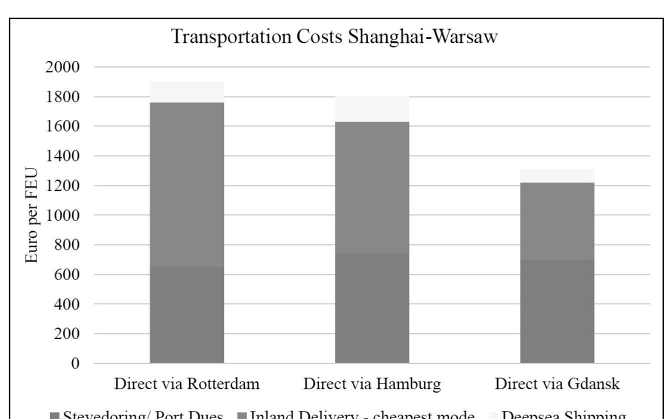


**Diagram 3** Cost graphic. Source: Ocean Shipping Consultants Ltd "Shipping Cost Study" September 2011

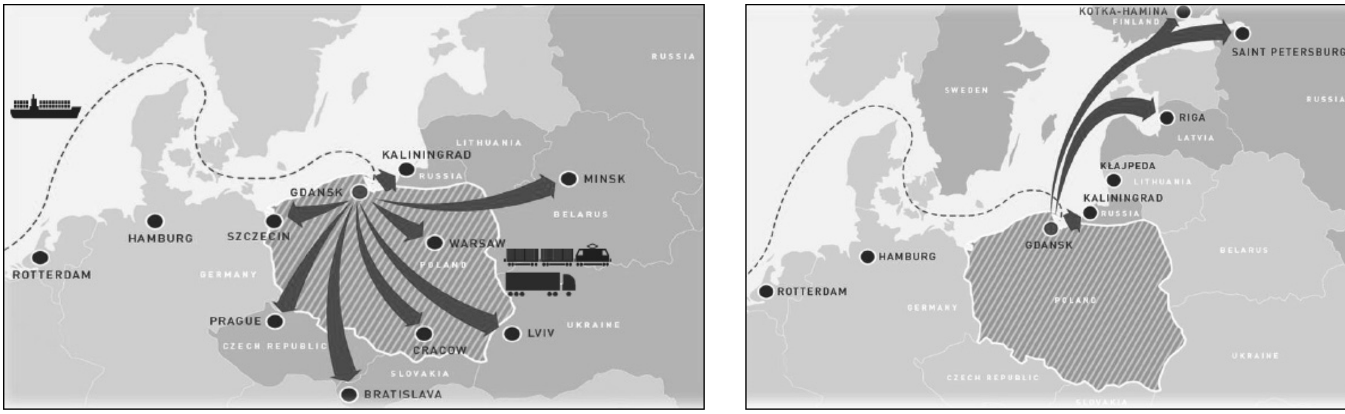


**Figure 5** Importance of hub of Gdansk for East Europe delivering

Every week from Wednesday late afternoon till Saturday morning DCT discharges and loads approx. 9000 TeU. Most probably importance of hub of Gdansk will systematically increase due to transit containers to East European Countries (figure 5).

## 4 MAERSK TRIPLE-E CLASS VESSELS

The Maersk Triple E class is a family of large, fuel-efficient container ships, designed as a successor to the Maersk E-class due to capacity is 16 % greater, with a maximum of 18,270 TEU (figure 6). The vessel is to be built in general as a double-skinned construction with 11 cargo holds, 24 bays holding 40 feet containers and 21 hatches. Containers on deck are generally to be carried in 23 rows and up to 10 tiers. A three-tier lashing bridge is to be installed on the upper deck. The name "Triple E" is derived from the class's three design principles: Economy of scale, energy efficient and environmentally improved. Apart from being the world's longest ships in service, are expected to be the most efficient container vessels per TEU of cargo.

The ships are 399 meters long and 59 meters wide. While only 2 meters longer and 3 metrs wider than E-class ships, the Triple-E ships will be able to carry 2,500 more containers due to an additional row of containers has been added, giving it 23 rows across its width, compared to 22 rows on board E-Class. With a draft of 14.5 metres, they are too deep to use any port in the Americas or cross the Panama Canal, but are able to transit the Suez Canal when sailing between Europe and Asia (Table 2).

One of the class's main design features are the dual 32 megawatts (43,000 horse power) ultra-long stroke two-stroke diesel engines, driving two propellers at a design speed of 19 knots. Slower than its predecessors, this class uses a strategy known as slow steaming, which is expected to lower fuel consumption by 37% and carbon dioxide emissions per container by 50%.

Five generators sets will provide 19,200 kilowatts of electric power and two 3,000 kilowatts shaft generators can convert main engine propulsion power into electricity, when the ship is steaming at sea. The hull of the Triple-E is more like a U-shape compared to traditional container ships. The more spacious hull and extra row provides additional capacity and with the more forward navigation bridge, containers can be stacked higher in front of the bridge without losing visibility. In addition to that, more containers fill the space behind the bridge above deck and below deck, using the space created by the engine room's position further to the back of the vessel.

**Main particulars of Maersk vessel**

- Capacity: 18,270 TEU
- Reefer Capacity: 600 plugs
- Length: 399 metres
- Beam: 59 metres
- Draft: 14.5 metres
- Height: 73 metres (above baseline)
- Height: 58.5 metres (above waterline)
- Top Speed: 23 knots
- Optimum speed: 19 Knots
- Shipyard: Daewoo Shipbuilding
- Owner: A.P Moller Maersk Group
- Cost: $190 millions
- Deadweight: 192,800 metric tonnes

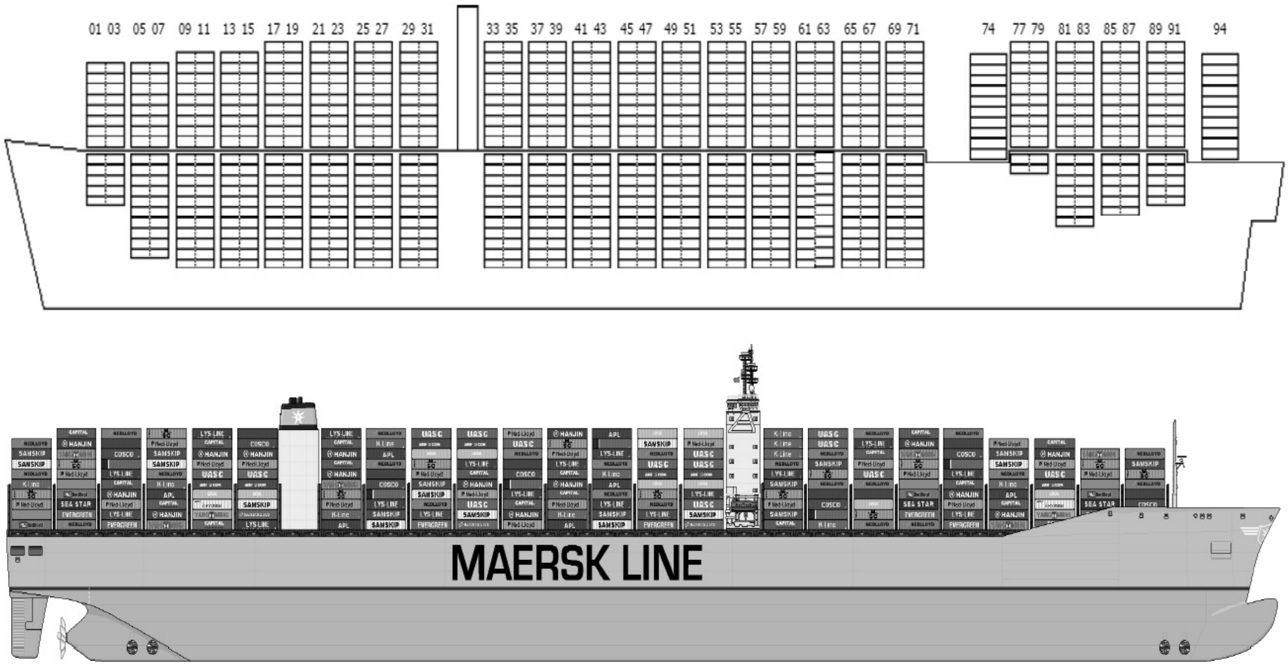


**Figure 6** 18,270 TeU Maersk ULCC

**Table 2** List of Maersk ULCC vessels

| Ship | IMO Number |
|---|---|
| Maersk Mc-Kinney Moller | 9619907 |
| Majestic Maersk | 9619919 |
| Mary Maersk | 9619921 |
| Marie Maersk | 9619933 |
| Madison Maersk | 9619945 |
| Magleby Maersk | 9619957 |
| Maribo Maersk | 9619969 |
| Marstal Maersk | 9619971 |
| Matz Maersk | 9619983 |
| Mayview Maersk | 9619995 |

**Asia – Europe service (AE-10)**

The Triple-E class vessels are doing the AE-10 Asia-Europe-Baltic loop of Maersk Line with frequently calls at Gdansk. Port selection is a key point in the discussion of such large capacity vessels and Gdansk has long been a Maersk port with the strong economy of Poland to back it up.

The ports included in this 42 days service are: Gdansk (Poland), Aarhus (Denmark), Gothenburg (Sweden), Bremerhaven (Germany), Rotterdam (Netherlands), Port Tangier (Morocco), Algeciras (Spain), Suez Canal (Egypt), Tanjung Pelepas (Malaysia), Singapore (Singapore), Yantian (China), Hong Kong (Hong Kong), Busan (Korea), Kwangyang (Korea) Ningbo (China), Shanghai (China) (figure 7 & figure 8)

It should be noted that some ports are achieved only in one way, e.g. Tangier Port is only called on the way from Europe to Asia and not from Asia to Europe. Another case could be Tanjung Pelepas in Malaysia, Singapore or Hong Kong as well. It is true that depending of the demand, some ports can be omitted on the way. As we can see in the following maps, some ports do not appear (Algeciras in Spain) due to that not every time are called.

## 5 NEW TERMINAL DCT2

On May 15th 2015 Construction of the second deep-water berth in DCT Gdansk (T2) became a fact. Completion of this project with an investment amounting to EUR 200 million, which is financed by the consortium of 7 banks, is scheduled for the third quarter of 2016.

DCT 2 will be ready within 19 months. Belgian N.V. BESIX – the general contractor and the designer of the new facility, will finish construction in August 2016, what will give an opportunity to operate 3 million container per year. New berth 650 meters long with depth of 16,5 meters is preparing for 24,000 TeU vessels. New Five cranes will allow to load/discharge 25 rows of containers (ULCC 24,000 TeU).

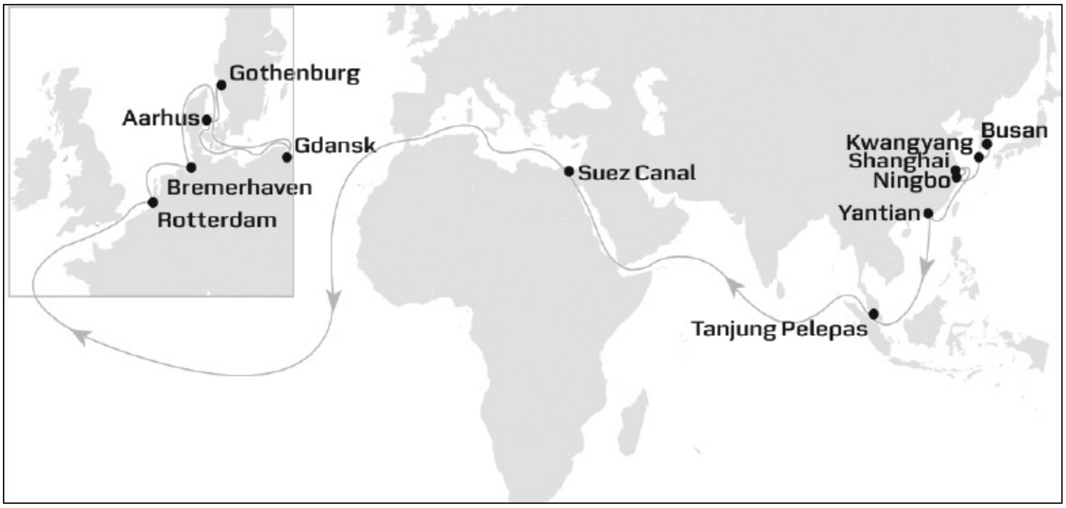


**Figure 7** Asia - Europe (AE-10) – Westbound service. (Source: Maersk)

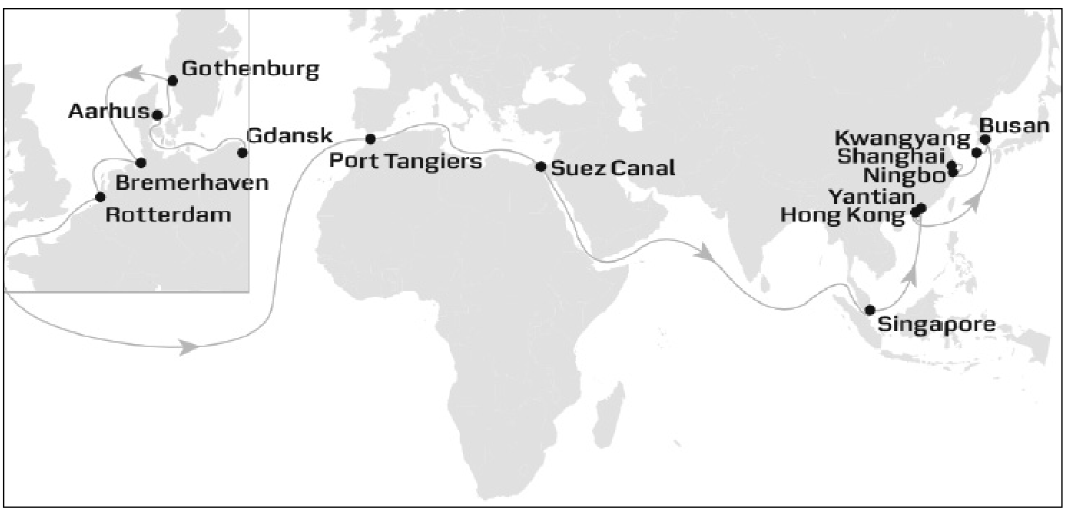


**Figure 8** Asia – Europe (AE-10) – Eastbound service. (Source: Maersk)


**Figure 9** Representation of future distribution. Source: DCT: Poland's Maritime Window on the World

**Figure 10** DCT development plans location. Source: DCT: Poland's Maritime Window on the World

## 6 APPROACHING OF DCT

Faculty of Navigation of Gdynia Maritime University developed and finally proposed new system of approaching port of Gdansk addressed for the vessels with draft 15 meters and more. Every student of GMU trains on Transas Navi-sailor 5000 as one of the obligatory exercise. Please find below two maps presenting approaching to DCT (Figure 11 and Figure 12) and final stage of maneuvering exercise to approach turning circle in DCT terminal.

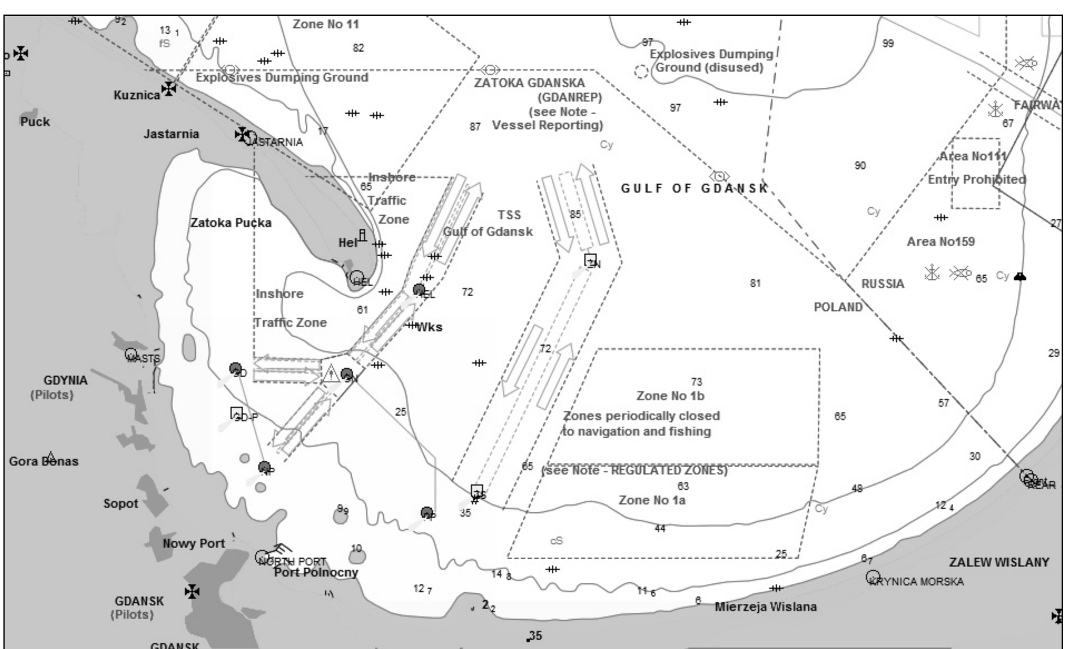


**Figure 11** System, of approaching ports Gdansk and Gdynia invented by Gdynia Maritime University

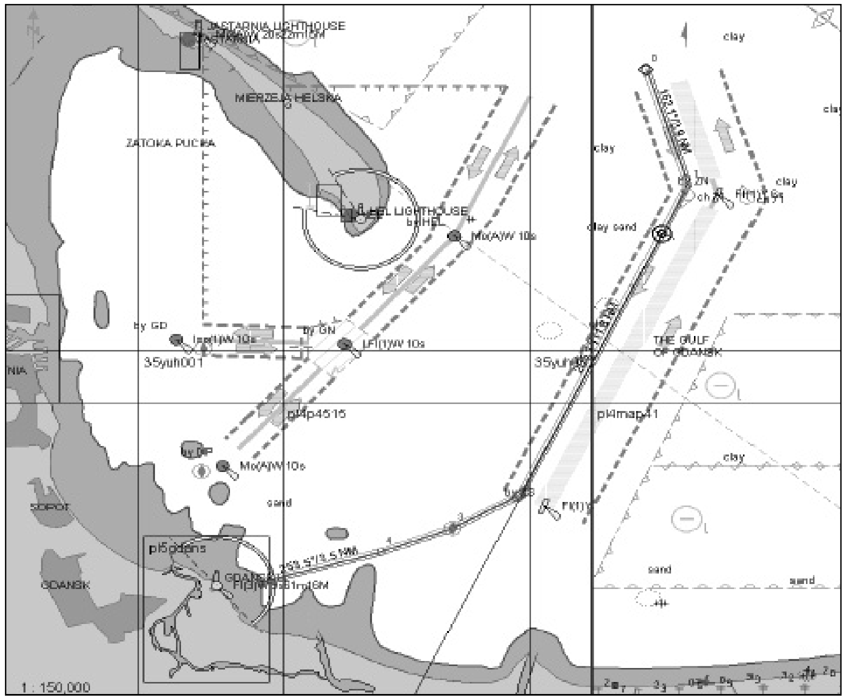


**Figure 12** Traffic separation scheme as an element of route to DCT

## 7 CONCLUSION

In the near future will come into operation 49 mega-container vessels (Ultra Large Container Vessel – ULCV), with a capacity of 18 thousand. TEU and more – English portal Vesselsvalue.com calculated. The total value of the contracts is estimated at 7.83 billion USD. This means that the total increase in capacity of the world container fleet will reach 913 300 TEUs. The biggest backlog is Maersk Line, which intends to pick up the 20 container ULCV. Further, the size of container ships ordered such owners as UASC (6 vessels), China Shipping (5 ships) and MSC (3 vessels). In addition, 6 ULCV container will go to China, Bank of Communications, with a further 6 to Scorpio Ship Management. According to experts the container market, at least 3 of them will be sailed on charter MSC.

There are many indications that the first container ship with a capacity of 20,000 TEU built in the shipyard Imabari Shipbuilding in Japan, and the operator will be Taiwan's Evergreen shipowner. Count series has 11 vessels of this type. Unofficially, he says that the container be created for the Japanese Kisen Kaisha Shoei owner and charter Evergreen them.

In the South Korean shipyard Daewoo Shipbuilding and Marine Engineering named currently the world's largest container ship MSC OSCAR, with a capacity of 19.2 thousand TEU, which will sail in the colors of the Italian shipowner Medditerranean Shipping Comapany (MSC). The next ship of the MSC series OLIVER, the company will receive in March this year. At the beginning of December last year record in this category was CSCL container GLOBE, Chinese shipowner China Shipping, with a capacity of 19.1 thousand TEU. CMA CMG ordered the South Korean shipyard Hanjin Heavy Industires 3 container ships with a capacity of 20.6 TEU for delivery in 2017.

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# EMPLOYEE RETENTION IN THE MARITIME INDUSTRY: A REVIEW AND ANALYSIS

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**Abstract.** Due to the global shortage of seafarers, maritime firms are in intense competition to hire and retain qualified mariners. These shortages are greatest in the highest ranks. Despite the particular interest that maritime firms have in retaining qualified employees, research suggests that firms in the industry are comparative laggards in the implementation of sound human resource management (HRM) strategy. The goal of this paper is to review and assess literature on employee retention in general, and in maritime industry in particular. We present some anecdotal evidence illustrating how maritime firms are responding to the challenge of employee retention and shortages of more highly skilled mariners and suggest some opportunities for improving the employee retention efforts of maritime firms through a focus on achieving commitment through perceived employee support (POS).

**Key words:** seafarer retention, commitment, perceived organizational support

## 1 INTRODUCTION

Maritime firms around the world face a significant seafarer retention problem that can threaten the safety of crews and the financial strength of the industry. The tightness of the labor market for seafarers is well documented by a number of surveys and studies. The BIMCO/ISF Manpower 2010 Update notes that while the global supply and demand for ratings were in approximate balance in 2010, the supply of officers was approximately 2% short of the demand [1]. Officer shortages persist and are estimated to be approximately 5-11% in 2015 [1]. This gap will continue to grow as world trade recovers from the 2008 recession [1]. The U.S. Bureau of Labor Statistics' Occupational Outlook Handbook states that the job market for captains' mates and other officers is expected to rise by 20 percent between 2010 and 2020 [2]. The continuing officer shortage suggests that the industry needs to focus on improving retention rates and on training recruits for progressively higher management positions.

The shortage of qualified officers can be attributed to high employee turnover and industry conditions that incentivize experienced seafarers to take maritime jobs on shore rather than pursue senior officer positions. When a qualified seafarer quits, it results in significant costs for maritime firms [3, 4]. These expenses come in the form of direct costs (*e.g.,* severance payments, vetting prospective candidates, training new hires) and indirect costs (*e.g.,* loss of productivity, diminished quality, increased safety concerns, loss of employee morale).

On average, research suggests that losing a qualified employee costs about 150% of the employee's salary [5]. Given the shortage of officers and the time that it takes to train and integrate into firm operations, it is reasonable to believe that employee replacement costs in the maritime industry are higher than average; publicly available data indicates that training costs alone can range from $35,000 to over $100,000 for ratings and junior officers [6, 7]. Hence, maritime firms have a major financial interest in extending the tenure of qualified mariners and encouraging them to gain the skills necessary to advance in rank.

Despite the critical importance of retaining qualified mariners, numerous studies suggest that the maritime industry is somewhat of a laggard when it comes to the implementation of scientifically rigorous employee retention policies [8, 9]. In this paper, we assess the seafarer retention efforts of maritime firms. We begin with a general review of research describing some employee cognitions that can lead to turnover. Next, we review and assess research relating to employee retention in the maritime industry in the areas of compensation, quality of life, and training. After suggesting some opportunities to improve the HRM practices and policies of maritime firms, we close with a final summation and a discussion of potential avenues for future research.

## 2 EMPLOYEE COGNITIONS LEADING TO TURNOVER

Although antecedents of employee turnover are many, numerous studies converge on a few employee cognitions that appear to have a highly significant influence on quit intentions. Understanding these cognitions may facilitate the development of more effective HRM strategy in the maritime industry.

One of the most extensive studies of the antecedents of employee quit intentions was conducted by Griffeth, Hom, and Gaertner (2000) [10]. Using a meta-analytic approach across hundreds of studies, their results suggest that organizational commitment is the employee cognition that has the most powerful relationship with quitting (next to self-reported intention to quit) [10]. Other studies confirm these findings [11-14].

Research suggests that commitment is strongly influenced by perceived organizational support (POS) [15, 16]. POS describes a sense in employees that the organization they work for appreciates their contributions and cares about their general welfare [16]. Employers can cultivate a sense of POS using several approaches. For example, they can give praise and rewards that are above and beyond those required by contract or by standards and informal norms. They can also support employees during a time of loss or during a period of great stress by providing increased time off or a lighter workload. Employers may also cultivate POS by supporting skill development, offering promotion opportunities, and investing in employee training. However, as discussed later, some types of training are more effective at encouraging retention than others.

Scholars have identified three types of commitment. Normative commitment describes commitment based on a sense that one ought to stay (*i.e.,* because an important project would have to be abandoned if one were to quit). Continuance commitment describes commitment based on a sense that one will experience significant costs if they leave the organization, such as when a person stays with a firm because their spouse has a great job nearby and there are limited alternative employment options in the area. Affective commitment describes commitment based on a general sense of identity and well-being that emerges through membership in an organization. It emerges when employees have many close social connections at work, identify with the goals of the organization, or believe in the firm's excellence. Affective commitment is thought to be the most desirable type of employee commitment from a managerial perspective because it leads to organizational citizenship behaviors (*i.e.,* going beyond the written and unwritten requirements of the job out of a sense of pride or belonging) [17].

## 3 EMPLOYEE RETENTION RESEARCH IN THE MARITIME INDUSTRY

Employee retention research specific to the maritime industry provides important insights when constructing HRM strategies. Seafarers cite loneliness, exhaustion, poor on-board conditions, safety hazards, and criminal liability concerns as some of the worst aspects of a career at sea. According to the Shiptalk 2012 Life at Sea Survey, an overwhelming majority (62%) of respondents felt social isolation was one of the worst aspects of being at sea[1] [18]. Piracy and excessive paperwork trailed behind in second place with 24% of respondents identifying them as some of the worst aspects of a career at sea [18]. When asked what would keep them at sea, 62% of respondents mentioned higher salaries [18]. Better benefits and shorter trip lengths were other important factors [18].

The 2012 Shiptalk survey suggests that when it comes to occupational commitment, seafarers care mainly about compensation. However, research suggests that while higher pay is positively correlated with occupational commitment, its impact on organizational commitment is short-lived [19]. Occupational commitment has to do with a general attachment to the industry/occupation. Organizational commitment has to do with attachment to the specific job and the specific organization while the latter has to do. Of all questions in the Shiptalk survey that related occupational commitment, compensation was, by far, the most important concern of respondents. [2] On the other hand, when asked what would make them chose to work on a particular ship (more closely related to organizational than occupational commitment), pay issues were less important than living conditions onboard the ship. When asked what they do not like about a seafaring career, respondents overwhelmingly point to loneliness and separation from friends and family. Increasing pay will do little to mitigate this problem and is a less cost-effective or efficient solution than a more coherent employee retention strategy can deliver.

Research suggests that one of the best ways to give employees a sense of organizational commitment is by providing organizational support (*i.e.,* creating a sense of POS) [15, 16]. The 2012 Shiptalk survey gives some indication of where employers may begin to stand out as an organization that supports its employees. Practices such as providing free internet access, family medical insurance and/or pension plans may serve to build a firm's reputation as an employer of choice, thus boosting organizational commitment [18].

Yet even if maritime firms can give seafarers a strong sense of organizational commitment, they will still lose qualified employees with low levels of occupational commitment. Although both high ranking officers and first to second year ratings can earn substantially more at sea than on land, seafarers between these positions can often find more desirable positions on shore [20]. As a result, entry-level seafaring jobs are increasingly seen as gateways into maritime shore jobs, including "pilotage, marine surveying, terminal/cargo operations, port operations, ship management, marine administration, and maritime education and training" [21]. Such jobs are numerous, comprising approximately 70% of all maritime jobs available in the European Union, and often require few skills other than those offered to ratings through on-the-job training programs [22].

In contrast, the career pathway from rating to senior officer is more daunting, typically requiring a bachelor's degree and 4-5 years of sea time. Caesar et al 2014 cite the "strenuous nature of working conditions at sea, learning difficulties, lack of progression opportunities, and plateauing of salary" as the main factors inhibiting advancement through a ship's ranks [8]. Such difficulties undermine seafarers' sense of occupational commitment.

In the remainder of this section we discuss research and anecdotal evidence from maritime firms relating to a few areas of HRM that consistently turn up in maritime research as being relevant to employee retention, noting that firm managers have more control over increasing employees' sense of organizational commitment rather than occupational commitment.

### Compensation

Surveys in the maritime industry often point to a relatively high emphasis on pay as a motivation to stay in the industry [4, 18, 23]. This makes intuitive sense because research suggests that there are fundamental characteristics of a seafaring career that make it diffi-

[1] The Life at Sea Surveys comprise of a series of five surveys of registered users of Shiptalk Recruitment. The data cited in this paper are from the first survey in the series – the Seafarer Attraction and Retention Survey Report. Of the 488 seafarers who responded to this survey, over 40% were from English speaking countries like the UK, India and USA. Filipino seafarers were conspicuous by their near absence comprising less than 1% of the respondents.

[2] The survey asks what motivated mariners to choose a seafaring career, why they stay, and what would make them stay longer (i.e., occupational commitment).

cult to provide as much satisfaction as many shore jobs [24]. For example, separation from family and friends is a major source of discontent among seafarers [18]. Yet this is an inherent part of the job and there is little that maritime firms can do to overcome this problem. Even a mariner who prefers a life at sea to a shore job must generally justify their decision to be apart from loved ones for long periods of time. Compensation, therefore, is the means by which maritime firms attract and retain qualified seafarers despite the inherent advantages of a shore job.

Yet even in this most critical and basic area of HRM, many maritime firms struggle to meet reasonable employee expectations. Maritime firms often view payroll costs as similar to any other costs of production (*e.g.,* fuel, the ship itself) and presume that pay should be minimized [9]. Jatau (2002) suggests that this is doubly true in the wake of the 2008 recession, which forced many employers to cut operating costs to the bare minimum [25]. However, this view of HRM represents the widely discredited "hard model". Rather than viewing employees as factors of production, the "soft model" of HRM emphasizes the relationship between the employer and the employee [9]. If employees feel that their employers are unwilling to invest in them above and beyond the bare minimum required by contract or unwritten norms and standards,the employee's sense of POS and affective commitment will diminish In the long run, this will lead to fewer organizational citizenship behaviors and a higher likelihood of quitting.

Actual practices of many maritime firms contribute to the shortages of qualified mariners experienced industry-wide. For example, some sources suggest that late or short payment of wages is a widespread challenge in the industry [26, 27]. Ships often arrive in port expecting to receive a wire transfer of wages that never arrives. Repeated such incidents send a strong signal that employers do not care about the welfare of their employees. The maritime industry is also relying increasingly on manning agencies and contract labor. For example, a Deloitte study reports that in 2010-11 over 70% of ratings and 30% of officers came from the Philippines, where firms tends to rely heavily on third -party crewing agencies [7]. Contract laborers experience very low costs when leaving the organization, leading to a correspondingly low sense of continuance commitment. Contract laborers also feel less normative commitment to continue employment, as there is very little sense that one owes one's employer a long-term commitment when the employer specifies that they have no such corresponding commitment to the employee.

Although compensation is useful for boosting occupational commitment, pay satisfaction is thought to be a less significant contributor to overall employee satisfaction than other factors, coworker satisfaction, supervisor satisfaction, or satisfaction with the work itself [28]. To achieve a more significant effect on employee retention rates, maritime firms must achieve a broader sense of normative, continuance, and affective commitment in employees based on high levels of POS.

**Training & development**

Training is widely cited in the maritime literature as important for employee retention. Training may be attractive investment for employers because it encourages lower ranking employees to gain the skills necessary to advance in rank, thereby mitigating the officer shortage problem. Employees understand that employers will only benefit from training expenditures if employees continue their tenure with the organization. Hence, training engenders a strong sense of normative commitment (*i.e.,* staying with the firm because one *ought* to). When compared with other types of commitment, research suggests that seafarers place the highest value on factors relating to normative commitment when making employment decisions [4] Training also leads to a heightened sense of POS and affective commitment because the employer is supporting the employee in the achievement of their goals.

Investment in safety training and recognition of safe employees appears likely to have a particularly strong effect on retention in the maritime industry. Survey data suggests that many mariners see safety as a major concern when choosing an employer. In the 2012 Shiptalk survey, ship condition & age was the number one reason for deciding whether or not to join a ship; 25% said that company safety record was important to their decision to join a ship [18]. Taylor et al. (2010) did a study of worker retention in the trucking industry, an industry with many HRM challenges similar to the maritime industry (*e.g.,* long-term separation from friends and family) [29]. They found that safety was an important reason for remaining with their employer. Eighty percent of contemporary maritime accidents are connected to human error [4], so investing in safety training has a direct effect on company profitability and longevity. Yet managers must always balance safety training against the opportunity costs of other retention activities. For example, while safety training has significant, positive, indirect effects relating to employee retention [29], the focus on safety to the exclusion of skills training (more important for advancement through a ship's ranks) can undermine commitment [21].

Training can be a double-edged sword in other ways. On one hand, training increases the employee's sense of POS and can lead to greater commitment [30]. On the other hand, training generally increases a worker's employment options, potentially leading to a higher likelihood of turnover [30]. Jatau (2002) suggests that shipping firms are reluctant to bear the costs of providing ratings and junior officers with necessary training due to the high churn rate in the industry and the relatively high cost of training ratings to be officers [25]. Nigeria's Maritime Administration and Safety Agency reports expenditures of approximately N8 million ($35,000 USD) per cadet [31]. Indeed, respondents in most nations indicate dissatisfaction with the company's role in paying for training for higher posts or new equipment, with 58% of Filipino ratings indicating that the company had not paid for training, in part or in full [32]. Moreover, almost half of all respondents worldwide indicated that they were rarely or never compensated for lost leave time when undergoing training [32].

Employer provided on-the-job training in the maritime industry has an even greater potential for creating a sense of POS in the employee than it does in other industries. Like all workers, maritime employees feel supported by a company that provides training because they are being helped to achieve their long-term goals. Unlike with many other professions, however, training onboard ship has the potential to bring relief from boredom and loneliness by providing something productive to do with time that might otherwise be idle. As will be discussed later, there are many unexplored mitigating factors potentially influencing the link between training and retention.

**Quality of life**

The Crewtoo Seafarers Happiness Index was launched in April 2015 to measure seafarer happiness with various aspects of life at sea and was computed using data gathered during the first three months of 2015 [33]. Seafarers were asked to use a scale of 1 to 10 to rate how happy they felt about ten issues (onboard food, ability to stay fit, wages, training, etc.). The average of these responses was computed to provide a rather dismal overall happiness index score of 6.42 [33]. Mean happiness was lowest for the two shore-related questions. The lowest average score (5.9) was for on-shore welfare facilities reflecting the enormous variation in the quality of welfare facilities, with some ports providing no welfare facilities at all while others provide excellent services [33]. Poor internet service and exorbitant phone and transportation costs left mariners feeling cheated at some ports [33]. Seafarers were similarly resentful of the fact that in many ports it was difficult to access shore leave [33]. This is primarily due to changes in the industry that have resulted in short turnaround times and terminals that are far away from population centers.

***Food.*** While there may be little that carriers and manning companies can do about shore-side facilities, the Crewtoo survey provides other information that is actionable. For example, average seafarer happiness with onboard food was a rather low 6.26, likely due to extremely low spending on food; Maersk ships, for example, budgeted only $7 per day for each seafarer for all meals [34]. A twenty percent increase in that budget would increase the daily food cost by approximately $35 per day for a crew of 25, approximately half of one percent of the average bulker's daily operational costs [35]. Higher quality meals would not only improve nutritional standards but would also lead to greater socialization among the crew. Most importantly, it would signal that the employer cared about the happiness of the crew and thus increase seafarers' POS. Such a signal is of critical importance to seafarers, many of whom noted that the "conduct, investment and support" of their employer influences their happiness.

***Communications equipment.*** A number of surveys emphasize the importance of providing internet connectivity. The 2015 Crewtoo survey reports that seafarers not only desire internet access, they insist on it [33]. Many seafarers noted that without internet access, it would be virtually impossible to attract the younger generation, for whom connectivity is an integral part of daily life. According to the 2012 Shiptalk survey, 81% of respondents indicated that the most important onboard crew facility was internet access [18].

In fact, according to the 2014 Crew Communications Survey, 69% of crew report that access to communications influences their decision to join a ship [36]. The popularity of this option was consistent across all age groups and ranks. The report also found that communications access was most important to mariners with greater technological savvy, precisely the kind of employees that will be more in demand as ship technology becomes increasingly complex and crew sizes continue to shrink.

## 4 IDEAS FOR IMPROVING RETENTION IN MARITIME FIRMS

Research suggests that the probability of success is significantly enhanced when an employee retention strategy includes a range of activities designed to cultivate all types of commitment [9]. Employee retention strategies at maritime firms are less likely to be successful if they are implemented piecemeal, rather than as an integrated group of synergistic policies (*i.e.,* a strategy) [9]. Yet Parsa's (2012) analysis of the U.K. liner industry finds that, although maritime firms often implement HRM best practices, these tend to be implemented in isolation or without consideration of connection with other policies [9]. This can lead to diminished, or even negative returns from investments in employee retention. This can be seen in pitfalls relating to the training and development of promising seafarers and encouraging them to advance in rank while staying with the firm that invested in their training.

**Training & development**

Investing in career advancement training is one of the primary means by which employers facilitate employee goal achievement, thereby instilling a sense of POS in employees which leads to commitment and potentially longer retention. However, as discussed above, training can be a double-edged sword. While career advancement training facilitates employee goal achievement, it also tends to create additional employment alternatives [30]. Therefore, managers are wise to combine training efforts with other meaningful efforts to retain employees like those discussed below. An employer with a strategy aimed at cultivating a strong sense of all three types of commitment in employees is far less likely to lose an employee after investing in training than an employer who has little other than a training program in its portfolio of employee retention policies.

For example, although there is a shortage of trained officers in maritime firms around the world, there are proportionally many more European and Japanese officers than Filipino or Indian officers (as a percentage of total seafarers employed from the respective country) [37]. This means that many firms with crews made up mainly of people from countries with a low proportion of officers (usually developing countries) often must hire European or Japanese officers [3]. While this can potentially lead to a range of HR challenges, one of the main problems is that such a crew structure sends a message to rankings that there is not a viable path for them to advance in rank. In such an environment, a training program will have little success without being integrated into a larger strategy to encourage rankings to participate (*e.g.,* allowing training during some paid hours).

Ratings may find safety training to be burdensome to the extent that they believe it is done at the expense of training in areas that could more directly lead to career advancement. Yet, as discussed above, safety training has the potential to provide significant employee retention benefits. Like career advancement training, safety training is likely to have a much weaker effect on retention if it is not combined with a larger employee retention strategy (*e.g.,* offering intensive training in areas more closely related to career advancement as a reward for excelling in safety training).

An example of a successful, growing firm that understands the importance of having an integrated employee retention strategy is a crewing firm based in Manila called Philippine Transmarine Carriers (PTC). As part of its model employee retention strategy, PTC makes wide use of partnerships with other firms to provide a range of support services. Outsourcing these functions allows PTC to maintain managerial focus other important parts of the business. For example, PTC partners with a local university to provide access to the training necessary for mariners to advance in rank, contributing to a strong sense of normative and affective commitment [3].

In addition to this, PTC has devised a range of innovative retention policies that fit together neatly to form an integrated strategy. A particularly innovative approach to employee retention at PTC comes through their partnership with a local bank. Through this partnership, PTC is able to offer employees discounted home loans. However, the home loans are generally targeted at residences in designated “seafarer communities” or small housing development blocks reserved for ownership by the employees of PTC [3]. These seafarer communities are able to support one another emotionally while family members are away at sea, leading to an enhanced sense POS and affective commitment. Being surrounded by other mariners, families in these communities are also likely to develop identities as seafarer families, potentially leading to an increased sense of normative commitment. Moreover, depending on the structuring of the home loan, the seafarer community arrangement could create a significant sense of continuance commitment.

In addition to using discounted bank loans for seafarer communities, PTC encourages the families of seafarers to take out small business loans [3]. Small businesses give families something to keep them occupied while loved ones are away on long sea voyages. They also provide income that is particularly useful between voyages This can significantly improve employee retention because, like most Filipino firms, PTC makes widespread use of contract labor and employees often feel strong financial pressure to quickly find a new contract after the expiration of an old one [3]. These innovative policies, integrated with more traditional ones like regular, organized social gatherings and employee recognition give PTC the type of integrated strategy that is likely to encourage long-term employee retention. In the remainder of this section, we suggest some specific policies, not inspired by PTC, that could be used to create a wider employee retention. We emphasize the development of developing successful training and development operations because these have the capability to contribute to both the employee retention and the shortage of senior officer problems simultaneously.

Harvard Business School provides an insightful case study focusing Maersk’s strategy for talent management and training [38]. Maersk focused on replacing “broad universal training programs” with “more individual training and development" [38]. Such a strategy requires firms to invest in creating individualized training programs. This may prove more cost-effective in the long run since employers can conduct more rating and junior officer training on ship and thus pay less for training at maritime institutes. This will also reduce the costs of hiring temporary workers to fill in for employees studying at such institutes.

Maersk had traditionally focused training efforts "almost exclusively on trainees" and found greater success by investing equally in training for experienced employees [38]. Such training can cultivate continuance commitment (*i.e.* increasing the opportunity cost of taking a job on shore) and normative commitment (*i.e.* providing a viable career pathway into the most desirable officer positions).

**Employee empowerment**

Bhattacharya (2014) employs principal component analysis to identify and rank drivers of seafarer employee engagement [39]. He finds that the most important drivers of engagement are work pressure and work autonomy (.975 and .931, respectively), pay (.900), career advancement (.812), and sense of work importance (.785). This is consistent with Manuel's findings (2011), which emphasize that employee empowerment is an important driver of engagement and retention [40]. Bhattacharya also finds that junior officers are less engaged than senior officers, perhaps due to a combination of limited work autonomy, plateauing salaries, and limited prospects for career advancement [39]. This contributes to high levels of attrition at the junior officer level. Entrusting junior officers and ratings with higher levels of responsibility and assessing relative performance may serve both to foster normative commitment and allow senior officers to identify the most promising prospects. Of course, entrusting greater responsibility to less experienced mariners could lead to other problems, like safety concerns, which would have to be mitigated with a wider HRM strategy. Vance (2006) notes, however, that engaged employees cause as few as one-fifth the safety issues as non-engaged employees [41].

**Internet connectivity**

As previously noted, internet connectivity is a crucial determinant of seafarer happiness. Improvements in satellite technology have made internet connectivity a prudent investment in firms seeking to improve retention. For example, the cost of a Ku-band VSAT system is approximately $60,000 including installation, 0.2% of the cost of a new Panamax bulker container ship [42]. The monthly costs of such a system (assuming medium usage of 1 GB/month) is $2,700 a month, 1.5% of the monthly operating costs of a Panamax bulker [35]. In other words, given the importance of internet access to seafarers, improving internet connectivity is relatively low-hanging fruit for firms seeking to increase retention. Paradoxically, the Shiptalk 2012 survey indicates that almost 40% of ships offer no internet access while a further 40% offer internet service that is unreliable and/or at a bandwidth that is insufficient for video conferencing, a major priority for seafarers [18].

Due to high costs of training new employees, an investment in internet connectivity can be financially justified even if it produces only a modest improvement in turnover rate. APM Maersk's annual employee turnover rate for ratings is 16%, though this is likely lower than average given the large number of manning companies in nations such as the Philippines and India that offer worse working conditions [38]. Publicly available costs of training range from $35,000 to $104,000. Assuming a 16% turnover rate and a conservative training cost of $35,000, training costs for a ship over a ten year period are approximately $10.5 million. The cost of purchasing, installing, and operating a VSAT system over this same period are $300,000 (though monthly operating costs are likely to drop substantially over this period). Thus, if a ship can reduce its turnover rate by 3% by installing such a system, the expense is justified in training costs alone. This calculation does not take into account other employee replacement costs or indirect benefits such as increased employee productivity and increased attractiveness to prospective employees.

**Use of third party crewing firms**

Nautilus International indicates that 40% of seafarers are employed via a third party ship manager or crew or through a crewing agency rather than directly by the ship owner. This is only expected to increase as the proportion of global seafarers shifts more heavily toward countries that rely more heavily on the third party crewing model [7]. Such outsourcing can, over a period of time, lead to the deterioration of the ship and a decreased quality of life for crew members. After all, third party crewing agencies and the mariners they employ, rather than the ship owners, bear the costs of poor ship conditions in the form of higher employee turnover and general misery.

To address this misalignment of incentives, the authors suggest that crewing companies discount their services based on the standard of living available on the ship: factors such as internet connectivity, satellite television, and luxurious staterooms and recreation facilities are particularly important. Such a policy will incentivize owners to periodically maintain their ships and make investments such as VSAT technology. The precise amounts of such discounts will be empirically calculable once more data regarding the correlation between facility quality and retention rate become available.

While the use of crewing services may offer some significant benefits, these benefits tend to decline as the number of ships held by a particular firm increases. Clipper is a large shipping firm with over 100 vessels specializing in dry bulk cargo transport. In an interview, Hanus Mikkelsen, the General Manager of Crewing Operations at Clipper, stated that after growing to about 100 ships, the firm had seen a substantial rise in retention rates as a result of moving crewing services in-house rather than relying on an outsource crewing firm as had been done previously [43]. Mikkelsen reports that after switching to in-house crewing they were better able to control the quality of operations and develop a brand with a reputation of high quality HRM that lead to a higher quality applicant pool [43]. Some firms concerned about the quality of HRM delivered through crewing services have reported success in hiring an on-site representative, managed directly by the shipowner, to physically oversee crewing service operations [43]. This gives an increased incentive for crewing firms to provide better quality HRM and may lead to an enhanced sense of POS in employees who are likely to view the company representative as a direct line to senior management through whom they can voice unaddressed concerns.

## 5 LIMITATIONS AND AVENUES FOR FUTURE RESEARCH

Overall, our analysis suggests that although there some maritime firms that are engaging in innovative and effective employee retention practices, there are many opportunities for improvement across the industry. Among other suggestions, we point to the need for firms to develop an integrated employee retention strategy, rather than experimenting with HRM practices in a piecemeal fashion. We also focus the reader's attention on a few areas relating to seafarer retention where firms may be able to achieve significant improvements.

While many firms may gain benefits from implementing some of these ideas, it is important to remember that each employee is different. What inspires one employee to stay with an employer for a long period of time may not inspire another. Research in the trucking industry suggests that scholars may gain significant insight into retention challenges by conceiving of employees as members of subgroups defined by common characteristics (*i.e.,* a somewhat more individualized analysis) [29]. Future researchers may benefit from considering employee characteristics when determining which retention strategies are likely to be effective. For example, even a simple assessment of the potentially varying retention requirements of male versus female seafarers, or among different races, or different levels of rank, or seniority seems to be largely absent from literature. A more fine-grained assessment like this is likely to lead to more significant research results that are more useful to practitioners.

It should also be noted that our study was limited due to the fact that all of the seafarer retention literature that we found focused on the quit intentions of those currently employed in the industry, potentially leading to self-selection and confirmation biases. To get a better understanding of how to improve retention rates it is important to survey not just those who choose to stay at sea but also those who choose to move ashore and/or quit the industry. We are not aware of any studies that attempt to do this and this could be a promising avenue for future research.

Another opportunity for future research includes the actual calculation of costs associated with seafarer retention. While the research provides some evidence, discussed above, suggesting that these costs are quite high, little empirical data on the costs of employee turnover in the shipping industry are publicly available. If convincing data of this type were available, it could transform managerial perceptions about the costs investing in POS. The absence of these data make it difficult to perform accurate cost-benefit analyses of investments in employee retention, such as training programs and investments to increase a ship's standard of living. The absence of such data almost certainly deters investment. In addition, there are few quantitative studies on the effects of such investments on retention rate. Identifying key investments to reduce employee turnover with a similar methodology as Bhattacharya (2014) may prove a promising area for future research.

Shiptalk (2012) results suggest correlation between safety and employee turnover, but detailed data are not available [18]. However, scholars studying the trucking industry have strongly established this link [29]. An econometric approach linking factors such as safety training, its effects on employee commitment, and the effects of both on incidence of safety issues has the potential to reveal a virtuous cycle. By investing in safety training, this cycle could allow firms to significantly improve safety (a potential financial gain). At the same time, firms would also be providing organizational support to employees who feel more strongly that their managers understand and respond to their concerns. Future scholars may benefit from exploring linkages among these variables to see if such a virtuous safety-commitment-safety cycle may exist in maritime firms.

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# FROM DIPLOMA TO DEGREE: EXPERIENCES, CHALLENGES AND OPPORTUNITIES

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**Abstract.** This paper explores some of the issues faced by the staff and students of the Australian Maritime College (AMC) as its seafaring qualifications program was changed from an Advanced Diploma program to a degree pathway. The work is based upon the recent experience of migrating this program as well as the feedback received from students, staff and the maritime administration.

For many years the Australian tertiary education system has been operated in two distinct sectors – the vocational education sector and the higher education sector. Seafaring qualifications are delivered and assessed either through the relevant maritime 'training package' or through an approved higher education pathway. The AMC had, since its formation in the 1980's, utilised the higher education route to its international seafaring qualifications. Following integration with the University of Tasmania in 2008, AMC conducted a review of its programs and determined to deliver the seafaring qualifications though a maritime degree program in preference to the Advanced Diploma used hitherto. The paper considers the Australian education environment with an emphasis on the different approaches to competency and the application of Bloom's taxonomy, which classifies learning objectives into cognitive, affective, and psychomotor domains, in a competence framework. The rationale for the change to a degree, in the context of Australian education is then explained.

Finally, the paper concludes by considering what this has meant for the student learning experience including the use of research/project-based approaches to parts of the syllabus and the enhanced role of simulators in a degree framework for both teaching and assessment. It also reports on the broader views of students and the marine administration.

**Key words**: MET degree, educational issues, training, qualifications

## 1 INTRODUCTION

Up to the 1970s, maritime education and training (MET) for seafarers in Australia was primarily focused on helping them pass exams set independently by national or state marine administrations. During that decade some sea service remission was granted to students by the marine administration when they successfully completed approved courses and associated assessments. A further development gave successful students exemptions from some of the 'non-critical' certificate of competency exams. The advent of the Australian Maritime College (AMC) in 1980 brought further, more significant changes. Courses were now incorporated into the national higher education system, accredited as diplomas and approved by the marine administration. When a course was successfully completed, graduates with the requisite sea service were now only required to pass the marine administration's oral exam before gaining their certificate of competency. [1] This approach remained fundamentally unchanged until the AMC integrated with the University of Tasmania in 2008. It then conducted a review of its programs and determined to deliver the seafaring qualifications though maritime degree programs in preference to advanced diploma programs.

The Australian tertiary education system has two distinct sectors – the vocational education sector (VET) and the higher education (HE) sector. Programs leading to seafaring qualifications can be delivered and assessed through either sector. The VET sector utilises the national maritime training package approach whilst HE utilises the Australian Qualifications Framework (AQF) approach followed by universities. Programs in both sectors must include the competencies listed in the International Maritime Organisation's (IMO) Standards of Training, Certification and Watchkeeping (STCW). To ensure compliance the Australian Maritime Safety Authority (AMSA), the national maritime administration, approves educational institutions allowed to offer programs leading to seafaring qualifications.

In migrating seafarer programs from diplomas to degrees a number of educational challenges and opportunities arose.

## 2 EDUCATIONAL ISSUES

Two of the major challenges faced in migrating seafarer programs from diplomas to degrees were:

– Fitting the different approaches to competencies taken by STCW and national training packages to the requirements of AQF, and
– Taking advantage of changing education paradigms to improve program delivery

### 2.1 Competencies

STCW was first written in 1978 and has been revised seven times. The 2010 Manila Amendments attempted to update the convention but the last major revision was in 1995 some twenty years ago. It is a fact that shipboard practices and technology move far faster than the process of updating STCW thus some competencies remain obsolete, inappropriate, or inadequate to deal with modern technology and practices. Appendix 1 illustrates the form of competencies contained in STCW. [2]

STCW provides a framework that must be used to design education and training schemes to develop competent seafarers. Although STCW has some flexibility, interpretations tend to be conservative, consequently MET has been relatively slow to incorporate the learning and teaching changes which continue to sweep through education in general.

A different approach to describing competencies is taken in the national training packages which are developed by Australian Government funded Industry Skills Councils (ISCs). The website Training.gov.au has been developed for the VET sector and is the official source of information on training packages, qualifications, accredited courses, units of competency, skill sets and Registered Training Organisations (RTO). [3]

As an example, the Maritime Training Package for the Advanced Diploma of Maritime Operations (Master Unlimited) contains 26 units of competency; each unit contains a small number of Elements each having a number of performance criteria. [4] Appendix 2 illustrates the form of competencies contained in training packages.

The Australian Qualifications Framework (AQF), which is the national policy for regulated qualifications in Australian education and training takes yet another approach to describing competencies. [5]

"The organising framework for the AQF is a taxonomic structure of levels and qualification types each of which is defined by a taxonomy of learning outcomes.

… The AQF levels define the relative complexity and depth of achievement and the autonomy required of graduates to demonstrate that achievement. …

Each level/qualification type is defined by a descriptor expressed as learning outcomes. The learning outcomes are constructed as a taxonomy of what graduates are expected to know, understand and be able to do as a result of learning." [6] Appendix 3 illustrates the form of competencies contained in the Australian Qualifications Framework.

It is a significant challenge to incorporate the competencies of STCW, national training packages and the AQF into the design of a new degree program.

### 2.2 Changing educational paradigms

Significant changes to education and training include the move away from teacher centred to student centred learning, the rise of lifelong learning, the provision of courses on demand, the global market for education, and the technology juggernaut which has made information available on demand and provided the capability to deliver courses anywhere/anytime

Change creates challenges and opportunities for all education and training providers, including MET, but MET has been relatively slow to uptake technology advances for learning, teaching and assessment, and use the full range of delivery techniques such as distance education, blended delivery, E-learning etc. This is due to factors such as conservative attitudes and resistance to change, MET's traditional teacher centred approach to learning, and lack of on-board internet access. For example; in late 2013 the Australian internet usage penetration rate was 87% but only 12% of seafarers on cargo ships had freely available internet access and 65% had none at all. [7]

One of the ways to improve the learning experience and overcome some of the conservative attitudes has been to promote the greater use of Bloom's taxonomy. The taxonomy is a classification of the different learning objectives that educators set for students. It divides objectives into three domains: cognitive, affective, and psychomotor (sometimes loosely described as knowing/head, feeling/heart and doing/hands respectively). Within the domains, learning at the higher levels is dependent on having attained prerequisite knowledge and skills at lower levels. A goal of Bloom's taxonomy is to motivate educators to focus on all three domains to create a more holistic form of education. [8]

In the past, Certificates of competency were about knowing rather than doing, were valid for any ship anywhere and were assessed by written and oral exams. This is no longer the case. Competence is about doing (effectively, efficiently, and safely) all the time with an acceptable level of accuracy. Using variants of Bloom's taxonomy helps educators to properly describe and assess learning objectives (competencies).

## 3 THE IMPACT OF MIGRATING TO A DEGREE PATHWAY

In the move to an undergraduate route to the qualifications there were a number of important factors evaluated by the course team and discussed with both internal and external stakeholders. These factors are discussed in more detail below and included:

- The schedule of delivery of the units
- The delivery style of the units and in particular the classroom contact
- Assessment methodologies
- Recognition by the marine administration
- Compliance with AQF
- Impact on students

### 3.1 The schedule of delivery of the units

AMC has, since its inception, adopted a schedule of course delivery that reflects the perceived need of the industry stakeholders in preference to the usually less flexible academic calendar often demanded by universities and colleges. In particular this has meant delivery in short blocks with units delivered discretely

Bloom's Taxonomy (Revised)

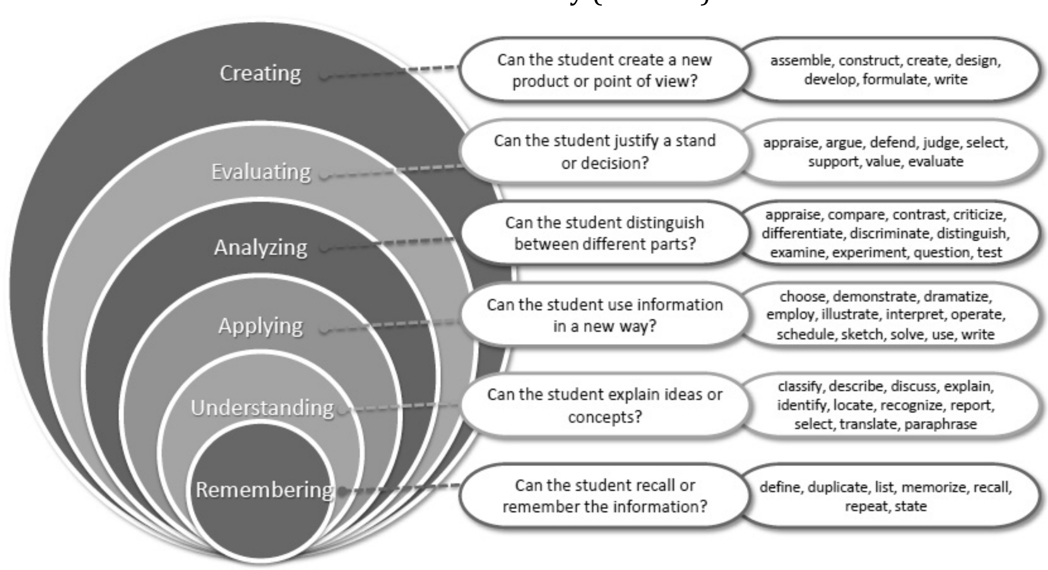



**Figure 1** One form of Bloom's taxonomy [9]

rather than longitudinally. Ensuring study in one area was not dependent upon success in a previous unit helps ensure maximum flexibility and accessibility for the students proceeding ashore from periods embarked their vessels.

Taking the Deck Watchkeeper diploma course as an example: prior to the inception of the degree, AMC delivered this course in three blocks of equal duration during the course of the year. Students were required to complete two blocks to cover all the units. Such an approach illustrated below allowed the students to enter at any of three entry points and they could complete their studies in one period of attendance or split their studies with a break (usually spent at sea).

The move to the degree program resulted in a comprehensive review of the contents of each unit and a careful evaluation of load. For both funding purposes and to match university policies an effort was made to align the content of each academic subject to the load required for a standard academic unit of study (one eighth of a year of study or 0.125 of a typical academic year). This review led the course team to re-align some content and the result was 12 units to cover the required syllabus. Finally the course team took this academic evaluation and in consultation with industry and regulators devised a rhythm of delivery shown below.

In fact the result was a course that offered greater flexibility of access to the students meeting both their needs and those of the sponsoring employer.

### 3.2 The delivery style of the units and in particular the classroom contact

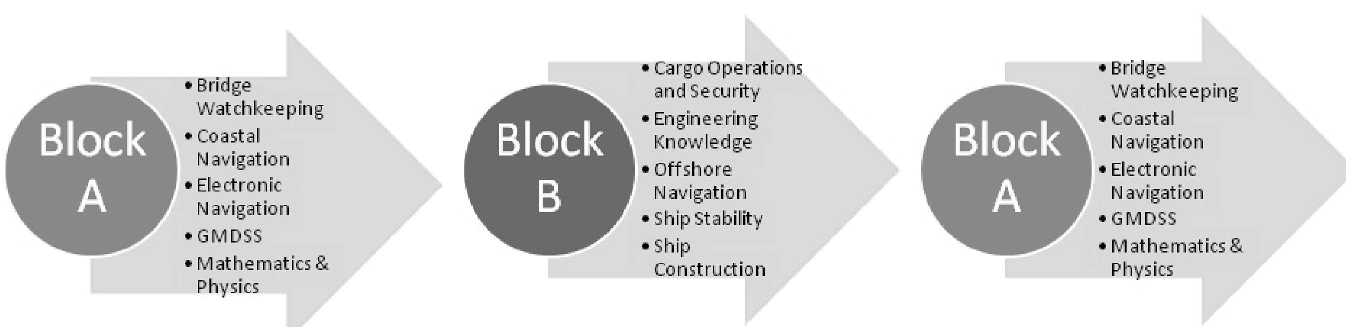
One of the features of the diploma program, and indeed other professional or vocational subjects, is often a strong emphasis on the teacher being at the centre of the learning process and a desire on the part of all in the learning process that all relevant material should be covered in the four walls of the classroom.

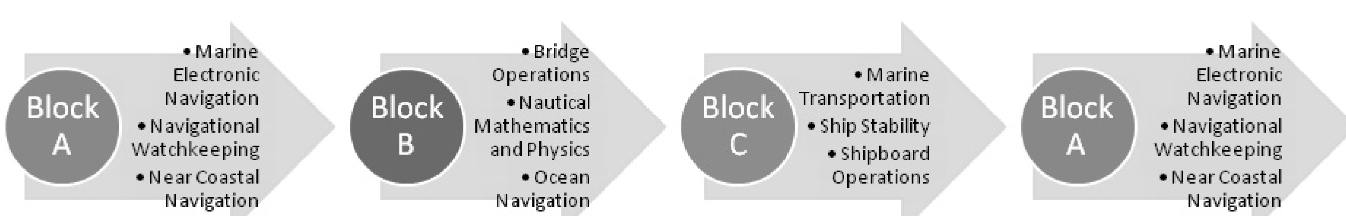
Consistent with this approach, the AMC, like many other maritime training institutions hosted a typical time-tabled week of 30 hours per student – all of it in class or laboratories. This was felt to be inconsistent with the characteristics of a degree program and student centred learning, and work was undertaken to develop different delivery techniques. In particular the delivery team sought to make the student the centre of the learning process by:

– Better use of the University on-line learning platform 'MyLo'
– Greater use of directed reading
– Updating of the learner guides
– Greater use of tutorials for reviews, discussions and feedback
– Increased use of simulation and practical activities

### 3.3 Assessment methodologies

The assessment of candidates for competence and the underpinning knowledge required in support of that competence is particularly important. Students learn in a variety of ways often at a different pace to one another. But the assessment is one that must be undertaken by all and in a manner usually of the choosing of the lecturer. In a block of delivery a typical assessment profile of the Diploma program was a single assignment piece of work to be undertaken and then a final examination conducted under traditional closed book conditions.



The move to the degree meant the course teams had to determine if such a regime would be appropriate for the future and whether or not it encouraged the graduate attributes expected by a university and met the expectations of a learning taxonomy and in turn the AQF. In most circumstances it was determined a modification to the assessments would be required. At the time of writing this is an area of ongoing improvement but the main aim has been to encourage the students to adopt those higher-order skills that reflect a *graduate* rather than a *diplomate*. They are expected to be more analytical in their response and to be more reflective of their own learning. This can be achieved by more incisive questioning in examinations, expecting more detailed responses to questions and also assessments requiring students to report back on their own learning during a particular activity.

### 3.4 Recognition by the marine administration

As part of the stakeholder engagement, AMC entered discussions with a number of companies but, perhaps more importantly ensured that the national regulator AMSA were fully engaged and consulted.

Recognising that the existing diploma programs have long-standing approvals AMSA sought re-assurance that the previously approved content was (as a minimum) covered in the revised delivery arrangements. At the same time it was recognised that Australia works in a complex regulatory framework and AMSA took the opportunity to require that AMC demonstrate compliance with both the latest amendments to the STCW Convention as well as the maritime training packages covering this area. This compliance exercise was conducted through a comprehensive mapping exercise in which all areas of the STCW code and the training package were checked against the learning content of the degree programs. The matrices developed though this exercise remain an important source of reference that helps ensure all areas are covered and that each is delivered at the appropriate level – Operational or Management.

Appendix 4 illustrates the form of matrix developed as a result of the mapping exercise.

### 3.5 Compliance with AQF

As identified earlier in the paper, the AQF establishes for each level the learning outcome criteria appropriate for the qualification award. A Bachelor degree is established as an AQF Level 7 award (See Appendix 3) and describes the requirements for the learning outcomes in terms of:

- Knowledge
- Skills
- Application of knowledge and skills

The development work and implementation of the degree criteria ensured that the course delivery and assessment would determine whether or not the candidate met these requirements.

A development matrix was established whereby the generic learning outcomes required by AQF were mapped to the course delivery. As an example:

**Knowledge** required by AQF:
*Graduates at this level will have broad and coherent theoretical and technical knowledge with depth in one or more disciplines or areas of practice.*

Subject Area: Navigation

In the field of navigation candidates are assessed in all three years if their studies.

In Year 1 the focus is on the fundamentals of navigation.

By Year 2 the work becomes more specialised looking at Electronic Navigation systems, Coastal Navigation and Ocean Navigation.

The theoretical and technical knowledge is developing each year and in Year 3 the candidate is able to demonstrate the “depth” through the Command Navigation module and the unit of Command Operations.

In each case a comprehensive mapping exercise determined the assessment methodology selected from:

- Formal examination
- Assignment
- Practical assessment
- Class test

The intensity or depth was usually determined by the year of delivery and reflected whether the responsibilities of the task lay at the Support; Operational or Management Level, with the management level requiring the deepest level of theoretical and technical knowledge.

## 4 THE IMPACT ON STUDENTS

History will judge whether the move to a degree pathway from the diploma was successful but for the moment this paper will conclude with some remarks on feedback from the students and whether or not such a significant change was important to them.

The feedback at the moment is mixed and trends along the lines of career expectations. In this sense the students can be grouped into three broad categories each of whom view the program changes in a different light. The groups are:

Traditional cadet and junior officers progressing through a ‘deep-sea’ career to a Class 1 Certificate of Competency. To these students the award of a degree is seen as a positive thing. It aligns a period of study with the award of a degree and makes their studies more recognisable when considered alongside their own generation of school-leavers. The perception is that when they move to a second or subsequent career choice then being a graduate will stand them in better stead than holding just a Diploma.

The second group that values the changes are overseas students. Having been selected for a specialised pathway of study the question that often vexed them and their employers was how to make sure these professionally qualified students were not disadvantaged from their peer age group who may have studied for a degree in their home country or overseas. Particularly in the Middle East, the award of a degree is highly valued and career opportunities may be limited to those holding a lower qualification.

Finally there is a group of mariners, typically from a coastal or fishing background seeking to upgrade their professional qualification to allow service in foreign-going ships engaged in the offshore oil and gas sector particularly the North-West shelf of Australia. For this group the award of a degree held little or no significance. They are already embarked on a second or third career and their principal interest is getting a senior certificate of competency as quickly as possible.

Whilst the paper describes one recent initiative and its associated challenges and opportunities, the future is certain to provide many exciting opportunities for MET. When will we see:

– the first massive open online MET course (MOOC) aimed at unlimited participation and open access via the internet?
– virtual reality apps which allow MET students to experience a wide range of shipboard tasks without actually stepping aboard ship?
– simulation used to assess the competence of seafarers and perhaps reduce sea service requirements?

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## APPENDIX 1 IMO STCW COMPETENCIES

**Example:** *Table A-II/2*

**Specification of minimum standard of competence for masters and chief mates on ships of 500 gross tonnage or more**

**Function: Controlling the operation of the ship and care for persons on board at the management level**

| Column 1 | Column 2 | Column 3 | Column 4 |
|---|---|---|---|
| **Competence** | **Knowledge, understanding and proficiency** | **Methods for demonstrating competence** | **Criteria for evaluating competence** |
| Control trim, stability and stress | Understanding of fundamental principles of ship construction and the theories and factors affecting trim and stability and measures necessary to preserve trim and stability<br><br>Knowledge of the effect on trim and stability of a ship in the event of damage to and consequent flooding of a compartment and countermeasures to be taken<br><br>Knowledge of IMO recommendations concerning ship stability | Examination and assessment of evidence obtained from one or more of the following:<br>.1 approved in-service experience<br>.2 approved training ship experience<br>.3 approved simulator training, where appropriate | Stability and stress conditions are maintained within safe limits at all times |

## APPENDIX 2 NATIONAL TRAINING PACKAGES COMPETENCIES

**Example:** Advanced Diploma of Maritime Operations (Master Unlimited) 6 June 2013 (26 units of competency)

MARA6001A Unit Descriptor

This unit involves the skills and knowledge required to control trim, stability and stress within safe limits at all times on a vessel 500 gross tonnage or more.

**Packaging Rules**

| **Core units** | | |
|---|---|---|
| **Field** | | |
| **A Handling Cargo and Vessel Stability** | MARA3001A | Contribute to safe cargo operations on liquefied gas tankers |
| | MARA3002A | Contribute to safe cargo operations on oil and chemical tankers |
| | MARA6001A | Manage stability of a vessel 500 gross tonnage or more |

**Elements and Performance Criteria**

| Elements describe the essential outcomes of a unit of competency | Performance criteria describe the required performance needed to demonstrate achievement of the element. Assessment of performance is to be consistent with the evidence guide. |
|---|---|
| 1 Manage vessel trim under normal operating conditions | 1.1 Stability analysis and weight distribution planning are conducted at a time frequency and scope appropriate to the proposed nature of the voyage and vessel operation |
| | 1.2 Weight distribution is arranged to maintain vessel within acceptable stability limits for the anticipated operational situations likely to be experienced during the voyage |
| | 1.3 ***Calculations*** are made to determine the draught and centre of gravity of vessel after adding, removing or shifting weight |
| | 1.4 Factors affecting the stability and trim of vessel are identified and allowances are made in calculations |
| | 1.5 Trim, draughts and list of vessel are controlled as required to ensure they are suitable to progress all anticipated vessel operations |

**Required Skills and Knowledge**

| Required Skills |
|---|
| • Apply IMO recommendations concerning vessel stability<br>• Determine stability and trim requirements for docking or slipping the vessel<br>• Determine the effect on trim and stability of vessel in the event of damage to and consequent flooding of a compartment, and countermeasures to be taken |
| **Required Knowledge** |
| • Causes and repercussions of a heeling vessel<br>• Effects of density of sea water on the draught and freeboard of a vessel<br>• Features of the load-line and draught marks of a vessel and procedures for carrying out related calculations<br>• Typical problems related to the control of trim and stability for vessels of 500 gross tonnage and more |

## APPENDIX 3 AQF COMPETENCIES COMPARISON OF AQF LEVEL 6 AND 7 CRITERIA

| Criteria | Level 6 | Level 7 |
|---|---|---|
| **Summary** | Graduates at this level will have broad knowledge and skills for paraprofessional/highly skilled work and/or further learning | Graduates at this level will have broad and coherent knowledge and skills for professional work and/or further learning |
| **Knowledge** | Graduates at this level will have broad theoretical and technical knowledge of a specific area or a broad field of work and learning | Graduates at this level will have broad and coherent theoretical and technical knowledge with depth in one or more disciplines or areas of practice |
| **Skills** | Graduates at this level will have a broad range of cognitive, technical and communication skills to select and apply methods and technologies to:<br>• analyse information to complete a range of activities<br>• interpret and transmit solutions to unpredictable and sometimes complex problems<br>• transmit information and skills to others | Graduates at this level will have well-developed cognitive, technical and communication skills to select and apply methods and technologies to:<br>• analyse and evaluate information to complete a range of activities<br>• analyse, generate and transmit solutions to unpredictable and sometimes complex problems<br>• transmit knowledge, skills and ideas to others |
| **Application** | Graduates at this level will apply knowledge and skills to demonstrate autonomy, judgement and knowledge defined responsibility: and skills<br>• in contexts that are subject to change<br>• within broad parameters to provide specialist advice and functions | Graduates at this level will apply knowledge and skills to demonstrate autonomy, well-developed judgement of knowledge and responsibility and skills<br>• in contexts that require self-directed work and learning<br>• within broad parameters to provide specialist advice and functions |

| Specifications | Advanced Diploma | Bachelor Degree |
|---|---|---|
| **Purpose** | The Advanced Diploma qualifies individuals who apply specialised knowledge in a range of contexts to undertake advanced skilled or paraprofessional work and as a pathway for further learning | The Bachelor Degree qualifies individuals who apply a broad and coherent body of knowledge in a range of contexts to undertake professional work and as a pathway for further learning |
| **Knowledge** | Graduates of an Advanced Diploma will have specialised and integrated technical and theoretical knowledge with depth within one or more fields of work and learning | Graduates of a Bachelor Degree will have a broad and coherent body of knowledge, with depth in the underlying principles and concepts in one or more disciplines as a basis for independent lifelong learning |
| **Skills** | Graduates of an Advanced Diploma will have:<br>• cognitive and communication skills to identify, analyse, synthesise and act on information from a range of sources<br>• cognitive and communication skills to transfer knowledge and skills to others and to demonstrate understanding of specialised knowledge with depth in some areas<br>• cognitive and communication skills to formulate responses to complex problems<br>• wide-ranging specialised technical, creative or conceptual skills to express ideas and perspectives | Graduates of a Bachelor Degree will have:<br>• cognitive skills to review critically, analyse, consolidate and synthesise knowledge<br>• cognitive and technical skills to demonstrate a broad understanding of knowledge with depth in some areas<br>• cognitive and creative skills to exercise critical thinking and judgement in identifying and solving problems with intellectual independence<br>• communication skills to present a clear, coherent and independent exposition of knowledge and ideas |
| **Application** | Graduates of an Advanced Diploma will demonstrate the application of knowledge and skills: of knowledge<br>• with depth in areas of specialisation, in contexts subject to change and skills<br>• with initiative and judgment in planning, design, technical or management functions with some direction<br>• to adapt a range of fundamental principles and complex techniques to known and unknown situations<br>• across a broad range of technical or management functions with accountability for personal outputs and personal and team outcomes within broad parameters | Graduates of a Bachelor Degree will demonstrate the application of knowledge and skills: of knowledge<br>• with initiative and judgement in planning, problem solving and decision making in professional practice and skills and/or scholarship<br>• to adapt knowledge and skills in diverse contexts<br>• with responsibility and accountability for own learning and professional practice and in collaboration with others within broad parameters |
| **Learning volume** | The volume of learning of an Advanced Diploma is typically 1.5 – 2 years | The volume of learning of a Bachelor Degree is typically 3 – 4 years |

## APPENDIX 4 AQF MAPPING EXERCISE MATRIX

| **Course Learning Outcomes** | | | **JND280 Marine Electronic Navigation** | | | | **JND281 Navigational Watchkeeping** | | | | **JND282 Near Coastal Navigation** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Demonstrate broad and coherent nautical knowledge by: | *Applying diverse navigation concepts to safely plan and conduct a voyage.* | ATs | T | A | P | E | T | A | P | E | T | A | P | E |
| | | | 2 | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | 2 |
| | | TLAs | L | P | W | TT | L | P | W | TT | L | P | W | TT |
| | | | 2 | 2 | | 2 | 2 | 2 | | | 2 | | | 2 |
| | *Applying principles of cargo handling and storage on board a ship.* | ATs | T | A | P | E | T | A | P | E | T | A | P | E |
| | | | | | 2 | | | | | | | | | |
| | | TLAs | L | P | W | TT | L | P | W | TT | L | P | W | TT |
| | | | | | | | | | | | | | | |
| Assess and solve nautical problems by: | *Analysing, interpreting and evaluating a range of available data as a basis for decision making in standard-operational and emergency related scenarios on a commercial ship.* | ATs | T | A | P | E | T | A | P | E | T | A | P | E |
| | | | 2 | | 2 | 2 | 2 | 2 | 2 | 2 | | 2 | | 2 |
| | | TLAs | L | P | W | TT | L | P | W | TT | L | P | W | TT |
| | | | 2 | 2 | | 2 | 2 | 2 | | | 2 | | | 2 |
| | *Implementing responses which acknowledge stakeholders expectations and needs.* | ATs | T | A | P | E | T | A | P | E | T | A | P | E |
| | | | 2 | | 2 | 2 | 2 | 2 | 2 | 2 | | 2 | | 2 |
| | | TLAs | L | P | W | TT | L | P | W | TT | L | P | W | TT |
| | | | 2 | 2 | | 2 | 2 | 2 | | | 2 | | | 2 |
| Practice effective leadership by: | *Applying Relevant management theories to control the operation of a ship and care for the persons on board.* | ATs | T | A | P | E | T | A | P | E | T | A | P | E |
| | | | | | | | 2 | 2 | 2 | 2 | | 2 | | 2 |
| | | TLAs | L | P | W | TT | L | P | W | TT | L | P | W | TT |
| | | | | | | | 2 | 2 | | | 2 | | | 2 |
| | *Exhibiting appropriate, communication, motivation, collaboration and decision making strategies which enables safe operation of a commercial ship.* | ATs | T | A | P | E | T | A | P | E | T | A | P | E |
| | | | | | 2 | | 2 | 2 | 2 | 2 | | 2 | | 2 |
| | | TLAs | L | P | W | TT | L | P | W | TT | L | P | W | TT |
| | | | 2 | 2 | | 2 | 2 | 2 | | | 2 | | | 2 |
| Demonstrate personal and professional stewardship through: | *Locating and adhering to regulatory frameworks and ethical codes relevant to ship operation in the international shipping industry.* | ATs | T | A | P | E | T | A | P | E | T | A | P | E |
| | | | | | | | 2 | 2 | 2 | 2 | | 2 | | 2 |
| | | TLAs | L | P | W | TT | L | P | W | TT | L | P | W | TT |
| | | | | | | | 2 | 2 | | | 2 | | | |
| | *Performing tasks in an ethical manner where the safety of persons and protection of the natural environment are of the greatest importance.* | ATs | T | A | P | E | T | A | P | E | T | A | P | E |
| | | | | | | | | 2 | 2 | 2 | | | | 2 |
| | | TLAs | L | P | W | TT | L | P | W | TT | L | P | W | TT |
| | | | | | | | 2 | 2 | | | 2 | | | |

In this table the following abbreviations have been used:

AT – Assessment Tasks: T – Test; A – Assignment; P – Practical; E – Examination

TLA – Teaching and learning activities: L – Lecture; P- Practical; W – Workshop

The number 2 indicates the matter is delivered and assessed at the ‘Support Level’ whereas Management Level studies are more intense and have Level 3 intensity.

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Sveučilište u Rijeci
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International Association of Maritime Universities

# STCW 78 CONVENTION AND CODE: MANILA AMENDMENTS, FIVE YEARS LATER

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**Abstract.** In accordance of STCW Regulation I/15 the Manila Amendments currently are under the transitional period until 1 January 2017. During this time, IMO works hard on the development and adoption of a large number of instruments on safety, security and protection of environment, which directly or indirectly affect the scope of maritime education and training (MET) and also research activities of Maritime Universities through STCW Convention and Code. The paper reviews and analyses the IMO instruments and current trends relating MET and research, which influence or can affect the STCW Convention and Code after adoption of Manila Amendments, including e-navigation, Polar Code, III Code, IGF Code, Ballast Water Management Convention…, etc.

**Key words:** STCW 78, Manila Amendments, education, training

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## 1 INTRODUCTION

June 25, 2010, Manila, Philippines. This day the Diplomatic Conference has adopted the amendments to the STCW Convention and Code. Amendments made significant changes to the Convention and entered into force on 1 January 2012 with a transitional period until 1 January 2017, as per Regulation I/15, i.e. now we live within the transitional period of Manila amendments. This year 2015 IMO and all shipping society celebrate the World Maritime Day (WMD) under the theme of Maritime Education and Training. It naturally gives the motive to draw attention once again to the STCW Convention, which is undoubtedly one of the most important IMO tools for providing safe, secure and efficient shipping on clean oceans. During this transitional period of time the IMO has changed the structure of its sub-committees and sub-committee STW (Standards of Training and Watchkeeping), which actually worked on the updating the Convention, from the 1st of January 2014 changed the name to HTW (Human Element, Training and Watchkeeping). It obtained a new function - “Human Element”, which fits perfectly to the framework and ideology of the STCW Convention and allows the sub-committee to work in other important area as ISM Code issues. In principle, for IMO it is timely and reasonable step forward, as such areas of activity, as training of seafarers, safety management, manning and fatigue are closely linked. Their separation when developing standards reduces the effectiveness of these standards themselves. The impact of non-technical training provisions in the Convention as Bridge Resource and Engine Resource Management, leadership, decision making, situation awareness, risk assessment confirms the reasonableness of inclusion the Human Element issue into former STW sub-committee activity.

It should be noted that the transitional period for the Manila amendments is not applied to Chapter VIII of the Convention – Watchkeeping. The amendments to this chapter are in effect since 1 January 2012. There are also a number of amendments, which began working since 1 July 2013 and 1 January 2014.

Five years have passed since the adoption of the Manila Amendments but STCW continues to be in progress, reflecting the dynamics of the shipping industry. The development of the Convention is impressive and it goes ahead in line with such great IMO instruments for regulation safety at sea and environment protection, as SOLAS 74 and MARPOL 73/78. This encourages maritime institutions providing education and training of seafarers to reflect all the changes in IMO tools. It is quite obvious that the questions relating to training of seafarers should not be considered only within the framework of the STCW and the work of the HTW sub-committee. Let’s try to expand the analysis of the data to functions of other IMO instruments, which impact on STCW 78 Convention and Code.

Almost in parallel with the development of the Manila amendments to STCW the IMO launched the development of two important issues which had substantive contribution to the STCW 78. These are amendments to Chapter V of SOLAS 74 for mandatory installation of ECDIS on ships operating under the SOLAS Convention (scheduled within 2012-2018) and the Polar Code (effective from 01.01.2017).

## 2 ELECTRONIC CHART DISPLAY AND INFORMATION SYSTEMS (ECDIS)

The period of mandatory installation of ECDIS as per SOLAS Convention practically coincides with the transitional period of the STCW Manila amendments. The absence of clear provisions of the synchronization between these two conventions on ECDIS installation (SOLAS 74) and training requirements on ECDIS (STCW 78) stimulated the IMO to adopt the explanatory circular STCW.7/Circ.18 in May 2012.

The identification by industry of various types of anomalies when using ECDIS encouraged IMO to develop the recommendations to collect and disseminate this information [1]. It can be considered as hazard identification procedure, i.e. the first step of risk assessment, when using ECDIS.

There is no doubt that ECDIS is a major navigational equipment to ensure the safety of navigation that is why the training of seafarers should be arranged with a great attention and high quality. A large number of papers on ECDIS developed by IMO stimulated NCSR sub-committee to merge all documents on ECDIS in the consolidated publication of “MSC circular on ECDIS – Guidance for good practice”, which contributes to a better perception of all the IMO tools on ECDIS [2].

It should also be noted that the NCSR subcommittee within e-navigation agenda item develops important issues on software quality and, so called, S-mode (*Standardized mode*, that means the creation of uniform approach to development of interface for navigation and communication equipment), which should greatly improve the efficiency and usability of navigation and communication equipment, including ECDIS.

By the way, the development of S-mode, in principle, can seriously facilitate the familiarization training on the use of all navigation and communication equipment.

## 3 INTERNATIONAL CODE FOR SHIPS OPERATING IN POLAR WATERS

The Polar Code (PC) and amendments to SOLAS Convention were adopted during the 94th session of IMO's Maritime Safety Committee (MSC) in November 2014. The IMO's Marine Environment Protection Committee (MEPC) during 68th session in May 2015 has adopted the environment-related provisions of the Polar Code and also the appropriate amendments to MARPOL Annexes I, II, IV and V to make use of the environment-related provisions of the Polar Code mandatory. PC will take effect on 1 January 2017 upon entry into force of the new chapter XIV (Safety Measures for Ships operating in Polar Waters) of the SOLAS 74 Convention and appropriate amendments to MARPOL 73/78.

Fig. 1 illustrates the Polar waters, as defined in SOLAS regulations. In order to meet the framework functional requirements of PC Chapter 12, masters and deck officers, serving onboard the ships operating in polar waters, shall be qualified in accordance with amendments to chapter V of the STCW Convention and Code.

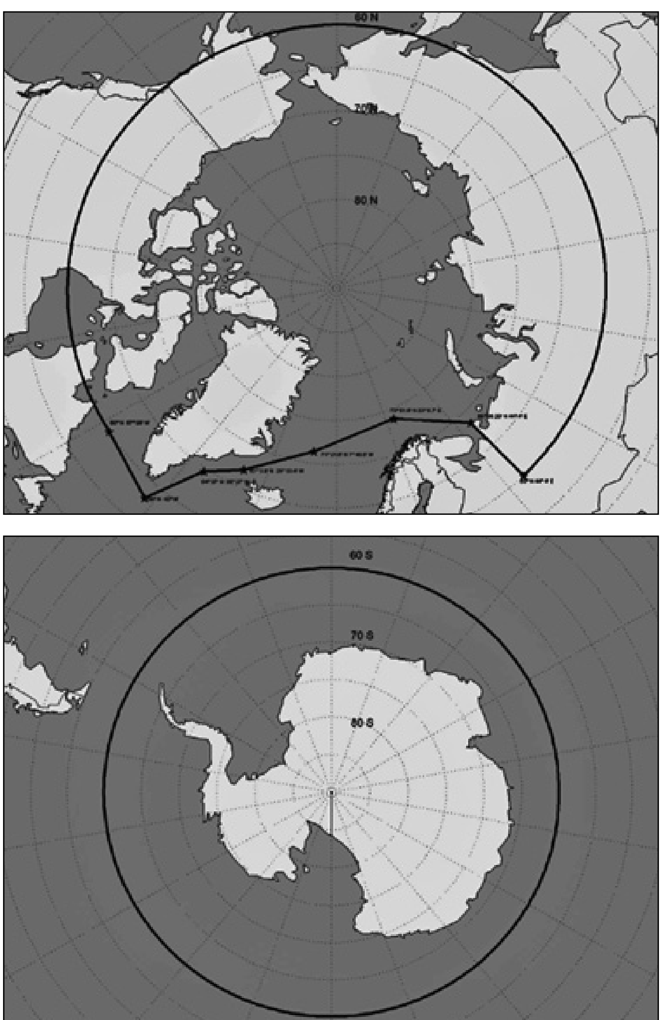


**Fig. 1** Arctic and Antarctic polar waters as per Polar Code

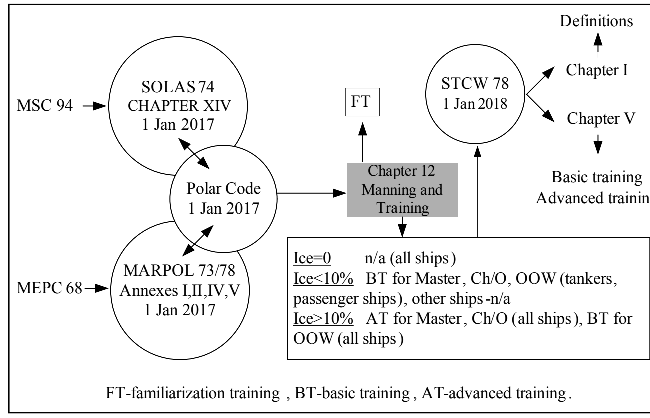


**Fig. 2** Development the amendments to STCW as a result of the PC Chapter 12 provisions

The whole procedure of development the amendments to STCW can be seen on Fig. 2, where dates indicate the entering of instruments into force.

## 4 IMO INSTRUMENTS IMPLEMENTATION CODE (III CODE)

The Assembly of the International Maritime Organization, meeting for its 28th session in London, has adopted key resolutions and amendments relating to the Organization's mandatory audit scheme, paving the way for the scheme to come into effect by 2016 once amendments to mandatory instruments have entered into force[1].

The mandatory audit scheme is seen as a key tool for assessing Member States' performance in meeting their obligations and responsibilities as flag, port and coastal States under the relevant IMO treaties and then offering the necessary assistance, where required, for them to meet their obligations fully and effectively. III Code provides a global standard to enable States to meet their obligations as flag, port and/or coastal States. It is effective for from 1st of January 2016 for all the IMO instruments listed below (see Fig. 3), including STCW 78.

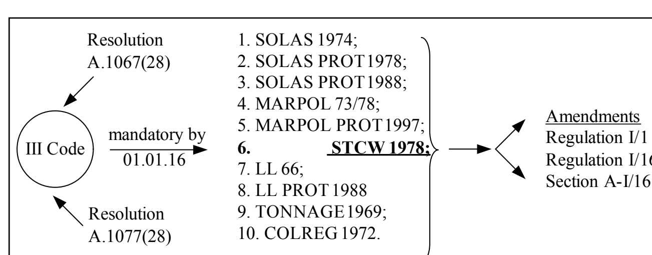


**Fig. 3** Mandatory audit of IMO Instruments Implementation using III Code

[1] http://www.imo.org/MediaCentre/PressBriefings/Pages/A-28-ends-.aspx#.VV_q3-9nUuM

Assembly resolutions, adopted on December 2013, particularly A.1067 (28): "Framework and procedures for the IMO member state audit scheme" and A.1077 (28): "2013 Non-exhaustive list of obligations under instruments relevant to the IMO III Code", support the functions of the Code.

## 5 INTERNATIONAL CODE OF SAFETY FOR SHIPS USING GASES OR OTHER LOW FLASHPOINT FUELS (IGF CODE)

The rising interest in using LNG as a fuel was also covered by the MSC through the approval, in principle, of the draft IGF Code, as well as draft SOLAS amendments to make the code mandatory. It plans to adopt both in 2015.

The IGF Code will provide mandatory provisions for the arrangement, installation, control and monitoring of machinery, equipment and systems using low-flashpoint fuels, focusing initially on LNG, to minimize the risk to the ship, its crew and the environment.

Fig. 4 shows the algorithm of developing the amendments to appropriate chapters of the STCW Convention to reflect the possible training and certification requirements related to IGF Code. The dates of taking effect is not yet set out at the end of May 2015 that is why square brackets are used for possible modification the dates of entry in force.

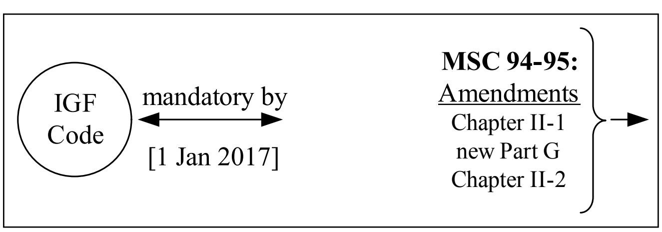


**Fig. 4** The procedure of development the amendments to STCW using IGF Code Section 17

MSC 94 approved for HTW sub-committee the extension of target completion year on IGF Code agenda item to 2016 and changed the description of the output from "Development of IGF Code" to "Amendments to the IGF Code and development of guidelines for low-flashpoint fuels" following the expected adoption of the IGF Code by MSC 95, to more accurately reflect the next phase of work. MSC 94 approved draft amendments related to the IGF Code, to the STCW Convention and the associated draft MSC resolutions and the STCW Circular, prepared by HTW 1 with a view to adoption at MSC 95 in June 2015 [3].

## 6 E-NAVIGATION

In 2006 almost in parallel with the development of Manila amendments to the STCW Convention and Code, the IMO launched to carry out new very important issue, which was named as "e-navigation".

The definition of e-navigation used by IMO is as follows: "*E-navigation is the harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment.*"[2]. In principle, the meaning of the term "e-navigation" can be interpreted as professional electronic network, similar to Internet, with common standards and protocols for information exchange to enhance the safety and security at sea and protection of the marine environment.

The MSC 94 in 2014 approved the e-navigation Strategy Implementation Plan (SIP), as set out in document NCSR 1/28, annex 7 [3]. During the development of SIP a lot of issues were discussed, some of which may relate to future progress of STCW Convention in terms of MET.

If to predict the possible Regulatory impact of e-navigation to STCW Convention, one can refer to Report of NCSR 1, where the following text is included[3]: *The provision and further development of e-navigation should consider relevant international conventions, regulations and guidelines, national legislation and standards. The development and implementation of e-navigation should build upon the work of IMO, including, but not limited to, the requirements prescribed in FAL, SOLAS, MARPOL and STCW conventions.*

Despite of HTW 1 had agreed[4] that it was premature to consider any training requirements, pending the finalization of the e-navigation Strategy Implementation Plan (SIP), the following tasks set out in SIP can't be avoided by MET process and might be reflected in future provisions of STCW Convention (original wordings as per NCSR 1/28): T1: Development of draft Guidelines on Human Centered Design (HCD) for e-navigation systems; T2: Development of draft Guidelines on Usability Testing, Evaluation and Assessment (UTEA) of e-navigation systems; T3: Develop the concept of electronic manuals and harmonize the layout to provide mariner with an easy way of familiarization for relevant equipment; T4: Formulate the concept of standardized modes of operation, including store and recall for various situations, as well as S-mode functionality on relevant equipment;

[2] Report of MSC 85,MSC 85/26/Add.1, annex 20: Strategy for the development and implementation of E-navigation, 6 January 2009.

[3] Report to MSC, NCSR 1/28, 16 July 2014.

T5: Investigate whether and extension of existing Bridge Alert Management Performance Standards (PS) is necessary. Adapt all other alert relevant PSs to the to Bridge Alert Management PS; T6: Develop a methodology of how accuracy and reliability of navigation equipment may be displayed. This includes a harmonized display system; T7: Investigate if an INS, as defined by resolution MSC. 252(83), is the right integrator and display of navigation information for e-navigation and identify the modifications it will need, including a communications port and a PNT module. If necessary, prepare a draft revised performance standard. Refer to resolution MSC.191(79) and SN/Circ.243; T8: Member States to agree on standardized format guideline for ship reporting so as to enable "single window" worldwide (SOLAS regulation V/28, resolution A.851(20) and SN.1/Circ.289); T14: Develop a Common Maritime Data Structure and include parameters for priority, source, and ownership of information based on the IHO S-100 data model. Harmonization will be required for both use on shore and use on the ship and the two must be coordinated.

Develop further the standardized interfaces for data exchange used on board (IEC 61162 series) to support transfer of information from communication equipment to navigational systems (INS) including appropriate firewalls (IEC 61162- 450 and 460).

Taking into account the outcomes presented in COMSAR 16/11 (annex 1), on gap analysis made by correspondence group on e-navigation one can come to conclusion that the following issues also have a trend be reflected in STCW Convention as *Proposed practical e-navigation solutions to address identified gaps (column "Training"*, original wordings as per annex 1): *(a) Develop training course for automated procedure of ship reporting; (b) evelop training course for procedure of data entry using harmonized data format and related equipment; (c) Mariner to be trained for proper filtering of information; (d) Familiarization to status information of each equipment; (e) Training to respond the equipment status if necessary; (f) Consideration should be given to the revision of training/education for affected equipment and impact on Bridge Resource Management Training reflecting operational changes and how it is incorporated into practice of navigation; (g) Develop the training course to be familiarized new symbolic presentation environment; (h) Operator must be trained for operation of data systems; (i) Revise the training course of current GMDSS for integrated GMDSS system; (j) Training course of GMDSS should be revised based on the standard operational procedure; (k) A basic level of relevant language competency should be required ahead of being able to use SMCP; (l) Users need to be made aware of the vulnerability of GNSS and the lack of integrity; users also need to be trained in procedures to be followed if GNSS is disrupted, or in the use of alternative systems; (m) Revise the training course to understand the system's automatic action and report to use; (n) Revise the training course to be familiarized with the new feature of maneuvering data presentation; (o) Revise the training course of ECDIS to be familiarized electronic procedure related passage plan; (p) different ships with different equipments, user must not need to spend more time to be educated for operation of same function; (q) Familiarization for using digital publication on user's computer; (r) Revise the training course on INS; (s) Training for a system should be focused to standardized operational procedure of e-navigation; (t) Revise the training course for simple and standardized procedure for priority message; (u) V 103 model training courses for VTS operators and STCW need to include training in this regard.*

## 7 TRAINING REQUIREMENTS RELATING TO PASSENGER SHIPS

Any industry responsible for lives must follow stringent safety measures and the passenger shipping sector is no exception. After the loss of the *Costa Concordia* in January 2012, last year was another watershed year for passenger shipping with the sinking of the 1994-built South Korean ferry, *Sewol* on April 16, 2014. More than 300 people died in the disaster, which was the result of a combination of factors including overloading, poor securing of cargo, and lower than recommended ballast[4].

Passenger shipping was then hit by a second high-profile incident towards the end of the year with a fire onboard the 2009-built *Norman Atlantic* in Greek territorial waters on December 28. These two incidents underline a worrying gap in crew training when it comes to emergency operations on ro-ro/passenger ships. This gap is partly of STCW Convention matter and HTW sub-committee is involved in development of amendments to STCW Chapter V on passenger ships safety. The main issues are on Fig. 5.

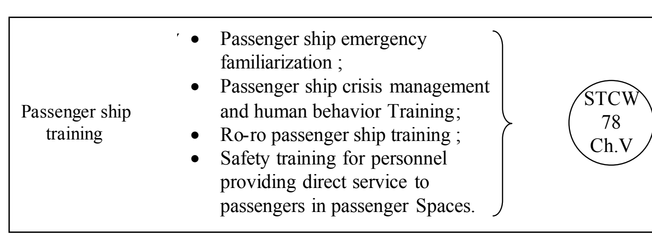


**Fig. 5** Main topics on passenger ship safety discussed for inclusion into STCW Chapter V

4 http://www.agcs.allianz.com/assets/PDFs/Reports/Shipping-Review-2015.pdf

HTW 2 Subcommittee also discussed the issue of *enhanced damage stability training* for officers and crew, but found this issue as premature to develop for STCW Convention for the time being.

## 8 BALLAST WATER MANAGEMENT CONVENTION (BWM CONVENTION)

The MEPC 68 has reviewed the status of the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention), 2004, which is close to receiving sufficient ratifications to meet the remaining entry into force criterion (tonnage). The number of Contracting Governments is currently 44, representing 32.86 % of the world's merchant fleet tonnage. The BWM Convention will enter into force 12 months after the date on which not fewer than 30 States, the combined merchant fleets of which constitute not less than 35% of the world's gross tonnage, have ratified it[5].

One of the significant issue of BWM Convention is the Ballast Water Sampling and Analysis requirements, that might need to have adequately trained personnel onboard ships on use the additional knowledge in applied fundamentals of organic chemistry, inorganic chemistry, bacteriology, virology; i.e. it might also require to develop the appropriate provisions related to STCW 78 Convention and Code.

## 9 CONCLUSION

It is common knowledge that MET is rather conservative sphere. In principle it is truth, but the shipping industry and supporting technologies, particularly information technologies, are continuously in progress. The dynamics of industry development is impressive, especially last decades and MET is obligated to keep the pace to be in line with this progress. Modern ships and new equipment require highly qualified personnel for serving onboard ships. The basic standards of MET, elaborated by experience of generations, and prescribed in STCW 78 Convention and Code, adequately reflect all these challenges and changes. During the time of development the Manila amendments more than 300 papers were submitted to STW sub-committee for consideration on different issues of maritime education, training, certification and watch keeping. From 2011 to 2015 the STW/HTW sub-committee has considered also about 300 papers on similar subjects. So, if the maritime universities can follow the rhythm of industry? They should do it, because life proves that MET should be as conservative, as well as dynamic.

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# DISTANCE DELIVERY OF IMO STCW COMPETENCY COURSES
## Making the Concept a Reality through Modern Technologies and Learning Tools

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**Abstract.** Maritime Education and Training (MET) is relatively complex compared to traditional education and training systems mainly due to space and time constraints experienced by seafarers. In addition,, the diversity of the seafarers' educational backgrounds, field experience, and competence make MET even more challenging. Therefore, the traditional, fixed-term, college based education systems are not always the most suited for seafarers to develop their competence to meet the needs of the industry.
With the advancements in Information and Communication Technology (ICT) distance learning, especially targeting seafarers at sea is becoming an attractive alternative in MET. In recent times, advanced software programs, simulation tools, and associated hardware enable multi-mode distance learning options ranging from passive delivery of material to interactive audio-visual sessions. These tools have enabled education institutions to package and deliver a range of programmes, including those traditionally considered as 'must attend' within regulated Certificate of Competency (CoC) courses, thus providing the flexibility that complements the life style of modern seafarers, as well as promoting self-directed and self-paced learning.
These advantages come with challenges such as the extensive efforts required in the development of: content, appropriate facilities, suitable assessment strategies, and channels of communication and feedback. The location and time separation between the instructors and students often hinders effective communication, which can be exacerbated if appropriate support is not arranged in advance with the ship owners and operators for the deployment and continuation of distance delivery programmes. These challenges need careful handling to ensure distance delivery of IMO STCW competence courses becomes a reality.
An example, specific to the Australian context, on the successful delivery of distance learning is the Math-Primer programme developed by the authors that uses modern ICT facilities to prepare students with the necessary background in mathematics irrespective of their location or educational background. This programme has grown in popularity across disciplines, with evidence clearly showing significant improvement of student competence and satisfaction. This paper outlines how the authors effectively used modern ICT to develop and deliver this programme through a blended delivery mode. In addition, lessons learnt in implementing this programme, associated challenges, and possible solutions are also discussed.

**Key words**: assessments, distance learning, IMO STCW competencies, seafarer, web based learning

## 1 INTRODUCTION

In recent years, it is observed that there is a continually growing interest and demand for the distance and/or blended delivery of seafarer qualifications; especially those conforming to the International Convention on Standards of Training, Certification and Watchkeeping (STCW) as stipulated by the International Maritime Organisation (IMO). The push for such options both within the seafaring community and vis-a-vis Maritime Education and Training (MET) institutions is two folds. The first is the economic and time constraints faced by the seafarers and their employers in adhering to the traditional college based education [1]. This is compounded by the limited number of MET institutions available across the world, their geographical locations, and the scheduling of the programme that can make attendance challenging, especially in light of demanding and changing shipping schedules and the scattered global catchment areas for seafarers. Although many MET institutions attempt to accommodate the scheduling of the employers, it is not possible to meet the varying demands from a range of employers each with differing requirements nor is it always possible to marry the needs of the shipping industry with the educational cycles of different jurisdictions. This has created a strong demand for changes and options for the current MET models that can be customized and fit into the working life cycle of seafarers without causing undue disturbance to their or that of their employers' schedules.

The second factor influencing distance delivery is the recent advancements of Information and Communication Technology (ICT) based distance learning methods, which have created platforms that can customise and enhance the delivery of MET programmes beyond the traditional boundaries. The growing use of ICT based blended learning methods and programmes within the wider tertiary educational industry has been one of the drivers motivating MET institutions to adopt them and develop customised delivery options for IMO STCW competency courses.

## 2 FACTORS INFLUENCING DISTANCE LEARNING

The advantages of distance delivery come with associated challenges. Some of these challenges are the extensive efforts required in developing content suitable for distance delivery, arranging appropriate facilities, developing appropriate assessment strategies, and ensuring channels for communication and feedback [2,3,4]. The development of content suitable for distance delivery is a major challenge for MET institutions, as it not only requires significant amount of resource allocation but also a change in the way of thinking about the delivery of material and the attainment of competence. Some of the important factors that must be considered when developing content for distance delivery are:

- targeted competencies and outcomes;
- profiles of the different learning cohorts and their requirements and limitations;
- understanding the impediments to the learning;
- presentation of the learning material to enable the students to attain the required competence, as the structure and format of the material and the methodology of delivering, as it plays an important role in scaffolding the learning to meet the stipulated competencies;
- time and cost of developing the learning resources and the availability and access to the associated systems to deliver them;
- ease of making the resources available to students and available support infrastructure and systems; and
- ease of ongoing access, follow up of lessons and feedback.

Traditionally, most distance learning material consists of course notes, worked examples, and support resources which are in the form of printed material. With the development of ICT, traditional paper based distance learning is being supplemented, and indeed replaced, with electronic based material. An immediate advantage of this shift is the replacement of 'volumes' of hard copies to distant learners with electronic material through vehicles such as the internet, data clouds, or simply on a USB drive, the latter overcoming issues of access by students to the internet. However, blended delivery is more than just sending the material in electronic form, it has to develop methods to enable students to engage and interact with the curriculum to help understand concepts, gain skills, and attain the required competence. The first step is supplementing the electronic notes with relevant audio-visuals and animations to promote engagement and enhance the learning.

The growth and advancement in ICT have made it possible to record lectures, tutorials, and laboratory experiments and make them available to students as media files across a range of formats, something that was not possible with the traditional paper based distance delivery system. However, recording and editing the electronic material to: promote engagement, meet professional standards, enhance learning, and enable easy access is no small task, requiring considerable amount of effort, time, resources, and knowledge to achieve the objectives. Badly made and unsuitable material and tools may drive students away, rather than promote learning. On average, each lesson requires extensive preparation by the facilitator, including the design, recording and editing of the audio-visual material to eliminate mistakes, target outcomes, and importantly make it interesting and engaging. This may require the use of professional technical staff, such as cameramen and audio-visual technicians, to ensure that the recordings are at the right quality and standard. This unfortunately can result in an upward spiral in cost and time, making the programme unviable. Thus, it is important to work out a balance on what can be achieved, carrying out a cost-benefit analysis that will provide the required outcomes within the available resources and time frame. Although compromise is important to achieve this, developers and managers must never lose focus on the outcomes and how they can be achieved. Thus, it is important to return to the factors that should be considered when developing content for distance delivery, identified at the beginning of this section.

In addition to the content development, arranging necessary facilities such as ICT infrastructure and systems, and staff training are other challenge faced by MET institutions. The latter can be across a number of areas, such as the use of ICT equipment, developing curriculum and material for blended delivery and assessment, managing distance programmes, etc. Many embark on the development process without the required skills and resources, which unfortunately results in substandard programmes that fail to meet stakeholder requirements and in the worst case abandonment.

Delivery of material is one aspect of a distance programme, as it has to be matched by assessments. Academic staff must develop appropriate assessment strategies that would reflect the true level of achievement of intended learning outcomes to ensure that the students have attained the required competence [1, 2]. The traditional approach of giving assessments to students and evaluating their submissions may not be optimal for blended delivery and assessment. While this gives an overall indication of students achievements, improvements can be made through web based tests and interactive assessment techniques [4]. Other issues that need consideration when developing assessment material and strategies include: ability for the student cohort to complete the tasks, feedback methods and timing, plagiarism, frequency, links to learning, suitability and link to learning outcomes and competencies, availability, equity, regulations, etc.

The location and time separation between the instructors and students often hinders effective communication, which can be exacerbated if appropriate support is not arranged in advance with the ship owners and operators for the deployment and continuation of distance delivery programs [5]. Therefore, creating and maintaining appropriate communication channels that suit both instructors and students are essential for the successful delivery of IMO STCW competency courses online [5, 6].

From the seafarer's point of view the successful receiving of the intended learning outcomes heavily depends on:

– how well the materials are packaged and presented;
– whether the seafarer has the required minimum educational background, knowledge, and skills to engage with and gain from the programme;
– availability of time to study while working onboard, or on rostered leave (which requires support and understanding from the employer and senior staff); and
– support from the MET institution, including availability of a facilitator/instructor, online assistance, quick turnaround, and feedback.

## 3 DISTANCE LEARNING REQUIREMENT AT AMC

The Australian Maritime College (AMC), an institution of the University of Tasmania, offers a wide range of maritime educational and training programmes ranging from certificates to post graduate degrees across a wide spectrum of maritime fields coupled with innovative and adaptive attitude which is in many ways is unique to the Australian Mariner, to differentiate themselves from the world market [7]. The Bachelor of Applied Science (Marine Engineering) provides marine engineers on ocean going ships training pathways from pre-sea to management level Certificates of Competency. It is structured to meet the requirements of new entrants to the industry as well as existing seafarers wishing to upgrade their marine engineering qualifications. Two exit points allow students to return to sea after completing their operational and management level qualifications. The two entry pathways to the programme are shown in Figure 1.

Entry requirements for grade 12 school leavers ensure that new entrants through this pathway meet the minimum mathematics requirement as stipulated by the AMC, that they are able to cope with academic content within the programme. However, students who have completed non-marine trade studies (usually through an apprenticeship that usually has very little academic, and specifically mathematical, content) are also admitted and are granted advanced standing in a number of practically oriented modules. However, a major challenge faced by them (and the instructors) is to successfully complete units within the degree pro-

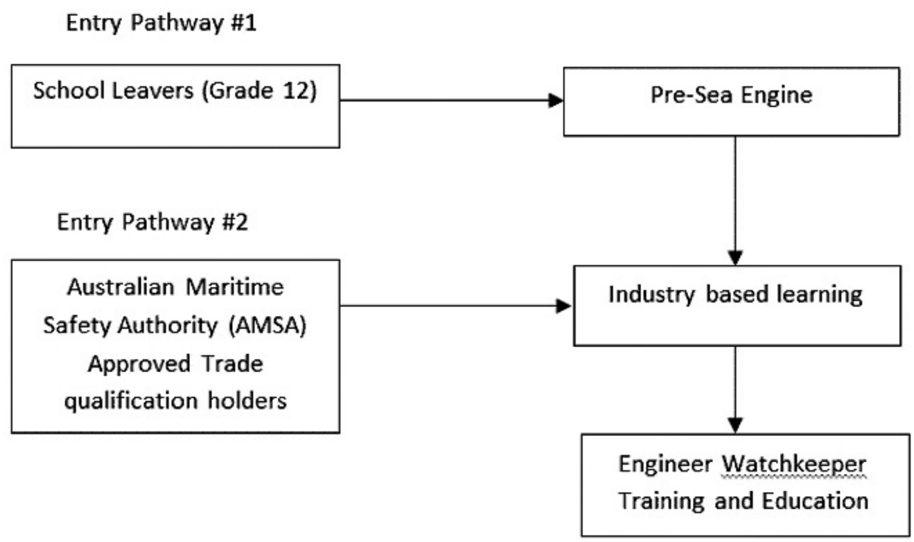


**Figure 1** Entry pathways for the Bachelor of Applied Science (Marine Engineering) stream at AMC

gramme that require a reasonable background in mathematics and science. This is compounded as students from both pathways sit in the same class with significantly different mathematical capability, presenting both the staff and the students with a number of challenges to engage with the content and achieve the required competence in a relatively short time span dictated by industry schedules.

In an attempt to assist these students a number of approaches were employed for several years with a relatively low rate of success. These included providing students having lower than required mathematical knowledge with: additional classes, peer assistance, improved learner's guides, remedial tutorials, etc. However, it was clear from a number of student interviews and information sessions with focus groups that these actions were retrospective; addressing the issues after students commenced their study rather than providing them with the necessary knowledge and skills for success at the commencement of the programme.

In order to address this issue, students with lower than required mathematical knowledge were advised to undertake a Mathematics Foundation units [8], provided by the University of Tasmania and delivered online. Thus, theoretically they could access and complete the programme while at sea completing their 'industry based learning' phase shown in Figure 1. This foundation course delivered through video recorded lectures made available through a web portal. Students were also provided learning material with embedded assessments.

However, this option did not provide an acceptable and convenient solution for most of the students as there were issues related to: difficulties in accessing material on the web especially large video files, inability to access the web at the required times for question and feedback while serving at sea, limited internet availability on some ships, differences between employers and employees linked to study time on ships, and inability to obtain support when required.

Further investigations into the requirements of the student cohorts, again through interviews and focus group sessions revealed that the students did not engage effectively with a distance delivery approach for mathematics or science consisting of learning from text books or watching recorded class room lectures. They also wanted the information in 'bite-size chunks' that the recorded lecture in the foundation units was unable, to facilitate. They required short, focused, and clear delivery of information using relevant and simple audio-video presentations that reinforces the key concepts and provides understanding of the processes that many found difficult to relate and remember.

## 4 MATHEMATICS PRIMER

With the abovementioned finding in mind, a blended delivery approach was developed for the delivery of mathematics for marine engineering students requiring to build basic mathematical concepts prior to, and during, their Certificate of Competency (CoC) courses, which was titled 'Mathematics Primer'. The first step was to identify the areas of mathematics that needed addressing. By reviewing the past formative and summative assessment results, areas within the mathematics curriculum that affected units requiring prior mathematical knowledge it was possible to identify 'critical gaps' that prevented students attaining the required competence. This was triangulated using a series of interviews with past, present, and incoming students as well as instructors, educational developers, and employers. Once the gaps were confirmed, a structure was developed taking into consideration the student requirements, constraints, and available technology to deliver the required content and competencies.

The first step was the development of a mathematics learner's guide to explain the basic concepts in simple details, with the areas of the curriculum broken into smaller manageable sections (i.e. the required bite-size chunks), sufficient examples and detailed logical processes. Using this learner's guide as a structural guide, separate audio-visual recordings were made for each section using a document camera. These recordings provided students guidance on progressing through the different concepts and problems, clearly describing the approach and process. Used together with the learner's guide students are able to focus on specific concepts and gradually develop their knowledge and skills to solve problems. During the preparation for recording, special care was taken to make sure that the recordings were short, focused on the subject matter, and presented in a simple format and language.

The Mathematics Primer programme commonly referred to as Maths Primer comprises of the learner's guide, linked work book, and 22 media files with a total media file time of about 8 hours. All of the above material was made available to students as electronic files copied onto a USB drive, thus addressing the issue of the unavailability or limited availability of internet onboard ships. The work book is provided with answers for all examples and tutorials except for the final assessment, which the students are expected to attempt and submit to the facilitator/instructor for marking enabling AMC and the students to determine their mathematical level at the end of the programme.

Students were instructed to follow the lessons in the learner's guide in conjunction with the relevant media files. The instructors in the media files take the students logically and systematically through the concepts and exercises in the learner's guide book providing a substitute to that the students would have experienced in a traditional a class room situation. There are sufficient worked examples which help students understand the concepts and practice them to gain familiarisation. A drawback to this approach is the absence of interaction with the teacher that would have been present in a real class room situation. On the positive side, the students can replay a media clip or a portion of it, any number of times until they grasp the

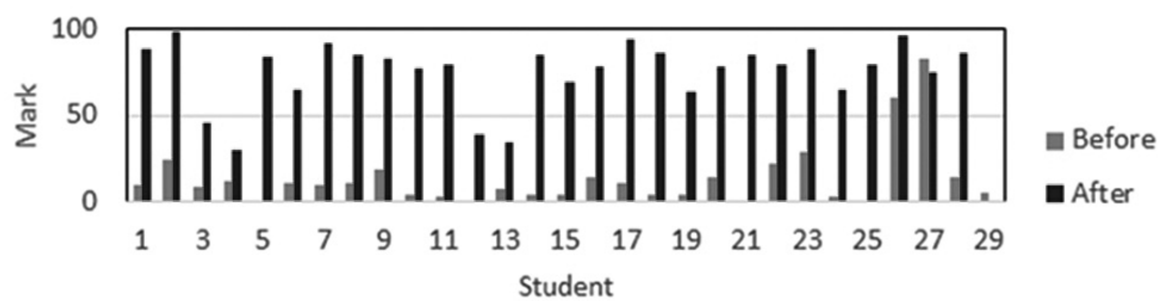


**Figure 2** Marks obtained by students in the mathematics tests before and after completing the Maths Primer programme

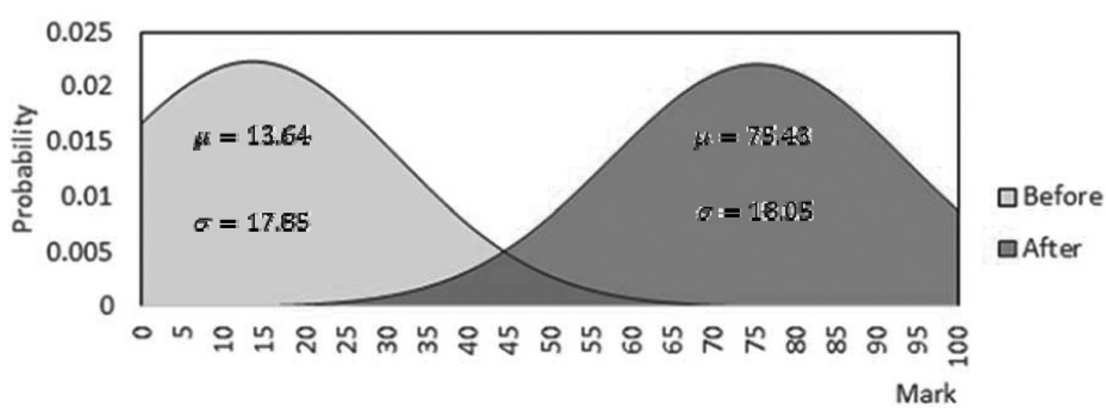


**Figure 3** Probability density functions derived from the mathematics marks obtained by students before and after completing the Maths Primer programme

concepts. Tutorials were also conducted in a similar manner. The students learn at their own pace and time, which is not always the case in a class room lecture, where they are compelled to follow at the pace of the lecture. It is evident from student feedback that this has been a strong reason for students to accept and embrace this mode of learning.

The effectiveness of the Maths Primer programme launched in January 2014 was examined by pre and post testing of a cohort of marine engineer watchkeeper students. All students of the cohort were given a pre-test, i.e. a mathematical test before embarking on their studies. They were then given the Maths Primer package and one week of self-study. At the end of the mathematics self-study programme the students were again tested, i.e. the post programme test. The results from the two tests for each student who followed the Maths Primer programme are shown in Figure 2, which shows that there is a significant improvement in students' performance after taking the Maths Primer course.

In order to analyse the results further, the normal distribution of the two sets of results were obtained and plotted as shown in Figure 3.

The statistical parameters mean (μ) and standard deviation (σ) of the two distributions are also shown in the same figure. There is a 5.5 times increase in the class average mark, which show a significant improvement in the students' mathematical knowledge after taking the Maths primer course. Another important point to note is that the standard deviation of the two distributions, in other words the spread of marks, doesn't show a significant change. This can be interpreted as an overall improvement in the mathematics knowledge in the class and that it has affected every student in a similar way.

Following the positive results from the delivery of Maths Primer in early 2014 its delivery has continued throughout the year, with student satisfaction recorded at 83% amongst marine engineering students, much higher than comparative class room delivered programmes. It has subsequently been extended to students following navigation courses by developing a 'Navigator's Maths Primer' targeting their specific requirements. Navigators' Maths Primer recorded a high satisfaction rate of 85%. The followings are extracts from the feedback received in surveys designed to test the effectiveness of the programme:

"Challenging… rewarding… refreshed past knowledge… good introduction… like having a private tutor… broadened understanding… liked the self-pace approach…encourage students to take a copy on-board as it will help us in work… helped background math and improved understanding… easy to follow."

In addition, 98% of the students recommended that the Maths Primer programme be given to all the students joining seafaring courses at AMC.

Presently the students who wish to join AMC for marine engineer watchkeeper CoC courses are encouraged to undertake an aptitude test available on the website. Students faring below a designated threshold in this test are required to complete the Maths Primer before joining the marine engineer watchkeeper programme, thus providing them with the required knowledge to confidently take on the academic rigors of the course.

## 5 FURTHER DEVELOPMENTS IN DISTANCE LEARNING

The success of Maths Primer programme has encouraged the authors to develop the Marine Mathematics unit, an integral part of the marine engineer watchkeeper CoC to be offered as a distance delivery unit. The unit is currently undergoing a pilot delivery programme that will provide further information on the suitability of method and required improvements. Further the preparations are underway to develop a related unit within the same course, i.e. Theoretical Marine Engineering, which will follow a similar delivery pattern. Currently the materials including the audio-visual are being prepared. An important lesson learnt from this work is that once the delivery format has been developed and the content identified based on the required competencies, outcomes, and a gap analysis, the development of the material should start with a learner's guide that suits the targeted audience and meets their expectations and capabilities.. Experience in the seafaring industry shows that this should be done in bite-size chunks, with simple explanations, and problems and examples solved in logically and systematically. Modern ICT equipment such as document cameras, video capture and editing equipment, and animations provide the developer with a range of options to create a student friendly learning environment, although staff will need training and patience to master their use, remembering such equipment offers the advantage of 'repetition until perfection'. Some equipment and systems may also need expert intervention to ensure quality and effectiveness.

## 6 CONCLUSION

The paper describes the use of modern ICT equipment to develop distance delivery options to transfer technical and academic content to seafarers through blended delivery programmes, enabling them to engage positively and attain the required competence. A pilot project in pre course mathematics was analysed with student feedback and achievements clearly showing significant improvement in the knowledge.

As the technology advances and the cost of recording devices and associated software drops, it is a matter of time before quality media clips can be produced by lecturers without incurring very high costs or effort. The advantage with the use of ICT equipment such as document cameras are that they can capture animations, power point slides, white board information, and real life demonstrations all at the same time without much cost. With such technology at our fingertips, it is inevitable that future students will move further away from traditional face-to-face contact time in MET institutions. Although the latter will yet remain a part of the training, blended training options utilising innovative techniques and modern technology will increase and possibly form the core of the training in the future.

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# ENVIRONMENTAL LIFE-CYCLE COSTING IN MARITIME TRANSPORT

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**Abstract.** The conventional life-cycle costing (LCC) is based on four categories to be assessed e.g. investment, operation, maintenance and end-of-life disposal expenses, while the environmental LCC method takes into account above mentioned cost also the external environmental costs. Given that maritime operations contribute substantially to global warming and air pollution, the paper analyses the concepts of environmental life-cycle costing and externalities with particular reference to transport sector, reviews the possibilities of environmental LCC application to maritime transport sector, and considers the role of public procurement in environmental issues. Evaluation is made of the sources of law at the European Union level, as well as of the environmentally conscious commitments of the maritime industry. The authors are advocating clean and energy-efficient maritime transport and comprehensive evaluation of environmental LCC aimed at ensuring effective implementation of environmental policy objectives and targets.

**Key words**: maritime transport, life-cycle costing, environmental engineering, environmental externalities, legal framework

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## 1 INTRODUCTION

Despite an increasing awareness for policy intervention in maritime transport, a comprehensive framework for environmental life cycle costing is still incomplete. Transportation sector exerts significant environmental impact. Although a number of rules and regulations have been imposed with the objective of reducing environmental impacts from ships, no systematic cradle to grave analysis has been performed for the maritime transportation sector to provide a total view on which policy development and research and development priorities can be based [1].

Throughout the paper the authors often refer to public procurement principles as it is obvious that public authorities and entities should pioneer the way for purchases of products, works and services which are least harmful for natural ecosystems, the people and the climate. Namely, because funding is limited, designers and facilities managers are traditionally focused on minimizing the initial cost. Unfortunately, this practice often has produced inefficient, short-lived structures with unnecessarily high operation and maintenance costs [2]. On the other hand, private sector is directly stimulated to reduce whole life-cycle costs, however with the tendency to externalize mainly the environmental and health costs to the society.

## 2 THE CONCEPT OF ENVIRONMENTAL LIFE-CYCLE COSTING

Environmental life cycle costing (LCC) summarizes all costs associated with the life cycle of a product that are directly covered by one or more of the actors in that life cycle (e.g. supplier, producer, user or consumer), and those involved at the end of life. Externalities that are expected to be internalized in the decision-relevant future comprise real money flows as well, and they must also be included. A complementary life cycle assessment (LCA) with equivalent system boundaries and functional units is also required. LCC cannot be approximated by the market price as the price reflects only costs from the cradle to the point of sale. Also, LCC is an assessment method, not an economic cost-accounting method [3].

The costs in LCC framework will differ from the perspective of the producer, consumer and NGO, see table 1.

Therefore, any product system will be looked upon in a different manner by: a consumer deciding on a new product, e.g. ship, a manufacturer deciding on the next generation design, or a public official deciding on transport policy (infrastructure costs, land use, employment, health impacts of pollution, leakage, noise, accidents, and other externalities).

Environmental impacts that are excluded from the financial transaction can become zones of conflict. Determining the system boundary that defines that is “in” and what is “out” becomes the central question of the analysis, and the answer evolves over time [3].

Therefore, assessing the real costs of purchase means calculating the total cost of an asset, from the point of purchase right through to the use phase and including the end-of-life costs. Unfortunately, at least in public sector, organisations are still faced with budgets which prioritise upfront purchase price over longer-term costs, and which may ignore social or environmental costs altogether. These problems can be exacerbated if one organisation purchases a product, service or work but another is responsible for its operation, maintenance and disposal. Such a scenario presents the so called ‘split incentive’ problem [4]. On the other hand, the development and application of LCC was stimulated by the US Department of Defence which mainly controls the entire life cycle of an aircraft or special vehicle. LCC has moved from defence systems to industrial and consumer product areas, where each user controls only a portion of the actual life cycle of the system [5].

The 2014 EU public procurement directives[1] specify that following costs may be taken into account in environmental LCC, whether they are borne by the contracting authority or other users [4]: (a) costs relating to acquisition, (b) costs of use, such as consumption of energy and other resources, (c) maintenance costs, (d) end of life costs, such as collection and recycling costs, and (e) costs imputed to environmental externalities linked to the product, service or work during its life cycle if their monetary value can be determined and verified, see Figure 1.

External costs may come from LCA analyses which assess the environmental impacts, such as greenhouse gas emissions, over the life cycle [4, 7].

LCA-method has only been used to a limited extent for sea-borne transportation means and confined to parts of the product chain and for a limited part of the system [1]. While environmental LCA has been in use since the 1960s and later standardized [11], environmental LCC is drawing on a long history of conventional LCC dating back as early as the 1930s, but is nevertheless a new tool within sustainability assessment as no standardized methods exist, but rather a range of different approaches [12].

LCC can play a role in public and private procurement and may be used to measure the profitability of

[1] 2014/23/EU (the Concessions Directive) [8], 2014/24/EU (the Public Sector Directive) [9] and 2014/25/EU (the Utilities Sector Directive) [10] – hereafter simply referred to as the 2014 Directives.

**Table 1** An example of life cycle cost categories framework from the perspective of different actors [3]

| | Perspective | | |
|---|---|---|---|
| **Life stage** | **Producer** | **Consumer** | **Society** |
| Research and development | Market research<br>Test equipment<br>Wages, salaries, benefits<br>Subscription to technical databases | School taxes | Public education buildings<br>Investment subsidies |
| Component/product manufacture | Materials<br>Energy<br>Capital equipment<br>Facility O&M<br>Logistics<br>Wage, salaries, benefits | Taxes<br>Health insurance | Waste treatment<br>Water treatment<br>Health impacts<br>Brownfield remediation<br>Infrastructure |
| Use | Distribution & logistics<br>Warranty<br>Consumer support services | Taxes<br>Transportation<br>Consumables<br>Energy<br>Maintenance and repair | Waste disposal<br>Pollution<br>Health impacts<br>Infrastructure |
| End of life | Take-back program | Disposal fees<br>Recycling deposit | Recovery and disposal<br>Pollution and remediation<br>Landfill development, closure<br>Health impacts |

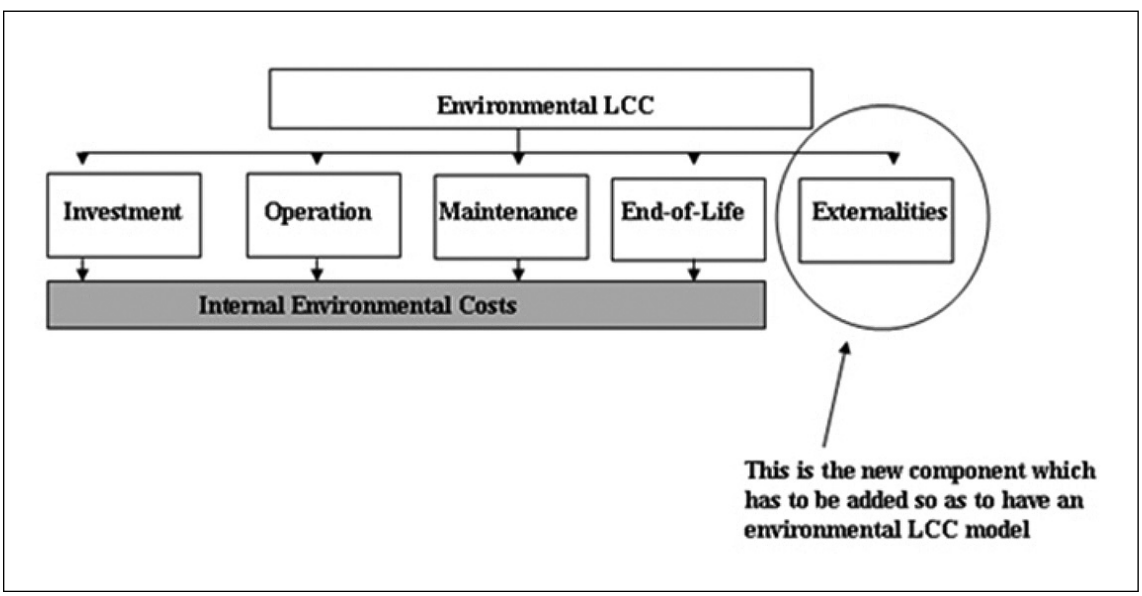


**Figure 1** Environmental LCC structure [7]

environmentally adapted choices [12]. A relatively simple formula for calculating life-cycle cost used by US Forest Service [2] should in authors' opinion be extended by one more addendum, i.e. the externalities.

$$LCC = I + Repl - Res + E + W + OM\&R + O + Ext \quad (1)$$

where LCC is the total life-cycle cost in present value (PV) dollars of a given alternative, I is initial cost, Repl is capital replacement cost (PV), Res is residual value (PV-resale value, salvage value) less disposal costs, L is desired useful life in years of the building or system, E is total energy cost (PV), W i total water costs (PV), OM&R is total operating, maintenance, and repair costs (PV), O is total other costs, if any, e.g. contract administration costs, and Ext is externalities.

## 3 EXTERNALITIES

Effective business practice requires clear definition of what is to be included in a financial transaction. Few could commit money to a poorly defined and open-ended obligation. But clear definition of what is included also means certain effects of the transaction are purposely excluded. These ignored costs, or "externalities", are imposed on the broader society. Noise, tire wear, and tailpipe emissions along those same roads impose costs on society for health effects and environmental damage. Ignored effects can become lost opportunities for new markets or future financial liabilities or regulatory costs imposed on the business. LCC can also be used as a tool for social decision support. A prime example is the discussions on the cost of nuclear energy, which extend into the future well beyond the operating time of the facility [3].

Externalities can be more or less established in the society as: (a) those that are already paid by someone along the value chain and are not included in the market transaction, for example municipal waste disposal, health costs, increased safety features of a product beneficial for the society (e.g. pedestrian protection), job security, and benefits of improved infrastructure for society, (b) those that can be monetized, are not intentionally paid, benefited, or gained by someone, and are not included in the market transaction (e.g. impacts from $CO_2$ emissions), (c) those that can be monetized, are intentionally benefited by an actor, and are not included in market transaction (e.g. free rider), and (d) those that are difficult to monetize (e.g. the aesthetic value of a species or product, or wellness) [13].

## 4 TRANSPORT SECTOR

Transport has a wide-ranging impact on the environment ranging from operational pollution, land-use, congestion and the risks inherent to the transport of dangerous goods. The measures should pursue the reduction of transport intensity and emission, reduction of land use, and the choice of carrier under considerations of sustainable aspects [14]. An integrated transportation and land use life-cycle assessment (LCA) framework [15] should also be a useful instrument and basis for environmental LCC.

European legislation requires the tailpipe emissions of $CO_2$ to be measured during the type approval procedures for new vehicles. This approach, known as tank to wheel (TTW) only counts the $CO_2$ emissions produced when fuel is burned by the vehicle engine. This however is a poor indicator of climate impact as much of that impact actually occurs during the production of the fuel – especially for alternative vehicle fuels. This is obvious in the case of electric and hydrogen vehicles which don't have tailpipe emissions. For these fuels the climate imp act occurs when the electricity or hydrogen is produced. If the electricity used to run the car is generated from coal or natural gas power stations the overall climate impact of the vehicle will still be high. If the electricity is generated from renewable sources, such as wind, solar or hydro power, then the overall impact may be close to zero. For biofuels like ethanol or biogas the $CO_2$ emitted from the tailpipe is actually the same $CO_2$ which was absorbed from the atmosphere when the plant was growing. Theoretically biofuels can therefore be climate neutral. However, energy is required to produce the fuel, and other emissions such as methane can be released during production – these factors must also be considered when assessing climate impact. A comprehensive assessment of vehicle climate impact needs therefore to consider both fuel consumption and the climate performance of the fuel used – this approach is known as well to wheel (WTW) [16].

Transport sector must take part in the effort to limit its impact on the environment by suggesting improvements in the design of the materials used but also the organisation of transport itself [17]. In authors' opinion, environmental aspects should be considered in three major areas: transport means (vehicles, ships, etc.), construction of infrastructure (with particular reference to land use) and also logistics services provided in supplying the goods, services and executing the works.

## 5 MARITIME TRANSPORT AND THE ENVIRONMENT

Besides climate change which presents an enormous challenge for shipping sector, sulphur oxides ($SO_x$), nitrogen oxides ($NO_x$) and particulate matter (PM) emissions are typically very high for shipping, especially when no abatement technologies are applied. Today shipping accounts for about a quarter of the world's $NO_x$ emissions, which causes smog and contributes to global warming [18]. Moreover, $NO_x$ lead to eutrophication (over-fertilisation), which negatively affects biodiversity both on land and in coastal waters. The shipping emissions are growing significantly as the marine transportation increases. Emissions of $SO_2$ and $NO_x$ furthermore cause acidification of soil and water [19]. The share of shipping in environmental impact is also through routine or accidental water pollution, noise emissions, as well as underwater noise and collisions with marine mammals, ballast water exchanges affecting the maritime environment, release of biocides from antifouling paints, oil spills, waste and sewage handling, hazardous materials released in ship scrapping [18], and also soil and sediment contamination, erosion, biodiversity loss and habitat degradation from port activities [20]. Various IMO regulations address some of these issues, but with the shipping industry continuing to be absent from international climate conventions, greenhouse gases can be considered the least regulated area [21].

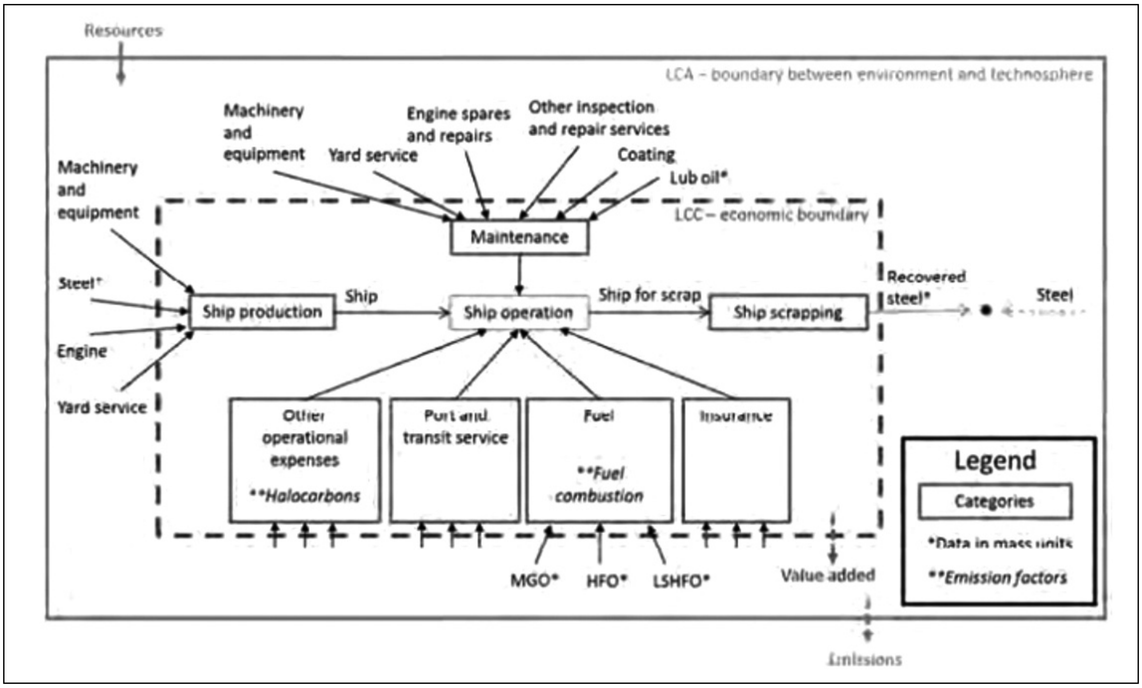


**Figure 2** Cash flows allocated to life cycle stages and categories for medium range tanker ship [21]

Figure 2 shows how cash flows were allocated to life cycle stages and categories as well as the economic boundaries for LCC and LCA from the study of a medium range tanker ship by Kjaer et al. [21] which in presenting the costs and environmental burden alongside each other shows where there are potential misalignments between the two and where there is a risk of external costs (e.g. pollution from fuel combustion) being internalized in the future (e.g. through taxes). For example, in the case study, fuel accounts for 89% of the $CO_{2e}$ but only 36% of the cost. Life cycle management of the ship itself is elaborated in [22] and life cycle of ship structure [23]. LCC and sustainability in fishing fleet is studied in [6].

An important benefit with ship transportation is the limited need for land areas. Methods to calculate the land use requirements for ship transportation and the pollution contribution from ports should be established. Furthermore, methods have to be developed to allocate the environmental impact of port activities to ship transportation. The scrapping phase has to be addressed as well. These problems are important to address to enable consistent comparison of alternative transportation modes [1]. The advantages of short sea shipping compared to road transport and integral environmental effect of shipping are analysed in [18].

Available research on sustainable procurement intensively focuses on international product suppliers and less on service suppliers such as logistics services providers. However, in addition to their well-known economic role, logistics processes have a strong impact on the environment (e.g. transportation-induced greenhouse gas emissions, noise and land consumption) and social issues (e.g. transport safety and physically draining occupations) [24].

## 6 PUBLIC PROCUREMENT

Sustainable public procurement can have a role in indirectly stimulating social and environmental benefits through exerting pressure on suppliers to reduce their own impacts [25]. In fact, LCC was developed and standardized in the United States after World War II to support public procurement [3].

As mentioned hereinabove, Article 68 of Directive 2014/24/EU enshrines a concept which did not exist in Directive 2004/18/EC, namely life-cycle costing (LCC). The aim is to send a political signal to public purchasers. This is clearly a powerful lever to change the production and consumption habits of public authorities [26]. Social protection and employment promotion have not been included in the calculation of the life-cycle cost [27].

The EU public procurement directives enable authorities and operators that have already developed appropriate methods in environmental LCC to continue improving this procedure.

## 7 DISCUSSION

The success of LCC is dependent on its scope (meaning the inclusion of environmental externalities or/and other externalities) and the methodology used (which in many cases is incomplete and based on experts' perceptions, not on hard scientific evidence) [25].

The use of LCC is often limited to quantifying the monetary value of selected costs. Moreover, purchasers tend not to be able to use LCC to inform bigger, more strategically advantageous decisions. Despite being aware of the benefits of procuring LCC cost-effective assets, procurers will continue to face the high capital outlay dilemma, and give way to selecting „best value for money at the time of purchase“ unless there is a express mandate for them to do otherwise [28].

There is no standard definition of environmental costs and environmental cost savings. Also, it may be difficult to determine the discount rates and the time horizon for discounting. In economic analyses it is often assumed that a given benefit or cost has a higher value now than in the future. For environmentalists, however, the discount value is zero [29]. An example may be that acidification is weighted less and less into the future, which means that if discounting occurs, the less important the losses due to acidification will be. Thus, discounting gives a bias against future generations and may seem inconsistent with sustainability [5].

From a social perspective, failure to consider all feasible options for transport effectively locks in the current system and supports the continued externalizing of environmental and social impacts. The goal of LCC is to better understand these costs in order to promote more sustainable practices [3].

## 8 CONCLUSION

Clean and energy-efficient transport initially has a higher price than conventional one. With pricing being the most widely used standard in comparing various alternatives for making investment decisions, environmental life cycle costing provides a viable framework for including all other costs which are incurred throughout life cycle of a product, service or works. A lot of interdisciplinary effort is still needed to fully integrate environmental aspect in the LCC instrument, in particular in the shipping industry characterized by long term investments, very sensitive to fuel prices, and capital intensive with regard to purchasing, operating and building the ships, marine equipment and port infrastructure. The challenge is to devise simple and sound calculator of externalities and here the role of policy makers in standardizing the approaches to LCC.

In project preparation stage an analysis of various possible alternatives should be carried out using environmental LCC which integrates numerous known impacts on the ecosystems, health, natural resources, the climate, as well as social aspects.

Public authorities and entities, being important actors in placing maritime contracts, particularly the concessions for shipping services as well as port infrastructure and services, can play an important role in fostering the inclusion of environmental externalities in calculation of LCC. In authors' opinion, the Directives on public procurement are a significant initial upgrade in the legal framework of harmonizing transport environmental awareness criteria at the European Union level.

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# BWM CONVENTION 2004 – NEW CHALLENGES FOR MET INSTITUTIONS

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**Abstract.** The International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM Convention) is expected to enter into force within next five years. Despite significant efforts paid meanwhile a number of measures and requirements are still not clearly defined as they should be for a proper interpretation and full implementation.

The most prominent "grey areas" yet to be resolved include actions in case of "polluted" ballast water or a malfunctioning treatment system on board, actions in case of early warnings declared by the destination port, sampling techniques and port state control procedures, sediment management, risk assessment and intra-regional voyages, more stringent standards that was or may be implemented by certain countries, costs and legal responsibilities in certain cases, etc.

It is quite clear that for efficient ballast water management and proper implementation of new requirements ships' crews need additional competencies. These competencies and related knowledge, understandings and proficiencies still have to be defined, eventually to be included into the STCW Convention. Moreover, it is recognized that seafarers, more than often, are not aware of risks the harmful aquatic organisms or pathogens (HAOP) and nonindigenous species (NIS) pose to environment. Consequently, learning outcomes dealing with the subject and associated learning modes designed to effectively and rather quickly ensure appropriate level of knowledge and training still have to be identified.

In the paper the findings and challenges related to ballast water management training are discussed. Particular emphasize is paid to programs delivered at higher MET institutions for seafarers with management responsibilities

Main findings and outcomes are based on the research and results of the Ballast Water Management System for Adriatic Sea Protection project (BALMAS) [3,5,6]. BALMAS project, worth approximately 7 million Euros, is financed by the EU AdriaticIPA Cross Border Cooperation 2007-2013 program. It involves 17 different beneficiaries (ministries, governmental and scientific institutes, universities, foundations and maritime associations) from 6 partner countries (Italy, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro and Albania).

The project integrates all activities aiming to ensure sound implementation of the BWM Convention measures in the Adriatic Sea. The main objective is to establish a common cross-border system linking all Adriatic research, experts and national responsible authorities to avoid the introduction of HAOP or NIS organisms into Adriatic Sea, through the control and management of ships' ballast water and sediments. The Faculty of Maritime Studies Rijeka is currently involved as project external expert institution.

**Key words:** ballast water management, ballast water and sediments, maritime education and training, Adriatic Sea.

## 1 INTRODUCTION

Processes and procedures related to ballast water management are operational in shipping for a while. They are defined mostly in the BWM Convention [2] and associated regulations and guidelines. Although the Convention is not in force yet, a number of requirements and standards are already implemented worldwide, sometimes significantly different in different regions or by different national authorities. Countries like Australia, Brazil, Canada, Norway, Ukraine, USA have already implemented national regulations related to ballast water management.

Sufficient number of ratification instruments is expected to be soon collected. According to the IMO database [18], the BWM Convention presently has 44 signatories representing 32.86% of the world fleet tonnage (June 2015). Since, some of the countries have confirmed that ratification process is in progress (Argentina, Indonesia, Philippines, Belgium and Finland) it seems that the required percentage of the world tonnage (35%) could be reached in 2015 or more probably in 2016.

Proper implementation of the BWM Convention requirements are still under continuous consideration among stakeholders and it seems as a quite challengeable process. Several well-known "grey areas" are still not clearly answered, such as sediment management, risk assessment, sampling techniques and port state control procedures, proper control mechanisms, equipment installation, intra-regional voyages, legal issues related to responsibilities, etc. Up to now, it seems that the most important area tackled is development of the shipboard equipment capable to perform as required by the Convention. The area next to the one mentioned where significant efforts that have been paid in development of the national legal frameworks and strategies on ballast water management.

On the other hand, one of the very key issues for the proper implementation of the new requirements is up-to-date education and training of persons operating and maintaining equipment to be installed. Beside ships' crews a wide range of shore-based personnel directly or indirectly involved with ships' operations also need to be informed and/or trained.

The BWM Convention provide various technical and procedural provisions related to control of the transfer of Harmful Aquatic Organisms and Pathogens (HAOP) through ships' ballast water and sediments but not clear and usable education nor training requirements to assist and support stakeholders in the implementation.

The training requirements are presented very generally. The Article 13 of the Convention is the only article where training is explicitly mentioned. And even there it is only an option for countries requesting technical assistance from the IMO or other international bodies "to train personnel". In addition, the Guidelines for the control and management of ships' ballast water to minimize the transfer of harmful aquatic organisms and pathogens (IMO Resolution A.868(20)) in Chapter 6 provide more detailed instruction on BWM training and education for ships' master and crews. According to the guidelines, marine training organizations should include in their study programmes the following content:

– instructions on the application of processes and procedures concerning ballast water and sediment management,
– application of treatment procedures,
– knowledge of duties regarding the control of pollution of the sea by HAOP.

Aforementioned training requirements could be considered as not mandatory because the guidelines "should be viewed as a tool which, if correctly applied, will help to minimize the risks associated with ballast water discharge". Training on BWM has not been visibly implemented in the STCW Convention [14] so appropriate competencies and related knowledge, understandings and proficiencies of the ships' crews related to BWM are still not clearly identified.

Furthermore, the implementation of the BWM procedures requires adequate knowledge on the topic by shore-based personnel involved in BWM planning and implementation. These personnel consist of, but are not limited only to, stakeholders involved with ship operations such as employees of maritime administrations, ports, shipyards, shipping companies, classification societies, marine laboratories or different ship inspectors.

Following aforesaid, it can be stated that effective implementation of the BWM Convention provisions, once it enters into force, need to be followed with adequate and appropriate training on BWM procedures.

Consequently, the main goals of the article are to provide picture on issues related to BWM training developing processes and challenges which MET institutions will face. Also, the training requirements for the personnel employed by different stakeholders are discussed.

## 2 BWM TRAINING – CURRENT STATUS

Introduction of harmful organisms and pathogens by ballast water has been considered as one of the major threat to marine environment, marine resources and human health [4]. Training on ballast water management measures and procedures can be considered as one of several education streams required in the future in order to ensure the proper level of marine environmental protection.

Education and training on environmental issues, most notably the prevention of pollution from ships, is partially regulated in the STCW Convention. The STCW Code, as a part of the function "Controlling the operation of a ship and care for persons on board at the operational level", contain among other competences the following: "to ensure compliance with prevention pollution requirements". In addition, the competence "Monitor and control compliance with legislative requirements and measures to ensure safety of life at sea, security and the protection of the marine environment" describes the function at the management level related to marine environment protection; at the supporting level the relevant requirements are included in the competence "Apply precautions and contribute to the prevention of pollution of the marine environment".

Provisions of the Chapter VIII on protection of marine environment require crew members to take all possible precautions to prevent accidental pollution of the marine environment, particularly within the framework of relevant international and port regulations.

In addition, the minimum standards in personal safety and social responsibilities (as a part of the Basic training course), include the competence „Take precautions to prevent pollution of the marine environment".

Following STCW requirements on marine environment protection, the IMO Model Course on Basic training in Marine Environmental Awareness has been developed [Model Course 1.38]. The Model Course is designed for masters, senior officers and officers in charge of a navigational or an engineering watch and in Part 8 "Introduction of invasive species" outline teaching objectives related to transfer of invasive species via ballast water and possible influence to marine environment and associated pollution prevention measures. Teaching syllabus recommends for lectures, including video presentations, only one hour.

As it is already noticed, provisions of the BWM Convention neither STCW Convention do not unequivocally require training for non-crew personnel. However, the IMO Marine Environment Protection Committee (MEPC) has adopted list of Guidelines (G1 - G14) with a main purpose to provide standardized implementation of different provisions of the Convention. Training is required for the following personnel:

- ships' masters and crews (G4 and G6),
- personnel in charge of and those employed in the provision of a ballast water and sediment reception facility including the treatment and disposal of ballast water and sediment (G1 and G5),

Training for ships' masters and crews should cover topics on the requirements of the BWM Convention, the ballast water and sediment management procedures and the Ballast Water Record Book as well as topics on the safety issues associated with the ballast water exchange procedures. Training should follow information from the relevant guideline.

Training for personnel of the reception facility should be organized internally and delivered by competent and skilled professionals.

It should be also mentioned trainings on ballast water management which are developed and implemented by the GEF-UNDP-IMO GloBallast Partnerships Programme throughout GloBallast Partnerships Projects for the period 2007-2016 [17].

According to the project objectives several training activities have been undertaken. Introductory and more advanced training packages have been developed and dedicated to agencies, port and shipping personnel as well as to those responsible to develop national and regional legislation, enforcement and compliance monitoring.

In addition, the GloBallast Partnerships Programme created a dynamic e-learning platform on operational aspects of the ballast water management accessible through a web-based learning portal.

In general, organisation of BWM training and education have been, up to now, much more carried out for various shore-based personnel. Classification societies and various MET institutions already offered different training courses for shore staff mainly for those who are or will be responsible for the BWM Convention implementation, for the shipping companies' personnel as well as for shipyard and port personnel.

It is obvious that there is quite a large gap between presently required marine environmental training and training required by relevant procedures outlined in BWM Convention.

Despite the fact that BWM Convention is not yet mandatory, numerous regional and national mandatory provisions on BWM management already demand appropriate skills and knowledge for responsible personnel. In that respect, beside competencies required from ships' crews, additional competencies have to be required from shore based personnel involved in application of BWM measures, in particular those dealing with control and monitoring measures.

## 3 ISSUES AND CHALLENGES REGARDING BWM TRAINING

The competencies required to efficiently implement the BWM Convention can be broadly divided in two main characteristics: essential competencies required from shipboard personnel and specialized competencies required from shore-based personnel.

Competencies required from shipboard personnel, as it may be assumed for the time being, are mostly those dealing with equipment operations, operational limits and equipment maintenance. Presently, crew members are initially trained during the Basic Environmental Awareness Course. It is more than obvious that recommended duration of training in BWM, according to the Model Course [12] (1 hour) does not satisfy the needs and does not cover quite comprehensive knowledge and skills required, especially knowledge and skills required by crew members with management level responsibilities

Taking into account the fact that presently numerous technical solutions exist (within the BALMAS project 116 different equipment sets have been identified as approved or expected to be approved soon [6]) additional knowledge and understanding is required to cover peculiarities of the set installed (or to be installed) on board. This additional knowledge is expected to be offered through dedicated training courses offered by the companies (so-called "in-house" trainings). So far, due to limited experience with actual equipment, it is not easy to estimate the minimal coverage of this additional training.

The MET institutions, particularly higher MET institutions, have to cope with even more complicated task. They have to offer generalized training providing adequate competences for any possible technology that may be found on-board ships, including ballast water management, treatment procedures and equipment, familiarisation with the regulations, guidelines and reporting procedure.

In both cases the main issues to be resolved are:

- What should be the appropriate duration of the training?
- Should the training be part of the already existing marine environmental protection course or should it be delivered as new standalone course?
- What should be competences of the lecturers and do they need to have additional individual training on BWM management and Convention requirements?
- What should be ratio of theoretical and practical training, if any? What equipment should/may be used?

The most straightforward solution would be development of harmonised training programme, eventually adopted as a Model Course by the IMO. However, for the time being there is no such model course developed and experience of the IAMU members could help a lot in that respect.

Competencies required from shore-based personnel are even more diversified. Training requirements range from very basic (for example, for staff operating shore BW reception facilities) up to highly specialized training (for example, PSCO responsible for control and monitoring procedures or actions in case of a breach of rules). In all these cases various technologies and their characteristics significantly impact design of respective curricula.

The areas where a number of unsolved issues are identified during BALMAS project development are briefly presented in the following paragraphs.

**Early warning system**. The coastal states may establish an early warning system (in accordance with Regulation C-2) in order to notify mariners of areas under their jurisdiction where ships should not uptake ballast water due to known conditions. To be effective, early warning systems need to support at least on-demand risk analysis, monitoring procedures, warning communication channels and response capabilities. There are no international standards in that respect and it is not clear what should be done on board when warning is issued. Consequently, procedures applied by systems developed in different regions may differ significantly, thus making quite demanding to train seafarers on proper actions to be implemented in such cases.

**Sampling techniques.** It is assumed that shipboard BW treatment equipment is delivering ballast water in accordance with respective standards. However, simple and straightforward methods to confirm that ballast water satisfies the requirements are still not widely available. Consequently, it is very much questionable whether seafarers should be trained and equipped in sampling procedures to verify the proper operations of the equipment.

**Port State Control procedures**. It is a duty of the PSC officers to ensure the proper implementation of the relevant international maritime conventions. Consequently, it can be assumed that BWM Convention will be included in a list of maritime conventions whose implementation is controlled through PSC mechanism. In that respect it is still not clear to what extend the PSC officers will be required to investigate ballast water on board (for example, when water from various sources are pumped in different tanks), how many times the ship will be required to sample ballast water and what will be the outcome in case when limits prescribed in Regulation D-2 are infringed.

**Risk assessment.** Baseline studies and associated risk assessments are the necessary preconditions for any relaxation procedure, in particular the exemptions in case of intra-regional voyages. Such exemptions are as a rule connected with fixed routes and reflect the local peculiarities. In order to be able to operate in such circumstances ships' crews, particularly those members with management responsibilities, have to be knowledgeable on applicable procedures, limits and requirements. At the moment it is not clear to what extent the knowledge and understanding of risk assessment procedures is appropriate and needed to be included in the training.

**More stringent standards.** BWM Convention in Regulation D-2 clearly sets a standard of ballast water quality. However, even before the Convention enters into force the USA administration already announced more stringent standards to be satisfied from ships calling in their ports. It means that seafarers, particularly those with management responsibilities, are obliged to be familiar with different modes of operations and related outcomes. If such practice is followed by other countries additional workload on seafarers will be created, requiring additional knowledge and understanding needed to properly implement different requirements.

**Responsibilities**. The new requirements and their mandatory implementation (once the Convention enters into force) will definitely create new legal responsibilities for masters and responsible seafarers. These responsibilities will create additional workload but also will add additional punitive measures against those who infringe the respective rules and regulations. Consequently, one can easily assume that seafarers should know the consequences of certain actions and possible legal courses of actions that may follow. However, it is not clear to what extent such knowledge is required.

As it is presented in the previous paragraphs, there are still a number of open questions that may impact the effectiveness of the BWM Convention and that require additional knowledge, understanding and skills. However, it seems that most of them are still not yet defined to the point that make possible to develop appropriate training modules. Consequently, as soon as BWM Convention enters into force and industry and MET institutions acquire the necessary experience, additional training programs will be needed, either as a standalone courses or as a part of the regular training for students at MET institutions. In that respect IAMU member institutions should provide the necessary educational support.

## 4 CONCLUSION

Effective and harmonized implementation of BWM Convention requires that cooperating administrations follow relatively uniform development path. One of the most important part of that path is development of training capabilities based on common and harmonised approach on ballast water management. In general, for efficient implementation of the BWM Convention, the training should be developed for two distinctive group of personnel employed by different stakeholders. Shipboard personnel need to be trained for essential competences while specialized competences are required from shore-based personnel.

Current status of the BWM training and education evidently indicate that there is a disproportion between currently required marine environmental trainings and required competences relevant to procedures outlined in BWM Convention and in numerous regional and national mandatory regulations on BWM procedures. Currently, trainings on BWM are commonly developed and offered by classification societies and various MET institutions solely to shore-based personnel involved in the legislative implementation of the BWM Convention.

In addition, it seems that there are a number of unsolved issues concerning proper implementation of the BWM Convention which causes challenges for the appropriate training development. Through the work on BALMAS project the most prominent issues have been identified and elaborated. These issues are summarized in the following areas of ballast water management: Early warning system, Port State Control procedures, risk assessment, implementation of more empowered standards and responsibilities in particular countries.

Effectiveness of the BWM Convention implementation, once it enters into force, inevitably will depend on the development of appropriate training and education. Based on acquired experience and considering all identified issues, MET institution, particularly higher MET institutions, should be prepared for development of appropriate and harmonized training programme on BWM. This is certainly a challenging process where IAMU members could significantly help providing the necessary support.

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# CULTURAL DIVERSITY AS A STRATEGIC ASSET AND A SOURCE FOR ACHIEVING COMPETITIVE ADVANTAGE IN MARITIME TRANSPORT COMPANIES

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**Abstract.** The paper states that interdependence of cultures in the modern world becomes more obvious and it appears at all levels of human vital activity, particularly in professional sphere. On the example of maritime transport companies it is shown, that cultural diversity can be considered as asset and source for achieving their competitive advantage.
Problems and difficulties resulting from peculiarities of intercultural dialogue as well as norms and values of representatives of different cultures in the multinational companies are considered. Necessity of formation tolerant attitude to other cultures during preparation of the future expert for work in the branch of Merchant shipping as a condition of his successful professional work is proved. The paper suggests the way of the educational process arrangement, ensuring formation of the competences necessary in this connection.

**Key words:** maritime transport companies, cultural diversity, maritime university, educational process, seafarer, manager, multinational companies etc.

# 1 INTRODUCTION

Becoming and development of merchant shipping can be considered as meaningful dialogue which penetrates all structure of interethnic interactions and inherently acts as a means of realization of communicative links, a condition of mutual understanding and interaction of participants of activity in the sea branch.

In a context of globalization and interdependence of markets it is important to improve market strategy which promotes increase of competitiveness of the companies working in the sphere of sea industry. Alongside with the basic strategies including: maintenance of advantage on costs, differentiations of services with the added value and purposeful adaptation to needs of a client, we allocate cultural diversity of companies' structure.

Introduction of new technologies, development of container, mixed and other kinds of transportations demand close interaction and coordination of activity all parties concerned, frequently representatives of different countries and nations. Namely, the resource of qualified experts employed in a shipping complex in many ways promotes achievement of competitive advantage of a company.

The issues related to the problems, arising in mixed crews, already have been discussed at different levels for a long time [2, 3, 7-11]. Such interest is proved by the fact, that 60% of the world merchant fleet now is completed by multinational crews. While the mixed crews were the usual phenomenon within many centuries, now crew agencies "purposely" hire crew members of various ranks and from different parts of the world. This theme continues to be actual one, but in this paper we shall concentrate our attention mostly on coastal companies involved in a field of sea transport. If onboard a vessel absence of mutual understanding owing to multi-language nature occurs, diversification of cultures can become apparent immediately, since fulfillment of duties as well as safety of a vessel, crew and cargo depend on it, at coastal companies the effect can be visible not at once, but nevertheless it may have also severe consequences.

# 2 CULTURAL DIVERSITY AS A STRATEGIC ASSET OF MARITIME TRANSPORT COMPANIES

A cultural diversity can act as a strategic resource of a company working on the basis of international cooperation. The multinational company is one of the most complex forms of the international business, but at the same time, it is quite typical for branch of merchant shipping. The multinational companies, as a rule, use the complex global philosophy of business providing economic activities both inside of the country, and beyond its borders.

Globalization of modern economy has led, first of all, to increase of interstate and inter-firm competition for economic resources and commodity markets, secondly, to stage-by-stage development of the interstate unions of the interfaced countries created with the purpose of achieving global advantages for the competitors in the world market. There is also fast development of integrated economic activities of sea companies (agency, crewing, forwarding and other companies working as branches of big companies in different ports, in different countries). Integration activity is expressed in increasing level of international competition that compels companies to search for ways of association of potentials and cooperation in struggle for a survival or market leadership.

Different scientists stipulate that the establishment of business partner relations among companies belonging to different countries and creation of business structures of a various degree of integration at the present stage acts as one of the most widespread organizational strategy of sea branch development [1, 4, 6, 11].

At present in world practice the Balanced Scorecard (BSC) is considered as one of the most effective control system, permitting to transfer strategy of the company in the balanced complex of key parameters. It is necessary to note, that recently the shipping companies undertake attempts of introduction in a control system modern concepts of management, first of all, BSC concept. One of the purposes of introduction of this system is quantitative and qualitative evaluation of different kinds of risks. Multinational contingent of the sea companies is considered as one of such risks.

We did not intend to allocate and justify all existing parameters, but we shall focus, in our opinion, on one of the most important – a multinational contingent of the transport companies. The reality is that results of shipping companies' work are influenced by numerous, not always favorable, factors of internal and external surroundings. Diversification of cultures is considered as such factor.

Diversification is understood as division, partition of common culture into separate components. Diversification of cultures can be partial and represents increase in degree of culture diversity. Similar process should be evaluated more likely positively as quite often it leads to formation of numerous subcultures and increase in cultural variety that at the end enriches any content. Development of the multinational environment in sea industry defines necessity of recognition factors of cultural diversity while creating relation system among participants of the market, formation of management system and making business by companies. Solving of this problem is connected with all-round studying of influence of different cultures and religions on economy and management of enterprises, with revealing mechanisms of transition to ethic business. Absence of taking into account partner business relations such intercultural factors as features of national behaviour, religious morals, ethical standards, organizational culture, negatively influences development of joint activity.

It is expressed in occurrence of disputed situations and, finally, increase in production costs of all participants involved in business that, in turn, results in decrease in competitiveness of joint business. It is well-known, that the higher predictability of partner relations and more reliable expectation from cooperation, the more widely an opportunity of mutually advantageous activity. As the analysis of activity performed in maritime transport companies in a direction of formation and development of organizational culture, during an establishment of business relations among partners, among representatives of different countries and people has shown cultural barriers often arise. Working in other cultural environment or being in a situation of intercultural communication, employees of multinational corporations can overcome these barriers and become successful, if they are guided by the following principles:

- support of mutual interest in culture of partners;
- extending of trust in business relations;
- finding common grounds in the legal field for the guaranteed performance of obligations;
- studying culture of the country in which experts work;
- adaptation of corporate values to national values of the company's employees;
- accounting of specificity of national cultures of partners, in particular valuable orientations, customs and habits in the organization and business dealing.

Adherence to the specified principles helps the experts working in maritime transport companies, in due time to respond to changes in their culture, and also expands knowledge of specificity of clients, partners, employees' culture from other regions and countries. The following fact is also obvious, the more diverse the cultural field of business dealing is, the clearer cross-cultural distinction, the higher risks and communicative barriers are. Poly-ethnic nature of maritime community and influence of globalization cause an expediency of accounting of cross-cultural aspects in sea business. Therefore, it is important for experts to work in a direction of formation and development of the poly-ethnic competence as the strategic resource of the company's development.

The poly-ethnic competence is understood as the integrated unity of following components: communicative (mechanisms, methods and strategies necessary for different nations); social (knowledge and understanding of intercultural contacts consequences, international-legal documents in sphere of interethnic relations) and linguistic (possession of native, state and foreign languages). The degree of poly-ethnic competence formation is defined not so much by amount of knowledge, but by quality of this knowledge.

For use of a cultural diversity advantages in a multinational company it is necessary to create such organizational culture and socially-psychological climate which would promote perception of cultural distinctions, and provide obtaining of synergetic effect from integration of various cultures into business activity, consisting of the use of an attractor, particularly, considering a tendency of the company development with a view of improvement of business quality. It is possession of poly-ethnic competence by experts based on acceptance and respect of a cultural diversity that is capable to provide advantage of maritime transport companies.

## 3 THE INDUSTRIAL PRACTICE OF FUTURE EXPERTS IN MULTINATIONAL COMPANIES

Any business is connected with a system of relations among people and to become successful in international market which, first of all, consists of people, it is necessary to learn to understand the process of "occurrence" in other culture, acquiring knowledge, skills, norms of communication and social experience. Intercultural communication competence is the major goal of students who develop both intercultural awareness and sensitivity. Communication competence reflects having the ability to negotiate and interact well across cultures [2]. The future sea experts gain such experience already during their passage of an industrial practice both on ships in mixed crews, and in the multinational companies (agency, forwarding, etc.).

This experience becomes an important stage while formation of poly-ethnic competence of students. We consider the poly-ethnic competence of students as the necessary personal quality, allowing to cooperate with representatives of other nationality on the basis of respect of their cultural values, the tolerant attitude to intercultural distinctions and to build a constructive intercultural dialogue.

For expansion of opportunities of graduates employment at AUMSU Admiral Ushakov Maritime State University (Novorossiysk, Russia) the Department of students' practice and assistance to employment of graduates is organized. The university has contracts

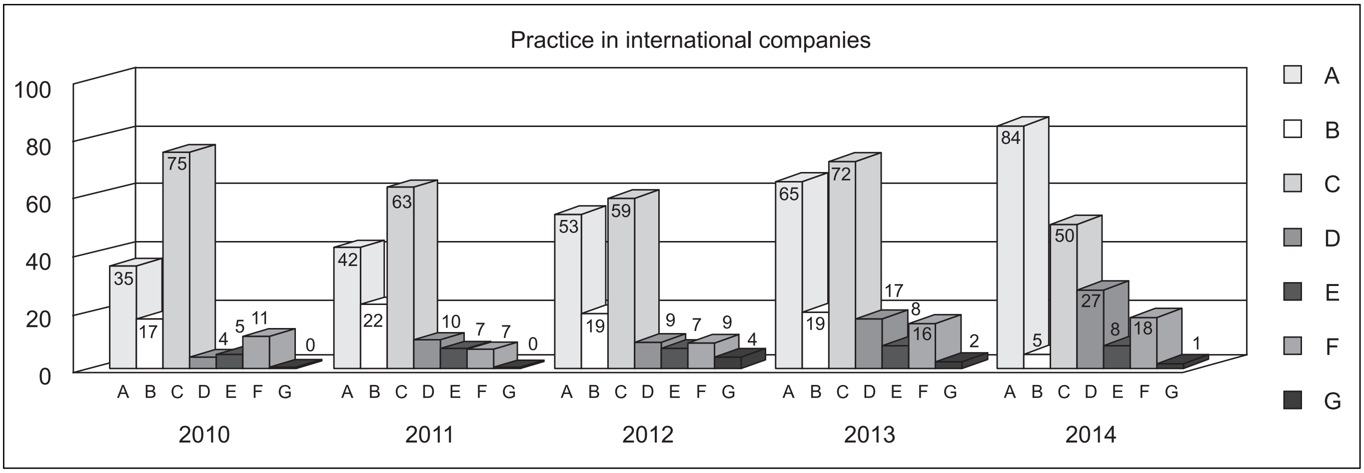


**Figure 1** Number of cadets, taking part in industrial practice in multinational companies.

with the leading shipping companies and arranges passage of training and probation period by cadets and students in foreign companies.

Participants of AUMSU cadets, taking part in industrial practice in multinational companies are shown in Figure 1.

Results of the performed analysis of cadets' participation in an industrial practice in the international companies have shown, that interest to these companies grows as a whole. Moreover this interest is mutual: both from cadets, and from employers. Practical training arranged in international companies provides for the continuous and consecutive forming of cadets' knowledge and skills. The cadets' practical training is organized in accordance with State and IMO standards. While practice process cadets are involved in different operations, so they obtain not only practical skills of working in different directions, but have a good practice of foreign language communication and cultural collaboration.

Properly structured and formal cadets' practice provide a unique possibility to combine theoretical and practical training of cadets in real working conditions aboard a modern ship and in shore companies and to qualify specialists for merchant marine. One of the most important factor is that cadets are provided with a strong support system, which includes experienced specialists to guide them through the job training and learning. The main goal of the collaboration with companies is to provide students to start their career as highly motivated and qualified marine specialists.

The multinational structure of crew, special working conditions during voyage, are the factors complicating the organization of joint activity and a coordination of actions of participants.

Now the situation is aggravated with the fact that absence or a low level of the poly-ethnic competence of students prevents constructability of an intercultural dialogue, influences display of tolerance in interethnic relations. Reasons for existing the said situation can be the following: presence of destructive elements in interethnic interactions – intolerance to another's opinion, egoism, internal hostility, ambition, a categoriality of judgments, unwillingness and inability to compromise, national chauvinism, misunderstanding of real processes occurring in the society, in the world, absence at students of culture of understanding and culture of perception of distinctions, loss of correctness of perception of ("I" concept) and others ("They" concept).

These reasons can be eliminated in a pedagogical process where system centered factor is the cultural diversity of Maritime branch and all Maritime community. In this connection formation of poly-ethnic competence reflecting a formed culture level of interethnic relations of students in poly-cultural educational space acts as grounded and reasonable objective.

## 4 FORMATION OF THE POLY-ETHNIC COMPETENCE WHILE TRAINING AT THE MARITIME UNIVERSITY

Values of culture, in our case, cultures of interethnic relations, tolerances, an intercultural dialogue – have the special importance in intercultural communication in the branch of sea transport which by virtue of its nature is multinational. Inclusion of cross-cultural content in curriculums of universities is caused by need in modern, polyvalent and freely guided in complex and constantly varying environment experts possessing high business culture, one of professional competence of which is ability to cooperate with representatives of different cultures in the organization, i.e. the poly-ethnic competence.

Today there is an obvious contradiction between objective need for formation at the future experts of readiness for the constructive interethnic attitude, ability to live in a poly-cultural society and insufficient development of theoretical and methodological bases of use of potential of poly-cultural educational space of higher school in poly-ethnic competence formation at students. We have assumed, that formation of poly-ethnic competence becomes effective if:

a) the concept of competence formation adequate to features of activity of these experts is put in the basis of construction of educational process:

- inclusion in the content of competence formation (in our case – the poly-ethnic competence), reflecting necessity to base not only on professional, but also culture knowledge inherent to representatives of other countries;
- use of educational technologies, forms and methods providing an adequate direction of all educational actions to formation and development of both professional competences and poly-ethnic competence;

b) the educational and material basis providing conditions for performance of educational actions is created:

- adequately reflecting industrial situations;
- adequately providing productive trajectory of educational actions;

c) modern information and telecommunication educational technologies and approaches to formation at experts of the poly-ethnic competence are used;

d) ways of performance of the educational actions adequate to modern industrial situations, taking place in branch in sea branch are developed and proved [5, 6].

Just during training of a future expert it is necessary to create conditions aimed at formation of poly-ethnic competence, expressed in tolerant attitude to the representative of other culture. In this case it is a question not only of perception of "Another", but also about the positive response on cognizable, that is expressed in feeling of tolerance, respect, readiness without aversion to perceive his/her abilities and behaviour and adequately evaluate them. These ideas are appropriated by the student and become subsequently a basis of his/her tolerant attitude to cultural "Another", defining the further character of professional and individual attitude of the future expert, and also an orientation of his/her actions and acts in sphere of the poly-ethnic communications.

Higher education challenges a complex of problems connected with formation of culture of interethnic attitudes of students in poly-cultural educational space. Among them there is a development of valuable installations of a personality by means of enrichment of his consciousness with national-specific values of different cultures, education of youth with the purpose of expansion and deepening of its ethno-cultural ideas. These questions often are solved independently on each other, on examples of separate courses or specializations.

Ability to communicate in one language is also an essential factor, determining success of a multinational company irrespective of the fact representatives of what nationalities work in it. A condition of successful work of multinational companies is ensuring basic knowledge of any common language before commencing work for the company. There is an imperative need not only to recognize presence of mixed companies both on language, and on culture, but also necessity in a new way to fulfill interaction and mutual understanding among their members. Both the organizers of educational process, and the heads of multinational companies should pay attention to it.

In merchant shipping English language plays an exclusively important role. It acts as a working language of majority shipping, crewing, stevedore, agency companies carrying out activity in the field of merchant shipping. Specificity of activity of merchant shipping means constant cooperation at the international level, and communication in foreign language.

In our earlier works we've already proved that at use of foreign language studying in process of professional activity training there are means of training of two kinds:

- already generated knowledge is used for understanding of the foreign language text describing the studied phenomena; thus foreign language is used as means of training;
- foreign language phenomena which have not been mastered yet by trainees, are studied to understand described with their use studied cultural and the professional phenomena. Thus, on the basis of foreign language two-floor means of training of activity is built. The first floor is already available knowledge, and the second is the process of studying of new foreign language [6].

Inclusion of future experts in the virtual intercultural communications aimed at formation of the poly-ethnic competence creates not only motivational base for speaking another language, but also form need for dialogue with native speakers, friends and colleagues, also concerned in perception of the culture of "Another". The organization of virtual communications on the basis of any common issue, which discussion and research is equally significant for partners from different countries, creates the real language environment. Here language acts in its direct function – formation and formulations of ideas, and participants of the communication are involved both in a discussed problem, and in other culture, and in themselves as carriers of cultural identity.

We consider foreign language competence as one of the key features of professionalism of sea specialists. The basic purpose is not formation of only special knowledge and skills, but professional-communicative competence expressed in ability of the communicative organization of professional work including cooperation in multicultural surroundings.

For this strategy, special emphasis is given to the Situational and functional approach to constructing the process of future specialists training [5].

The idea of the Situational and functional approach is in carrying out of the student through the professional situation of training filled with the poly-ethnic content and in it inclusion in functional system operating in this situation of formation of competence by performance of adequate educational actions. In other words, process of formation and development of poly-ethnic competence of students consists of:

a) creation of the initial situation consisting of readiness of a teacher, providing a program of inclusion a student in current poly-profile, poly-ethnic and communicative educational actions and possible means of their performance, readiness of a student for performance of current poly-profile, poly-ethnic, and communicative educational actions of productive and creative character and readiness of offered for a choice possible means of performance of these actions;

b) inclusion and providing action of functional educational system of formation and development of the poly-ethnic competence.

Performance by students of various situations adequately reflecting activity of a multinational company, their decision in different educational communications at continuous and incidental support of a teacher and different interactions with other students and at different levels of independence leads to formation (at students) abilities operatively to perceive, learn and solve the industrial situations arising in poly-ethnic society, to the development of the poly-ethnic competence.

Construction of process of poly-ethnic competence formation consists of the following:

a) creation of a trainee orientation on poly-profile and communicative activity of this expert in poly-ethnic society, prospects of formation of his outlook and ability to live, attitude and motivation on a current mastered component of the content of education in view of a current state of its erudition;

b) drawing up by a teacher of a forthcoming activity program forming a current component of poly-ethnic competence in view of a current condition of a trainee's erudition;

c) preparation of means of performance system by a trainee of his actions creating a current component of his poly-ethnic competence;

d) inclusion of functional system of educational interactions, creating or developing the poly-ethnic competence of the expert of merchant shipping;

e) organization of subject-objective and subject-subjective relations of a teacher and students and educational actions directed to selection and transformation, integration of poly-profile, poly-ethnic and communicative information;

f) use of intermediate results for the organization or corrections of current educational actions.

Criteria of poly-ethnic competence formation are:

- motivational and valuable (aspiration to constant accumulation of an expert features, capable to work in multinational society which is characterized by a cultural diversity);
- cognitive (a set of professional, speaking another language and culture knowledge; possession of bases of analysis of cross-cultural problems, interaction usual for business sphere; knowledge of ways of intercultural conflict management and negotiating on its settlement);
- operational (development of means and forms of interpersonal interaction; recognition of reasons of a cultural shock and a finding ways of its overcoming);
- reflective (subjective approach in purpose formulation; skill to diagnose the personal growth; skill to analyze and project interpersonal and group communications in poly-cultural society).

Summarizing the above-named skills it is possible to group them as follows:

a) professional motives and aims directed to intercultural communication and a cultural diversity;

b) professional communicative (including speaking another language) skills;

c) knowledge of interaction tolerance (formation of emotional intelligence);

d) reflective position.

Formation of poly-ethnic competence is directed to completely organized understanding of social and cultural reality that assumes a support on the value motivational bases of culture of a young man.

We consider it necessary to allocate principles of educational process construction:

- principle of ethno-cultural pluralism (acceptance and understanding of representatives of other cultures; breeding of tolerance to another's opinions and beliefs; a recognition of an equivalence and equality of all ethnic groups);

– principle of acculturation (process of occurrence of a person in other culture; formation of positive attitude to an ethno-cultural diversity; acceptance of idea, that diversification of cultures is not only a norm, but also the advantage);
– principle of culture conformity (the account of specificity of the environment to live and use its opportunities);
– principle of an interethnic dialogue (interaction with representatives of other nations, cultural exchange);
– principle of inter-disciplines (reflection of an ethno-cultural material in different disciplines);
– principle of poly-linguistic arrangement (perfection of native and foreign languages learning).

Practical introduction of model of poly-ethnic competence formation at students in poly-cultural educational space of maritime higher school testifies its efficiency and suitability in vocational training of future sea experts.

Possession of the poly-ethnic competence will allow young men to resist to extremism which is formed on a background of deformation of social, cultural and political life of a society, and also will allow to develop the cognitive interest that will enrich process of their personal and professional becoming. Formation of students' ideas about tolerant interaction in the mixed crews and coastal multinational companies means expansion of "field" of mutual stay and interaction of a future expert and a cultural "Another" in conditions of the international dialogue, providing their inter-cognition, mutual change and possession of experience of positive emotional perception of a partner.

The expediency of the described methodical mechanisms of poly-ethnic competence formation at future experts is based on the fact, that effective interethnic interaction promotes not only the successful ethno-cultural adaptation of a person assuming achievement of social and psychological integration with one more culture without infringement of his own, but also promotes professional development both the separate individual, and all company, as a whole.

## 5 THE CONCLUSION

The poly-ethnic competence representing the integrated unity of communicative, social and linguistic components reflects feature of a person expressed in availability of a set of objective ideas and knowledge of this or that ethnic culture, realized through skills, the models of behaviour promoting effective interethnic mutual understanding and interaction. As a whole poly-ethnic competence assumes presence of such amount of knowledge and skills which is necessary not only to adapt to realities of poly-ethnic environment, but also to be ready and capable to operate in it actively.

As mechanisms of poly-ethnic competence formation while vocational training the following types of work prevail: individual, pair and collective interactions occurring in trainings, discussions, performance of projects, participation in role and business games. These interactions can be specially organized (during training) and spontaneous or partially organized (in game, labour activity, especially during an industrial practice or from external sources of information).

The position offered by authors proves necessity of creation special poly-cultural space for the educational institution, including representatives of all groups – social, cultural, gender, racial, ethnic, etc. It is shown, that the urgency of poly-ethnic competence formation at future sea experts is defined by poly-ethnic nature of environment of their ability to live and specificity of a sea profession. The poly-ethnic competence is shown in certain situational contexts and as any competence should be supported and developed constantly in compliance with development of global and local contexts, extended in various new situations of intercultural dialogue, pass check on adequacy and efficiency as both identity of communicators, and cultural contexts, and communicative strategies are constantly developed and diversified.

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# PARTNERSHIPS AS A SIGNIFICANT CONTRIBUTION TO ENHANCING PRODUCTIVITY IN MARITIME TRANSPORT

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**Abstract.** In the article various forms of partnership of maritime high school are considered. The basic directions of interaction with business, in particular target contract preparation and maintenance of bases for sailing practice are allocated. It is specified that the desired outcomes are joint ones. They include student outcomes, desired outcomes for the business and education partners as well. So, good result can be achieved only on a collaborative basis. Problems of interaction are designated and ways of their solution are shown. It is proved, that the partnership of maritime high schools and business is not only a way of creation of effective, modern and innovative system of professional maritime education, but also acts as the important factor of development and a significant contribution to Enhancing Productivity in Maritime Transport.

**Key words:** maritime transport, partnership, collaboration between schools and businesses, maritime university, learning opportunities and skill development, recruiting, training.

## 1 INTRODUCTION

The educational space represents conditions for performance of educational interactivity. Its actions are directed to change of the objects located in this space. Therefore at its creation issues of definition of necessary structure of objects in the space, their qualitative characteristics and quantitative representation are solved and also issues of objects existence and character of their deterioration are considered. Construction of educational space of the institution is carried out on the basis of understanding of its essence, but directed to creation of practical conditions for performance of educational actions. Such phenomenon as partnership acts as one of the most important condition of functioning and development of the educational space [3-5].

Researchers allocate different forms of partnership of higher schools [1, 3-7]. They include: the scientifically-strategic partnership carrying out coordination of interaction with representatives of scientific academic community; the educational partnership, which purpose is the coordination of interaction with educational institutions at all levels; the information-strategic partnership coordinating information space; the state-private partnership carrying out coordination of interaction with representatives of sector of economy or with bodies of the government; the partnership among the business and the higher schools, providing interaction directed to maintenance of skilled training of specialists for the certain branch; the partnership at the international level, assuming organizational planning and support of projects directed to improvement of professional skill and professional retraining of scientific and pedagogical workers of different institutions.

The recommended size of the paper does not allow consider all kinds of mentioned partnerships, therefore we shall stop, in our opinion, on those which have the direct relation to the theme of the conference – the partnership between enterprises and higher school, defining both organization of professional training in the higher school, and guarantee success of activity in sea branch and also on the international partnership which necessity is dictated by the nature of activity of sea branch, in many respects depending on integration and globalization of modern economy.

## 2 PARTNERSHIP BETWEEN THE ENTERPRISE AND THE HIGHER SCHOOL

In the system of modern economic relations, characterizing by high independence of managing subjects in it, direct contacts of each certain enterprise with an educational institute, capable to provide business with experts is becoming objective necessity.

Different forms of co-operation with employers are distinguished: the target order for preparation of experts of the certain structure, seminars, conferences, meetings with employers, direct involvement of customers in a higher school structure, for example in methodical or trustee Councils, participation of employers' representatives in drafting of curriculums, their involvement in a management of diploma papers, etc.

Fast development of innovative processes in the branch of merchant shipping leads to necessity of constant knowledge updating at sea experts and continuous improvement of their preparation quality. Maritime education becomes one of leading factors in development of the maritime branch. Quality of preparation of graduates of maritime higher schools depends on many conditions including quality of: the educational program; the scientific potentials of personnel involved in the educational process; trainees; means of educational process (material, experimental base; methodical maintenance etc.) and educational technologies.

Mutual relations between the maritime enterprises and Maritime higher schools when both parties are extremely concerned in formation of closer communications, enable higher schools to react definitely to the development of the branch, making duly changes in the process of training. The enterprises in turn can influence in a greater degree on process of training, for example, by direct participation in it.

Variety of the enterprises carrying out activity in the branch of Maritime transport (shipping, crewing, forwarding, agency, etc.) and set of the various requirements to preparation of sea experts, do not allow a higher educational institution independently, in full consider and reflect all these requirements in programs of training. But it is absolutely clear, that ignoring by higher schools requirements of employers can lead to restriction of a demand on graduators of educational institutions. Hence, constant development of cooperation between enterprises and higher schools acts as the objective precondition of successful activity both higher schools, and Maritime companies and certainly, the maritime branch as a whole.

Interaction of maritime higher schools and the enterprises of the maritime branch is understood as a set of their interconnected and separate activity as a whole. Character of modern interaction of sphere of the education and business is defined, first of all, by the fact that it occurs in conditions of a formed labour market.

In this connection it is possible to allocate the basic directions of activity:

– attraction of employers of the various sea companies to development of offers directed to perfection of procedures of educational activity licensing and the state accreditation of the Maritime higher schools carrying out training of sea specialists;

- perfection of volume planning of the sea staff preparation for maritime business;
- development and introduction of the program of career support of students and graduates in the sea companies;
- perfection of system of the industrial practice arrangements including training on ships and in the coastal companies (forwarding, crewing, agency, etc.) both national, and foreign.

Maritime institutions performing sea experts' training in interaction with maritime companies carry out the following functions:

- monitoring demand of sea experts of any rank on a labour market;
- defining conditions of young experts working activity and their support at a stage of becoming;
- partial or the full indemnification of expenses for preparation/training of young experts;
- an establishment of requirements to quality of sea experts preparation in view of calls of sea branch and international conventions.

Also the following fact is important. The interaction of higher schools and the enterprises occurs in the social and economic environment which is under influence of the external and internal factors including the following:

- professional Maritime education is realized basically on the basis of educational institutions at insignificant participation of employers and trade unions;
- preference is given to standards of a profession, without taking into account the poly-profile nature of sea experts activity;
- leading role belongs to general educational (instead of applied one) component.

Forms and mechanisms of partnership of Maritime higher schools and enterprises working in the field of maritime transport in preparation of experts of fleet cover sphere of relations between subjects which is defined by interests of the participating parties. Therefore it is prudent to speak about ways of coordination of interests of subjects in the partnership.

The partnership of Maritime higher schools and the enterprises of the maritime transport, adequate to new conditions of managing and requirements of the market and sea branch, is based on long-term contracts of educational institutions and the enterprises on preparation and retraining of the sea specialists.

Organizational and contractual forms of partnership "higher school – the enterprise" are the most widespread. Example of such form is the conclusion of bilateral contracts on preparation of experts, students' support at enterprise while an industrial practice, a choice of a theme of final qualifying work, etc. The basic directions of interaction with business, in particular target contract preparation and maintenance of bases for sailing practice are allocated.

Target contract preparation of experts can have different forms: regional, branch programs of a professional training, etc., realized on the basis of the employers' requirements which are integrated in industrial-educational programs.

Such kind of partnership puts the enterprise-customer in a position of the responsibility for planning of preparation and retraining of personnel and participation in its organization, that in turn, strengthens links of an educational institution with a labour market, improves realization of employment of graduates of Maritime higher schools. The educational institution fulfils obligations on the basis of needs of a labour market, conducts work on selection of the sea companies for realization of a target contract preparation of sea experts, and if necessary carries out their additional target training.

The usual practice is, that by a target preparation, the employer undertakes to provide the student with extra charge to his scholarship, arranges his industrial practice and training, concludes the contract with an educational institution about compensation to an educational institution the expenses for a student training on additional target program. Moreover company is to employ this student after the termination of a higher school. The student undertakes to arrive to the organization of the employer for performance of his official duties within the stipulated period. Otherwise the student is to compensate to the employer all expenses occurred.

Another form of a partnership with higher schools is an improvement of professional skill of the personnel. In Admiral Ushakov Maritime State University (AUMSU) the Institute of Professional Development which is the largest training establishment of Russia on training of ship experts is created. The Institute carries out special professional training of sea specialists according to international and national requirements, first of all, STCW 78/95 Convention with 2010 amendments [2]. Alongside with teachers and instructors, working at university, the majority of which have scientific degrees and marine experience on vessels, representatives of sea companies also teach.

Practical training is arranged only with application of the realistic ship equipment (life boats, rafts, rescue boats, helicopter, fire-prevention equipment etc.). The simulator equipment and software imitate all main situations occurred on board and provide interaction of all participants and objects involved in the process. The Control system of quality corresponds to standard ISO_9001:2000 and DNV classification society (Norway). All offered kinds of training and certification are under the control and Sea administration of Russia, and IMO.

The effective form of the partnership between business and Maritime education is the educational and industrial group, capable to realize innovative projects and programs directed to improvement of educational services quality, promoting optimum balance of experts' competences formed during training, and sea branch requirements to graduates and operating experts.

Important thing is that at university there is a close link with the enterprises of sea branch that allows promote graduates' employment. All parties concerned understand that it is unprofitable to disregard process of graduates' employment. Work of a higher school connected with the decision of issues of graduates' employment promotes formation and support of favorable image of educational institution and its efficiency.

Moreover, the educational centers and the laboratories working in close cooperation with business and science allow extend activity of all parties bringing the powerful contribution to increase of efficiency of the branch of Maritime transport.

We have tried to generalize kinds of partnership between higher school and the enterprise and to develop its mechanisms. They are the following:

- organizational and structural mechanism, including advisory councils consisting of representatives of different sea companies, working in the field of Maritime Transport;
- boards of guardians meeting requirements of certain regions and certain employers;
- tripartite contracts, assuming rights and duties of an employer, an educational establishment and a student and allowing the graduate to adapt more quickly in industrial conditions new to him;
- organizational and technological mechanism, providing performance of an industrial practice of students both for sailing and coastal specialities;
- psychological and pedagogical mechanism, providing adaptation, professional socialization, formation of professional culture of the sea expert in view of an opportunity to work in mixed crews and multinational companies;
- social and pedagogical mechanism, based on mutual interest of both educational establishments, and social partners and providing performance of social needs;
- target mechanism, including model of a graduate in view of required competences; purposes caused by internal and external opportunities of an educational institution and target training of experts for Maritime Transport.

In this context it is expedient to mention not a certain profession, but field of professional activity, meaning a set of diverse functions carried out by specialists from adjacent areas and the kinds, defining not only their functional readiness, but also a social maturity and ease of adaptation, determined by professional structure and character of work in the branch of Maritime transport.

One more kind of the partnership is the creation of employment support in maritime higher schools. For expansion of opportunities of graduates' employment in structure of methodical management of AUMSU such department is organized. Main functions of the department are:

- formation and regular updating of vacancies databank in the national and foreign companies;
- questioning and professional oriented consultation of students and graduates;
- regular presentations of company-employers;
- assistance to sea companies in search of young well skilled experts;
- help to students in search of work, etc.

For maritime institutes distribution of educational space on the enterprises, working in the branch of maritime transport and providing places for an industrial practice is typical. It influences on a certain order for experts prepared by educational institutions. Arrangement of such work provides advanced understanding of risk management and its application to maritime practice in the context of existing and new national and international rules and regulations.

## 3 THE INTERNATIONAL PARTNERSHIP

The following kind of partnership which we would like to consider is the international partnership.

In educational space of any modern higher school alongside with others the international component exists. The international communications in this space are necessary for maintenance of future experts' training and preparation to contacts with foreign partners, to coordination of adjacent industrial actions with foreign companies, for mastering the valuable orientations which have been developed in the world, for preparation for inclusion in the international programs, projects and researches. In general it leads to the international coordination of some components of educational programs and spaces.

Maritime Universities continue to endeavor to improve methods of teaching, to develop technologies directed to training of highly skilled professionals, capable to work in the field of Maritime Transport. In this connection it is necessary to provide high skilled personnel to be involved in maritime education, especially in the academic field. In this way, AUMSU has been developing a number of projects dedicated to initial and continuous training of its stuff, both beginners, i.e. young lecturers in the maritime educational system and experienced lecturers and instructors. An international successful maritime training requires improved pedagogical methods and new ways of cooperation, which allow bring together like-minded maritime educators and share ideas and best practices.

Main purpose of the Projects, developed for international cooperation is to assist Maritime Education and Training institutions as well as their teaching staff in arrangement and introducing new training courses or in enhancing, updating or supplementing existing training material in order to improve quality of Maritime Education and Training system as a factor which strongly impacts worldwide the competitiveness of the shipping sector. Extending of maritime universities' activity through educational projects based on partnership is of great value.

While designing the international educational projects it is necessary to remember that projects aimed to educational international cooperation render escalating influence on change of the content of education that promotes realization of idea of the open education [3].

Substantial increase of competitiveness of a future expert can be reached by means of "personal" diversity of obtained education by introduction in educational activity of higher school of the international dual programs of the preparation promoting significant expansion of a set of individual educational trajectories.

Dual educational programs in the system of higher professional training, including maritime, can be considered as productive means of modernization of higher education and simultaneously as innovative model of the organization of educational activity in a higher school. A dual educational program is a way of modernization of educational activity of a higher school, providing synergetic effect of improvement of preparation quality due to integration, merges and interactions of various components of dual educational programs.

It is specified that the desired outcomes are joint ones. They include students' outcomes, desired outcomes for the business and education partners as well. So, good result can be achieved only on a collaborative basis.

It is obvious, that at realization of the international partnership there is a lot of complexities among which, first of all there are different educational standards of preparation, different legislation, different terms and, certainly issues of financing. So, for example, legal maintenance of programs demands perfection of legal base both in the field of education, and the migratory legislation, and the decision of issues of foreign citizens staying in territory of certain country, etc. It is clear, that the higher school cannot independently solve such problems, but bilateral contracts between higher school-partners within the frames of educational projects to some extent allow overcome this difficulty. This moment also concerns re-trainings, improvements of professional skill, and also carrying out of scientific researches, the congresses, conferences, symposiums and other similar activity.Also the issue of different terms of training is solved. Practice of issue of Diploma Supplement of the European standard is optimized. Educational institutions have such right.

The most complicated issue for distribution of joint or double diplomas is the necessity of expansion of base of their financing. Such programs are more expensive in comparison with usual, that is caused, first of all, by necessity of financing of the international mobility and mechanisms of management of mentioned programs. Today the most widespread practice is the indemnification of charges to participants of a program or even to students. Higher schools in this case provide students with preferential system of payment.

Example of work in this direction the educational project offered by AUMSU professors recently, namely, creation of a databank of joint educational programs can be [7].

Each Country Member can take advantage of the offered joint programs at its own discretion and even to adapt them under the conditions, introducing joint programs both basically, and in elective or optional component of the curricular. Such databank of programs could be popular even because all Maritime *higher* schools anyhow work under the programs approved by the International Maritime Organization, in many respects they coincide under the basic characteristics and in any case, they will be in demand. Joint educational programs also can be offered to students as optional and those who counts on obtaining double diplomas can also choose additional programs which are necessary for him/her and to carry out them proceeding from his (trainee's) opportunities.

Creation of joint educational programs databank will allow not only to systematize the collected experience in the international Maritime education, and also to understand, in what degrees different programs or models can be applied, and to reveal examples of the most successful programs [7].

It is proved, that the partnership of maritime higher schools and business is not only a way of creation of effective, modern and innovative system of professional maritime education, but also it is the important factor of Maritime Transport development.

Internationalization of education entails structural innovative changes on governmental, ministerial, and at a level of management of higher school. For higher school internationalization of education means qualitative change of strategy and statement of the innovative system educational purposes on three mainstreams: internationalization of a student's contingent; the organization of presence of an educational institution in other countries through joint projects; internationalization of innovative pedagogical experience.

## 4 CONCLUSION

Adjusting influence on system of continuous advancing personnel maintenance of the branch of maritime branch can be effected by concerned federal ministries and departments, the supreme bodies of authority of subjects of federation and municipalities and, certainly, by employers.

Close contacts of the educational system and the enterprises of branch of Maritime transport stimulate professional growth of teaching structure of educational institutions; guarantee to graduates of institutions employment on the selected speciality with clear prospect of career growth, promote formation and perfection of their professional competence; provide to maritime higher schools the guaranteed paid order for preparation of experts, an opportunity of development of base of practice, increase of a level and diversity of provided education, a level of material support of teaching structure and stimulation of its professional growth. As to the enterprises they get an excellent opportunity on the basis of maritime institutions, academies and universities in advance to prepare the competent staff who can realize tasks of further development and perfection put before the maritime branch. So, partnerships between educational institutions and business in all kinds can be considered as the significant contribution to Enhancing Productivity in Maritime Transport.

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# ANALYSIS OF THE ENTRY INTO FORCE OF THE USE OF FUEL LOW SULFUR TO THE MARPOL ANNEX VI, AND ITS INFLUENCE ON THE ASSETS SHIPS AND NEW CONSTRUCTION

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**Abstract.** Although the fuel used in maritime transport accounts for approximately 4% of the total consumed in the world, most shipping routes pass near the coasts of maritime shipping countries, and in some cases as The Channel, The Straits Gibraltar The Strait of Malacca, etc. With a very high density of maritime traffic and near the coast, makes much of air pollution from ships landing on the shores of the countries where they navigate, causing, among other effects, acid rain.
The MARPOL Annex VI requires that from 1 January 2015 the sulphur content in fuels used by the main and auxiliary engines of ships operating in ECA areas less than 0.1%.
Also from January 1, 2012, the same annex, has forced international shipping vessels than the maximum sulphur content of these fuels is 3.5%, and from 2020 will be lowered to 0.5%.
The above measures have caused a tsunami in shipping, for strict compliance with the rules set in the Annex VI of MARPOL, for the ECA areas, ships sailing in it, requires shipowners to use fuel with sulphur content less than 0.1%, which makes it necessary to use MGO fuel between 40-55% more expensive than HFO, which makes the ship operating costs skyrocket, and therefore, shipping is more expensive, leading in some cases the change of shipping to road transport.
Due to the above stated reasons, the shipowners have to make the decision to continue using HFO that meet specified in Annex VI of MARPOL, or change to other fuel that also comply with these regulations. For this there are several possibilities:
1st Use high sulphur HFO fuel and install systems for exhaust gas cleaning, scrubbers, to remove the sulphur they contain.
2nd Use of dual fuel engines that burn LNG, that do not contain sulphur.
3rd Use HFO fuel with low sulphur content.
4th Using biofuels.
In this paper we study the alternatives, with all its advantages and disadvantages, which can be used in existing ships and new construction in a manner that allows the owners thereof, that they comply with the rules of fuel use low sulphur content, regardless of the navigation zone because, from 2020 the global minimum content is 0.5%, this amount, near 0.1%, and therefore is desirable to have means to allow the use of low-cost fuels and sulphur, and doing that maritime transport be more respect with the environment.

**Key words:** energy efficiency, energy management, energy policy, shipping economic

# 1 ASSESS THE EVOLUTION IN RETROFITTING OF VESSELS VERSUS NEW BUILDINGS USING ALTERNATIVE FUELS AND THE POTENTIALITY OF NEW TECHNOLOGIES

## 1.1 Retrofit solutions as potential alternatives for new Sulphur regulation

Besides using alternative low sulphur content fuels, LNG fuel, methanol, liquefied petroleum gas (LPG) or biofuels which whilst potentially attractive to new build projects, there are two additional compliance methods that involve retrofitting of vessels; that is:

1. Introducing exhaust gas cleaning technologies to remove SOx from emissions. Two effective and mature technologies could be widely used (wet and dry scrubbing). A third, less mature option is non-thermal plasma.
2. Converting to Dual Fuel engines and install LNG Tanks

Table 1 shows the main features of both retrofitting options regarding financial, technical and regulatory issues, that is:

**Table 1** Financial, technical and regulatory issues of retrofit options

| Compliance method | Financial issues | Technical issues | Regulatory issues |
|---|---|---|---|
| **Exhaust gas cleaning technologies: scrubbers** | Financial loss due to the need to pause the operation of a ship, approximately for one month, in order to fit scrubbers onboard.<br>Shipowners stressed that retrofitting for compliance methods requires high investments. For many shipowners this option is not feasible because there is no financial support by the private entities, therefore such projects are only feasible if there is financial support programs.<br>The investment costs ranges from 100-200 €/kW for new installations and from 200-400€/kW for retrofit installations. In other words, it is about 1.2 to 2.2 M€ for new vessels and from 2.2 to 4.5 M€ for retrofit vessels. However, other sources said that the investment cost is 10M$ for an engine of 10,000kW.<br>Then we should consider an additional use of fuel about 2%, maintenance cost (about 0.5-0.7 million €/year) and purchasing cost of NaOH and fresh water for closed systems and cost for disposal of sludge.<br>Due to the vessel lifetime is 20 years on average it is just recommended for new ongoing vessels since the amortization period is about 3 to 5 years. | Companies are facing various technical challenges, since the installation of a scrubber is complicated due to the size of such equipment (mainly in small vessels).<br>Also the weight and the impact of this technology onboard should not be underestimated. | There is a currently lack of regularity clarity on whether the discharge of was water and bleed off water is permitted in ports of the world or the EU ports due to conflict between the Water Framework Directive and the Sulphur Directive.<br>In fact, wet scrubbing is associated with wash water discharge that this was water is subject to internationally agreed controls for pH<6.5, PAH and turbidity which are continuously monitored and recorded (MEPC 184(59)). |
| **Converting to dual fuel engines and LNG tanks** | Financial loss due to the need to pause the operation of a ship, approximately for 75 days, in order to fit scrubbers onboard.<br>The converting cost, which includes engines and fuel tanks, is very costly. If the engines are substituted the cost could reach the 25-30% of the total vessel cost whereas it will be about the 10% if the engine is just adapted. | Dual engines will be able to consume both HFO and LNG fuel, according to the regulation applied.<br>In practice, all vessels can be converted where available space (key factor) exists for the LNG tanks onboard the vessel.<br>But, the installation of the LNG tanks will reduce the vessel capacity because the LNG cannot be stored in the double bottom tanks. It must be stored in independent tanks.<br>It requires about 1.8 times more volume than MDO with equally energy content. But if the tank insulation is need, then the volume is about 2.3 times higher[1]. | The use of LNG involve compliance for a range of potential future legislation (SOx, GHG, harmful particulates).<br>Burning LNG produces 85-90% less NOx than the conventional fuel, and GHG emissions are reduced by 15-20%. |

[1] TransBaltic (2012). Implications of new regulation regarding sulphur content in ship's fuel on maritime transport sector within Baltic Sea Region. Baltic Ports Organization Secretariat.

Mentioned options are recommended for vessels operating in ECAs sea basins. However, for ocean-going vessels that operates periodically with ports and stays for short periods in ECAs it is suggested to use low-sulphur content fuels and assume higher rates instead of doing a large investment to transform its engines.

## 2 FUEL PRICE EVOLUTION AND OPERATING COST INCREASES

During the last years, the cost of bunkering fuel has been characterized by large fluctuations. Despite the dip in 2009, an increasing trend has been observed until last months of 2014, when oil price collapsed. Figure 1 shows this price evolution from the nineties.

As it can be observed, at the beginning of the nineties bunker price was rather low so the difference per tonne between HFO and distillates was not too high and was about 50-100 USD per barrel. As the bunker prices increased the difference deepened. According to the evolution depicted in previous figure, distillates fuels were from 30 to 100% more expensive than HFO.

Additionally, from the 1st January 2015, low-sulphur content fuels (0.1%) gets more importance in ECA areas. The differences per metric tonne between those fuels and HFO or MGO are depicted in figure 2.

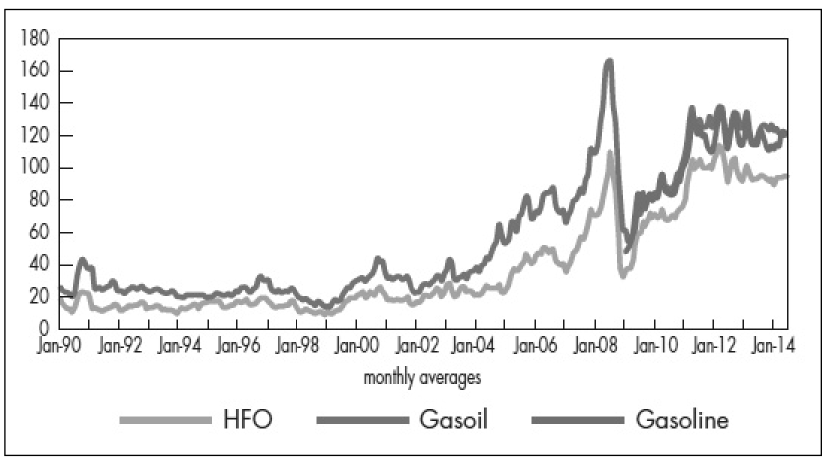



**Figure 1** Rotterdam bunker oil prices (USD/barrel) evolution from the nineties
**Source:** Key World Energy Statistics, IEA (2014)

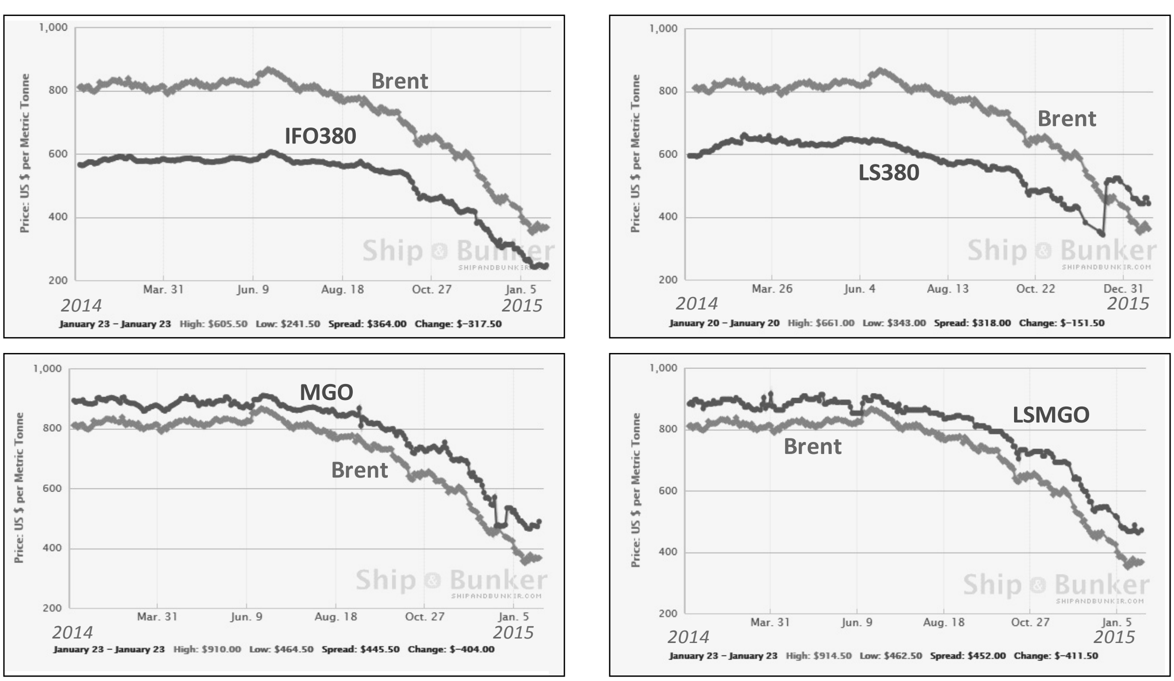



**Figure 2** Rotterdam bunker and Brent price ($/metric tonne) evolution from January 2014 to January 2015.
**Source:** www.shipandbunker.com

**Table 2** Daily prices (metric tonnes) of by Ships and Bunker for the port of Rotterdam (23th January 2015)

| Type of fuel | | Price | Change (vs. non LS) | Change (vs. LS MGO price) |
|---|---|---|---|---|
| HFO | IFO 380 | 247,50 $/mt | - | +90% |
| | IFO 180 | 280,50 $/mt | - | +68% |
| Marine diesel | MGO | 489,00 $/mt | - | -4% |
| Low-sulphur fuels | LS380 | 442,50 $/mt | +79% | - |
| | LS180 | 366,50 $/mt | +31% | - |
| | LSMGO | 471,00 $/mt | -4% | - |

Figure 2 shows the evolution of daily prices reported by Ship and Bunker for the port of Rotterdam during 2014. For instance, the price differences registered the 23th of January 2015 in the port of Rotterdam (Table 2).

As it can be observed, there are large differences between low-sulphur fuels (0.1%) and conventional HFO fuels, while differences between marine diesel prices are small. Actually, at mid December 2014, LS380 prices increased drastically while IFO380 kept decreasing. Thus, price differences between low-sulphur and non low-sulphur are currently about 80% for LS380, while for LS180 price change is lower (about 40%).

## 2.1 Low-sulphur fuel prices projections

The future price of low-sulphur content fuels is unforeseen and different projections have been made. The Table 3 summarize most relevant.

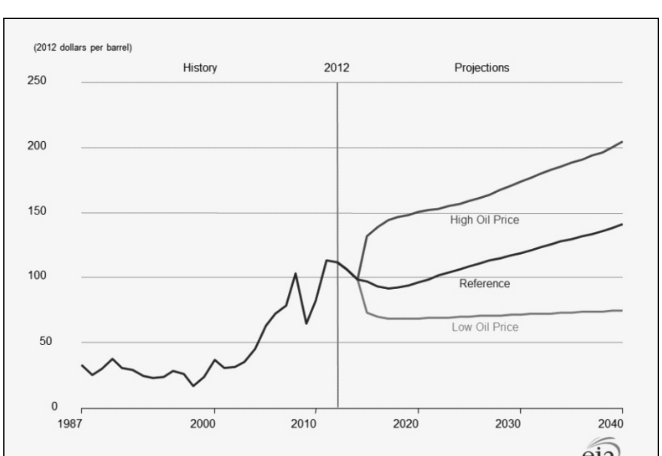
## 2.2 LNG price projections

The future price of LNG as shipping fuel is also uncertain. Its price may be indexed to that of oil, as is the case for most current long-term LNG contracts. Similarly to Table 3, the Table 4 shows the different price projections assumed.

**Table 3** Fuel price projections by 2025.

| Source/Study | Projections |
|---|---|
| Maritime Fuel Price and Uptake Projections to 2035 (based on energy and fuel projections produced by the OECD, the International Energy Agency (IEA) and the US Energy Information Administration (EIA). (see Figure 3) | The variation in HFO prices is correlated to the movement of oil prices. Its prices will range between $350 per tonne to $1,000 per tonne in 2015, and from $300 to $1,200 per tonne, in 2025. MGO prices will range between approximately $500 ($12/mmBTU) per tonne and $1,500 ($37/mmBTU) in 2015, and from $480 to $1,800 per tonne by 2025. |
| DECC Fossil Fuel Price Projections (2013) | Three different scenarios are defined to project oil price evolution: central, high and low. The projections are sense-checked against external forecasts such as those made by the IEA and EIA. |

**Source:** OECD, IEA, EIA



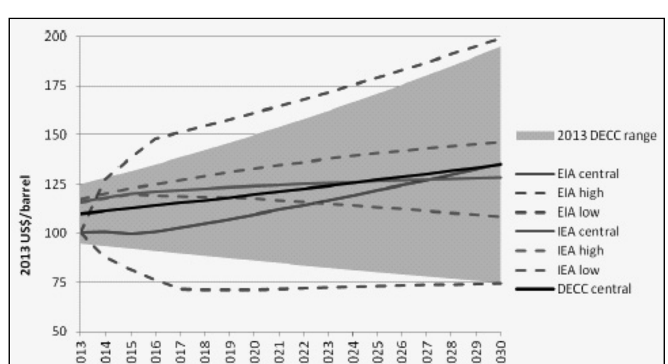




**Figure 3** Energy prices projections by EIA ($ per barrel) and DECC (2013). **Source:** www.eia.gov

**Table 4** LNG price projections by 2025.

| Source/Study | Projections |
|---|---|
| Maritime Fuel Price and Uptake Projections to 2035 (based on energy and fuel projections produced by the OECD, the International Energy Agency (IEA) and the US Energy Information Administration (EIA). | LNG prices evolution goes from 320 to 800$ per tonne (7 to 17$/mmBTU) in 2015 to the range of 400-1200 US$ per tonne (9 to 26$/mmBTU) in 2025. |
| World Ports Climate Initiative (WPCI). IAPH – Port Environment Committee. | Based on a relatively constant projected oil price of 100$ per barrel through to 2030, future oil-indexed LNG contracts at prices of 10-15$/mmBTU (1mmBTU=293kWh) have been used in a range of studies assessing the costs and benefits of LNG as a shipping fuel[2]. |
| Ocean Shipping consultants (*Royal Haskoning*), LNG as a bunker fuel: future demand prospects & port design options (2013). | A Danish Maritime Authority study[3] focusing on Northern Europe estimated future LNG prices in comparison to MGO price forecasts. The results of the analysis stated that LNG prices will be within the range 60-80% of the HFO price on energy basis. |

**Source:** OECD, IEA, EIA

**Table 5** Increasing rates on daily operating costs per type of vessel.

| Type of vessel | Increasing range(%) [$1.2\ P_{HFO} - 2.0\ P_{HFO}$] | Type of vessel | Increasing range (%) [$1.2\ P_{HFO} - 2.0\ P_{HFO}$] |
|---|---|---|---|
| Container vessels | [15-75%] | Tankers | [15-60%] |
| Conventional dry cargo vessels | [13-65%] | Ro-Ro vessels | [10-50%] |
| Dry bulk vessels | [13-65%] | Car and passenger ferries | [11-55%] |

**Source:** Finnish study and own elaboration

## 3 VESSELS´ OPERATING COSTS

It should be noticed that not all types of vessels will be similarly affected by the increased bunkering prices. It depends on the share of bunker costs on vessel's voyage operating cost and on the route concerned.

According to the COMPASS study and price costs in 2005, bunker costs represents on average 47% of the daily operating costs for a container vessel, 32% for a Ro-Ro vessel, and 22 and 12% for large and small RoPax vessels, respectively. The total daily cost included manning, insurance, repairs and maintenance, stores and lube oils, administration, capital investments, interests, bunkering costs and port fees. Nevertheless, it should be considered that fuel consumption is very sensitive to the vessel speed. In fact, the relationship between fuel consumption and vessel speed follows a logarithmic function.

In such a context, a Finnish study[4] estimated the effect of the estimated price rise for fuel on the day-to-day running costs for container vessels. For container vessels the bunker costs share is about 75%; 65% for conventional dry cargo vessels; 65% for dry bulk vessels; 60% for tanker vessels; 50% for Ro-Ro vessels and 55% for car and passenger ferries.

## 4 IMPACTS ON OPERATING COSTS

Thus, the increasing range on daily operating cost can be estimated according to the following expression: $S(\%)(P_{LSMGO}/P_{HFO} - 1)$; where S (%) is bunker cost share per type of vessel. Table 5 shows increasing ranges when the price of LSMGO ranges from 1.2 to 2.0 in comparison to the price of conventional fuel HFO.

## 5 USING LNG AS FUEL FOR NON-METHANE CARRIER SHIPS

Using LNG as fuel for non methane carrier ships is one of the most used alternative to traditional fuel oils.

Payback time for a LNG fuelled ship is attractive from a price differential between LNG and oil of about 15%. Oil price reduction on 2015 at about one half than last year has made difficult to justify its use.

In Figure 4 is the forecast for the evolution of different fuel's price. HFO is Heavy Fuel Oil, LSHF is Low Sulfur Heavy Fuel, MGO is Marine Gas Oil and LNG Is Liquefied Natural Gas. The current HFO prices in the

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[2] World Ports Climate Initiative (WPCI). IAPH – Port Environment Commitee. (http://www.lngbunkering.org/lng/business-case/incentives)

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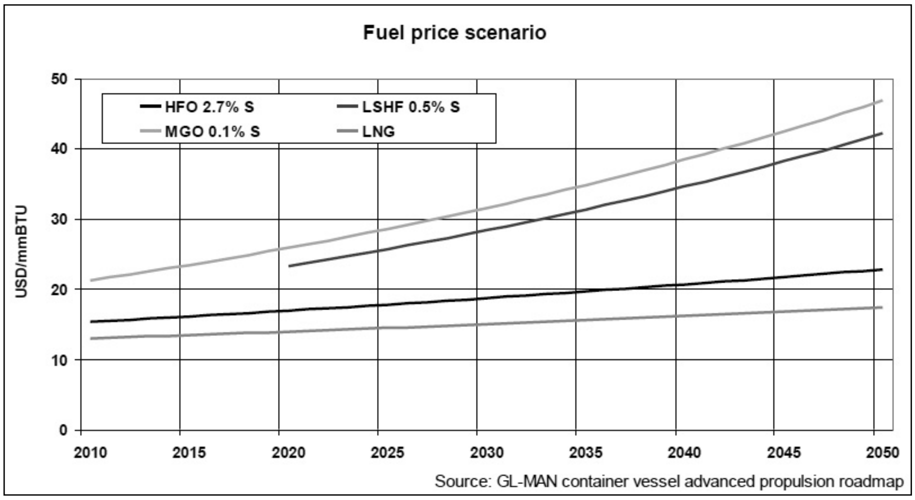


**Figure 4** Fuel price scenario
**Source:** GL-MAN *Costs and Benefits of LNG as Ship Fuel for Container Vessels.* MAN Diesel & Turbo, 2012

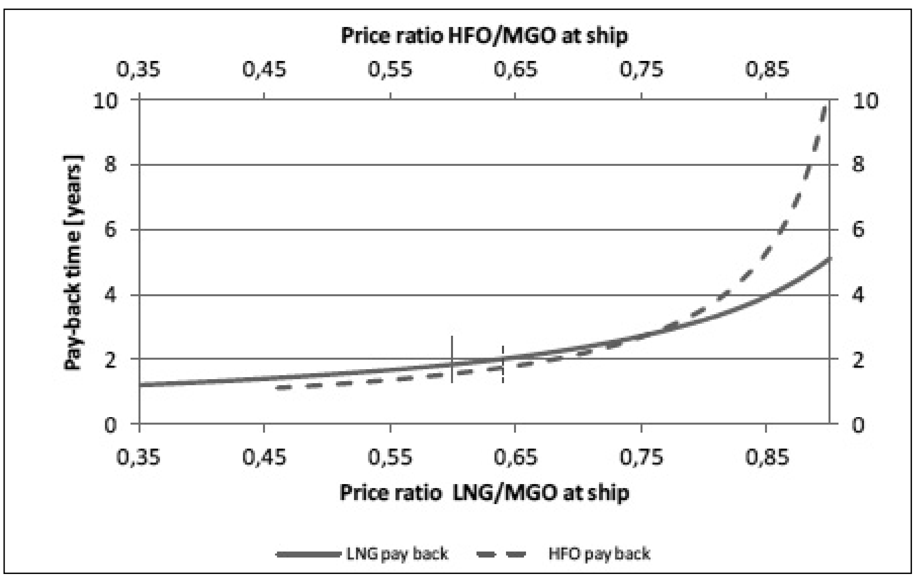


**Figure 5** Payback time for different fuel prices
**Source:** Danish Maritime Authority

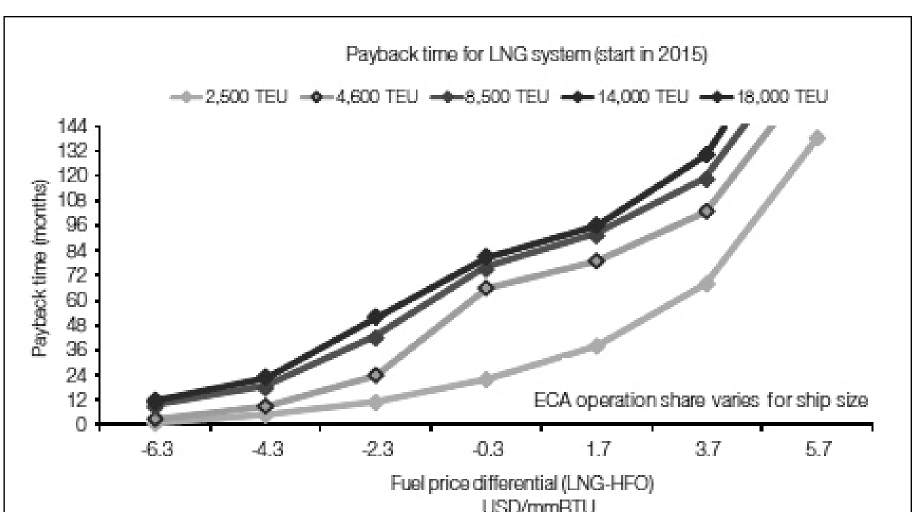


**Figure 6** Payback time for LNG system
**Source:** GL-MAN *Costs and Benefits of LNG as Ship Fuel for Container Vessels.* MAN Diesel & Turbo, 2012

first half of 2015 are below this value but this may be a transitorial exception.

In Figure 5 is the payback time for different fuel prices. It is shown for the relationship between HFO and MGO and also for the relationship between LNG and MGO.

It is very important the percentage of time that the ship is sailing in ECAs where lower emissions are allowed.

In figure 6 is the payback time for different ship sizes each with different ECA operation share.

## 6 SAFETY OF EQUIPMENTS AND OPERATIONS OF LNG

Safety must be ensured in the whole ship during all operations, when fueling or sailing. All gas piping should be double pipes with nitrogen or circulating air between both and with gas detectors. Air renovations in the engine room should be high enough using extractors and fans, up to thirty air changes for hour, though this may render difficult gas leaking detection.

Gas compressors should be placed in a room out of the engine room and some propose that it should be two gas compressor rooms separated tightly.

The gas supply system should be duplicated in order to avoid stop of engines or black out if there is some problem in this system. Gas Combustion Unit (GCU) should not be duplicated.

## 7 STORAGE ON BOARD OF LNG

LNG has a density about one half of traditional fuel oils and it is more difficult to optimize cargo and fuel spaces. In addition, tanks must be isolated due to the cryogenic temperatures of LNG. Then, the overall volume occupied for all LNG facilities on board is between 2.5 and 4 times higher than for conventional fuels, which represents a significant loss of cargo space for most types of ships.

IMO A, B, C and membrane tanks are used. Membrane tanks have the advantage to adapt well to the ship spaces though tanks type C can withstand Boil Off Gas (BOG) pressure. This allows storage of BOG for up to two weeks. Insulation is usually a combination of vacuum, perlite or polyurethane. Tanks and tanks compartment need special ventilation and tank vent piping to raised vent mast on deck,

## 8 BASIC TYPES OG LNG ENGINES

There are three basic types of LNG engines:

1. Lean burn, spark-ignition, pure gas types, operate on the Otto cycle and use a spark plug to ignite the gas/air mixture in the combustion chamber, they range in power from 300 kW to 10000 kW.
2. Dual fuel with Diesel pilot engines operate on the Otto cycle and use natural gas together with a second fuel source, which may be distillate or heavy fuel oil. They allow the operator flexibility in deciding which fuel to use, based on price and availability. They range in power from 700 kW to 18,000 kW.
3. Direct injection with diesel pilot engines operate on a diesel cycle, with natural gas injected directly into the cylinder near the top of the compression stroke. Conversion of an existing diesel engine requires limited modification to the engine itself, so this type of engine offers a higher potential for retrofitting existing units for direct injection operation. Gas must be injected at high pressure. At present, no medium- or high-speed marine engines are available in this category, but slow-speed engines now on order can deliver up to 42,700 kW.

## 9 ADVANTAGES OF LNG

Fulfillment of environmental laws and norms regarding SOx, NOx, PM, and less $CO_2$ emissions though there is an increase of methane emissions due to the crossing of engine valves.

## 10 DRAWBACKS OF LNG

Not all harbors have facilities to supply LNG to ships.

A stress analysis for LNG piping following ASME 13B1.3 is required taking account of the dilatations and contractions of piping, and other additional forces as wind, snow or ice or strain produced by the hogging and sagging of the hull.

When the ship is anchored or in port or sailing very slow, it may be produced more BOG than the fuel consumed by the engines and then not necessary gas must be burned in a boiler or in the GCU.

Challenges for future development:

- Develop tanks and systems able to manage BOG and adaptable to the hull's shape.
- Modify the engines in order to avoid methane emissions due to valve crossing.
- Ensure the supply of LNG in all ports.

## 11 BIOFUELS

Biofuels can be derived from three primary sources: edible crops, non-edible crops (waste, or crops harvested on marginal land) and algae, which can grow on water and does not compete with food production.

Algae-based biofuels seem to be the most efficient and the process has the added benefit of consuming significant quantities of $CO_2$, but more research is needed to be done to identify alga strains that would be suitable for efficient large scale production. Concerns related to long-term storage stability of biofuels on board ships, and issues with corrosion are also necessary.

All biofuels can be mixed with traditional fuels. Besides the lower GHG emissions they can biodegrade rapidly and thus is less noxious in case of a spill.

Another biofuel is Bio-LNG:

- Bio-LNG is produced from biogas. Biogas is produced by anaerobic digestion. All organic waste can rot and can produce biogas, the bacteria do the work. Therefore biogas is the cheapest and cleanest biofuel without competition with food or land use.
- Biogas is produced from organic waste, sewage sludge, agricultural waste and landfills by anaerobic fermentation. The aim is to produce constant flow of biogas with consistently high methane content. The biogas must be upgraded: removal of $H_2S$, $CO_2$ and trace elements. The bio-methane must be purified (maximum 50ppm $CO_2$, no water) to prepare for liquefaction.
- Bio-LNG is of better quality than fossil LNG. The bacteria do not produce ethane, propane and butane. Therefore Bio-LNG has a higher methane number than (most) fossil LNG, which is important for engine performance and efficiency.
- Bio-LNG has a much lower carbon footprint than other fossil fuels or even many other biofuels: Bio-LNG can even be carbon negative.
- Anglo Dutch Liquid Methane BV estimates that bio-LNG can replace 20% of our fossil transportation fuels by 2020 in inland navigation, heavy duty trucks and cold ironing in ports.

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# MODELING OF FUTURE REFRIGERANTS IN A VAPOUR COMPRESSION CYCLE

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**Abstract.** the refrigeration plant on a fishing vessel is one of the main contributors of the overall energy usage of the vessel. Any increase in efficiency of the refrigeration system will reduce the fuel consumption and can improve the overall efficiency of the vessel. The Montreal Protocol states that all environmental impacting refrigerants must be phased out. Therefore there is a need to find an environmentally friendly refrigerants that meets the global legislation requirements as well as high refrigeration efficiency. The present study investigates different refrigerants in a vapour compression refrigeration plant for efficiency and operational cost with special consideration on environmental impact. With the aid of simulations, the Coefficient of Performance (COP) for different refrigerants were determined. The results showed that carbon dioxide (R-744) and ammonia (R-717) have the highest calculated performances and therefore carbon dioxide can be recommended as a future refrigerant. On the other side, the hydrocarbons have the lowest COPs of 2.67, 3.01 and 2.98 for methane (R-50), ethane (R-170) and propane (R-290) respectively. Overall, the hydrocarbons have 24.72%, 10.63% and 11.74% less performance compared to R-134a. The safety consideration for the use of ammonia (R-717) and carbon dioxide (R-744) showed that carbon dioxide is the preferred future refrigerant. For new built refrigeration systems, carbon dioxide is recommended for its low global warming potential.

**Key words**: refrigeration system, PRO\II, future refrigerant, vapour compression cycle

# 1 INTRODUCTION

Refrigeration system in a fishing vessel such as a trawler or long liner is a second largest contributor to the overall energy consumption of that vessel with the largest being the propulsion system. Therefore, any increase in the efficiency of the system will reduce the fuel consumption and can improve the overall efficiency of the vessel. The refrigeration system must be able to ensure that all marine life caught are stored in proper operating conditions (varies on the type of fish in terms of temperature) which will allow the meat to be preserved and ultimately increase the market value. For this reason, it is essential that the system runs as economical as possible without compromising the overall performance. Further, with tighter regulations on the environmental impact of refrigerants [1], there is a need for a non-polluting refrigerant which a high efficiency. However, there are various types of refrigeration systems existing in the marine industry. Some of the variations of the refrigerant systems include: single stage and multistage compression cycles, primary and secondary refrigerants and cascade systems. In this study, a single stage vapour compression cycle is considered.

# 2 LITERATURE REVIEW

Seafood industry shows the important of improving the refrigeration efficiency to reduce the amount of fish wasted caused by poor refrigeration systems. The two common refrigeration systems, the use and history of refrigerants as well as energy reduction methods are discussed next.

## 2.1 Seafood industry

Seafood industry represents 6% of the total protein demand worldwide and the importance of seafood will vary from country to country [2]. For some countries, fish is a major food source where in others fish is more of a luxury. As the human population increases, the world catch of fish must also increase to fulfill the demand. The current world catch is $7 \times 10^7$ tonnes of fish. However, not all of this is used for human consumption. $1 \times 10^7$ tonnes is wasted and another $2 \times 10^7$ goes towards the production of fishmeal. However, the world catch may not be able to increase to a higher level without causing local and global depletion. Hence the improvement of efficiency in refrigeration systems will allow the catch to be properly stored and chilled, thus there will be a decrease in amount of fish that is wasted [2].

## 2.2 Refrigeration systems

The purpose of a refrigeration plant is to transfer the heat from one source into another. This task is completed by passing air through an evaporator containing chilled refrigeration liquid, (called a refrigerant), running through the system [3]. The size and type of the refrigeration plant is based on the need of that particular fishing vessel [4]. A small trawler may only require a small fish hold of a single species and therefore only a single temperature setting is required, whereas a larger trawler may require different temperatures for different fish species [5]. For an example, one fish hold may require the fish to be frozen whereas another fish hold may only require the fish to be chilled [4]. For example, when dealing with many tuna species the temperature required is much lower than that of other fish holds [4].

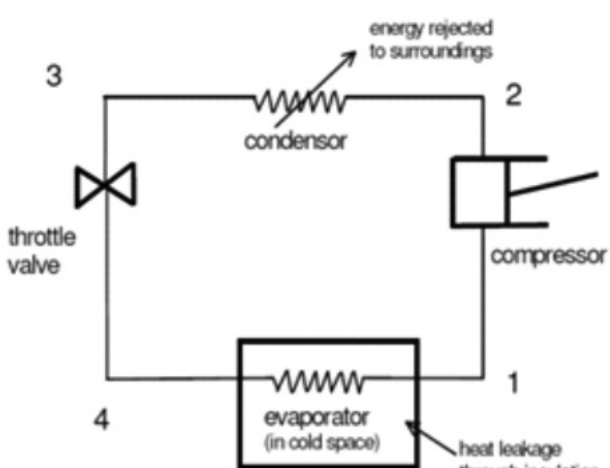


**Figure 1** Schematically presented principle of a compression refrigeration system [6]

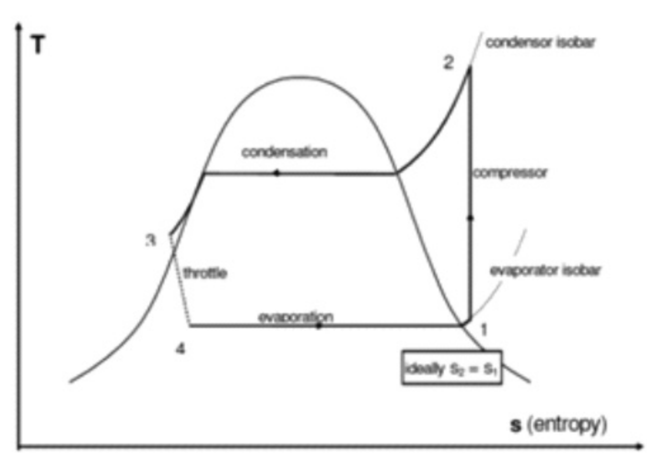


**Figure 2** T-s Diagram for an ideal Vapour Compression Cycle [9]

The main areas for future improvements for refrigeration systems can be divided into two main categories; economic and environmental. The economic analysis is evaluating the cost of running the system which leads into finding the practical size of the system. The running cost is a major concern for refrigeration systems due to the potential large losses in efficiency [6]. This issue is addressed in the simulation models. The second category is based on the environmental concerns such as ozone layer depletion, global warming and fisheries depletion [1, 2, 7]. The main factors addressed are the global warming and the ozone layer effect of the refrigerants used. Fishing depletion can be reduced by ensuring that there is no wasted meat due to an ineffective system which is to be covered in the simulation models [5]. There are two main types of refrigeration plants that exist in the industry as described below [2].

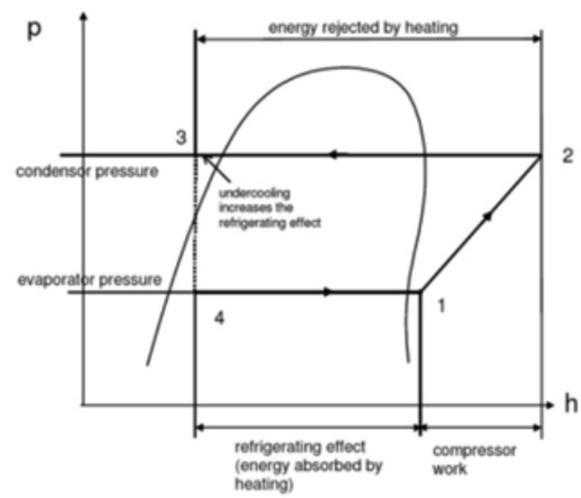


**Figure 4** P-h Diagram for the Vapour Compression Cycle [9]

### 2.2.1 Vapour compression refrigeration system

The compression refrigeration system is the most commonly found system in the marine sector [8]. The system uses a compressor and a condenser to force the refrigerant (the medium) to condense and dissipate heat [6]. A refrigeration system can vary from a simple design to a complex design based on its purpose such as a single stage compression system and multistage compression system.

A simple vapour compression refrigeration cycle consists of four major components, each having its own process and function as shown in Figure 1. The processes of the simple refrigeration cycle in relationship to temperature and entropy is shown in Figure 2. It can be seen that between points 1 and 2, there is a region of constant entropy (isentropic process). However, this is for an ideal refrigeration system. In a real refrigeration system, the entropy is not constant between points 1 and 2 and heat losses will occur throughout the system. Figure 3 shows a more realistic temperature and entropy diagram for a vapour compression cycle. Figure 4 shows the process of a simple refrigeration cycle in terms of pressure and enthalpy. Processes 2-3 and 4-1 can be seen to be at constant pressure for the condenser and evaporator. These pressures can also be called delivery and suction pressures respectively.

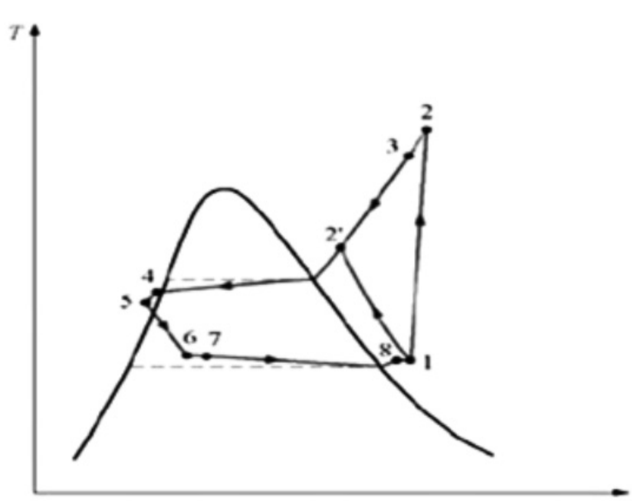


**Figure 3** T-s Diagram for a real vapour compression cycle [10]

### 2.2.2 Absorption refrigeration system

The single effect absorption refrigeration system is the most commonly used design due to its simplicity [11]. Providing that the heat exchange has a large external heating source, the use of absorption refrigeration systems in fishing vessels has become a viable choice [12]. A single effect absorption refrigeration system is shown in Figure 5.

Unlike the compressor refrigeration system, the absorption refrigeration system replaces the mechanically driven compressor with a heat generator, liquid pump and an absorber. The generator can be used in conjunction with a heat exchanger to utilize the recovered heat from the prime mover's exhaust gases [14]. In theory, the efficiency can be improved by 60% by using a waste heat exchanger to improve the overall efficiency of the system [15].

## 2.3 Refrigerants

Many refrigerants are used in all refrigeration cycles as the medium which transfers the latent heat energy throughout the system [9]. The two most common re-

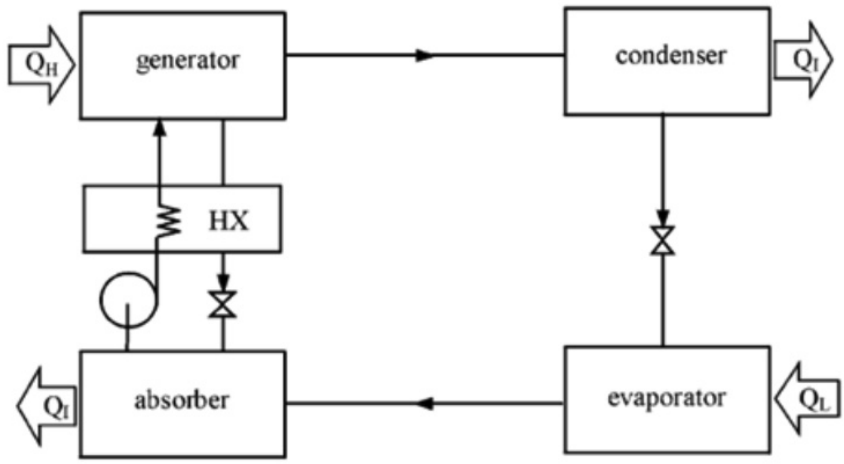


**Figure 5** Single effect absorption refrigeration system [13]

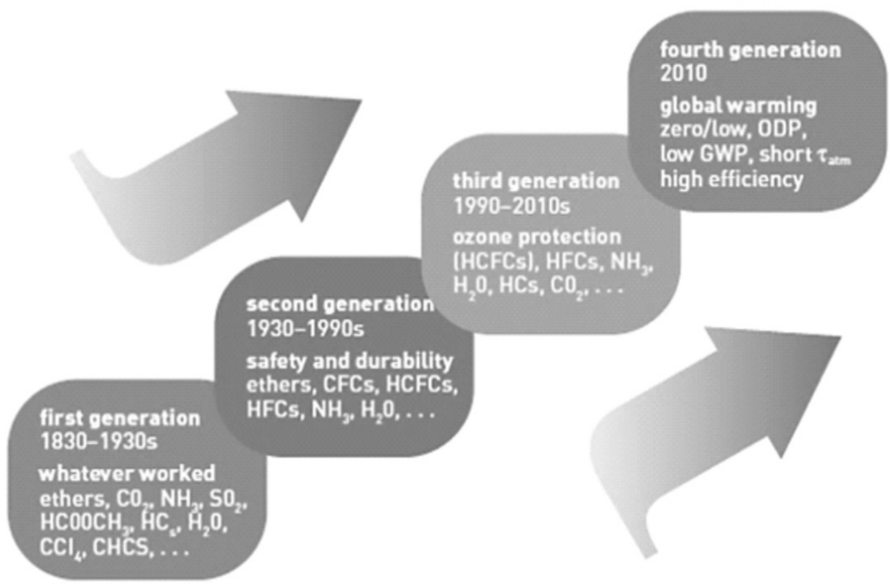


**Figure 6** Generations of Refrigerants from 1830 to 2010 [19]

frigerants used in the fishing industry are chlorodifluoromethane (R-22) and 1,1,1,2-Tetrafluoroethane (R-134a) [1]. However, R-22 is required to be replaced due to the *Montreal Protocol.* The *Montreal Protocol* states that chlorofluorocarbons (CFC) and hydrogen chlorofluorocarbons (HCFC) are to be phased out by 1995 and 2020 respectively for developed countries [16]. Hydrofluorocarbons (HFCs) do not pose a threat to the ozone layer and therefore no further depletion [17]. An overview of the *Montreal Protocol* is shown in Table 1.

Hydrofluorocarbons (HFC) such as R-134a, at this stage does not need to be replaced although does have a global warming potential. Potentially R-134a may need to be replaced in later years if global warming is proven. On-going studies are being conducted to find replacement refrigerants that are environmentally harmless as well as safety considerations such as toxicity and flammability. The main two factors that determine the environmental impact of refrigerants are Global Warming Potential (GWP) and Ozone Depletion Potential (ODP).

Global Warming Potential (GWP) is a relative comparison of vapours compared to that of carbon dioxide ($CO_2$) in terms of greenhouse gases across a time interval commonly 100 years. Carbon dioxide is used as the reference point as it is regarded as the highest contribution to greenhouse gases. However, the topic of global warming is highly controversial. A low GWP is preferred but not required for refrigerants. Ozone Depleting Potential (ODP) is an index comparison of the refrigerants potential to destroy the ozone layer.

**Table 1** Summary of Montreal Protocol control measures in Australia [16]

| Ozone depleting substances | Control Method |
|---|---|
| Chlorofluorocarbons (CFCs) | Phased out end of 1995 |
| Halons | Phased out end of 1993 |
| $CCl_4$(Carbon tetrachloride) | Phased out end of 1995 |
| $CH_3CCl_3$ (Methyl chloroform) | Phased out end of 1995 |
| Hydrochlorofluorocarbons (HCFCs) | Freeze from beginning of 1996<br>35% reduction by 2004<br>75% reduction by 2010<br>90% reduction by 2015<br>Total phase out by 2020 |
| Hydrobromofluorocarbons (HBFCs) | Phased out end of 1995 |
| Bromochloromethane ($CH_2BrCl$) | Phase out by 2002 |

**Table 2** Short list of ODP and GWP of common refrigerants [18]

| ASHRAE Number | Chemical Formula | Chemical Name | Ozone Depletion Potential (*ODP*) | Global Warming Potential (*GWP*) |
|---|---|---|---|---|
| R-12 | $CCl_2F_2$ | Dichlorodifluoromethane | 1.0 | 1890 |
| R-22 | $CHClF_2$ | Chlorodifluoromethane | 0.05 | 1790 |
| R-134a | $C_2H_2F_4$ | 1,1,1,2-Tetrafluoroethane | 0 | 1370 |
| R-50 | $CH_4$ | Methane | 0 | 23 |
| R-170 | $C_2H_6$ | Ethane | 0 | ~20 |
| R-290 | $C_3H_8$ | Propane | 0 | ~20 |
| R-717 | $NH_3$ | Ammonia | 0 | <1 |
| R-744 | $CO_2$ | Carbon Dioxide | 0 | 1 |

The reference point ODP is R11, as it is considered to have the largest effect on the depletion of the ozone layer. Any refrigerant replacements are required to have a zero/low ODP [16] to satisfy the *Montreal Protocol*. A short comparison between the ODP and GWP for different refrigerants is shown in Table 2.

## 2.4 Evolution of refrigerants

Throughout the years, there have been various concerns to the environmental impact of the refrigerants. Each generation of refrigerants has been an improvement over the previous generation in terms of efficiency and safety. The evolution of refrigerants is shown in Figure 6.

For the first generation refrigerants, no environmental concerns were addressed. If the refrigerant worked, then it was used for that system. The refrigerants were nearly all flammable, toxic and high reactive which lead to accidents on a common basis [19]. Some of the first generation refrigerants included carbon dioxide (R-744), ammonia (R-717), sulphur dioxide (R-764) and water (R-718).

The second generation refrigerants addressed the issue of safety and durability with the a shift to the fluorochemicals (CFC, HCFC and HFC) [20]. Commercial production of R-11 and R-12 started in the early 1930s which became the standard refrigerants for most refrigeration needs with R-717 still preferred for large scaled plants [20]. However, with an increase of awareness, the ozone layer was considered to be depleting which started the production of the third generation refrigerants [21].

The third generation refrigerants concentrated on the removal of ozone-depleting substances (ODSs) with the creation of the *Montreal Protocol* [19, 21]. With chlorofluorocarbons (CFC) to be phased out by 1995, a replacement for Dichlorodifluoromethane (R-12) was required. 1,1,1,2-Tetrafluoroethane (R-134a) was created in 1995 with a similar performance to R-12 with zero ODP [22].

The fourth generation refrigerants look into ways of having the highest efficiency with little to no Global Warming Potential [12]. The interest in a “natural refrigerant” had grown to replace HFCs (R-134a) due to the global warming potential [16]. Possible “natural refrigerants” are ammonia ($NH_3$), carbon dioxide ($CO_2$), hydrocarbons (HC) and water ($H_20$).

Studies were conducted previously to compare different refrigerants in similar size refrigeration systems as there are some refrigerants that can be used as a

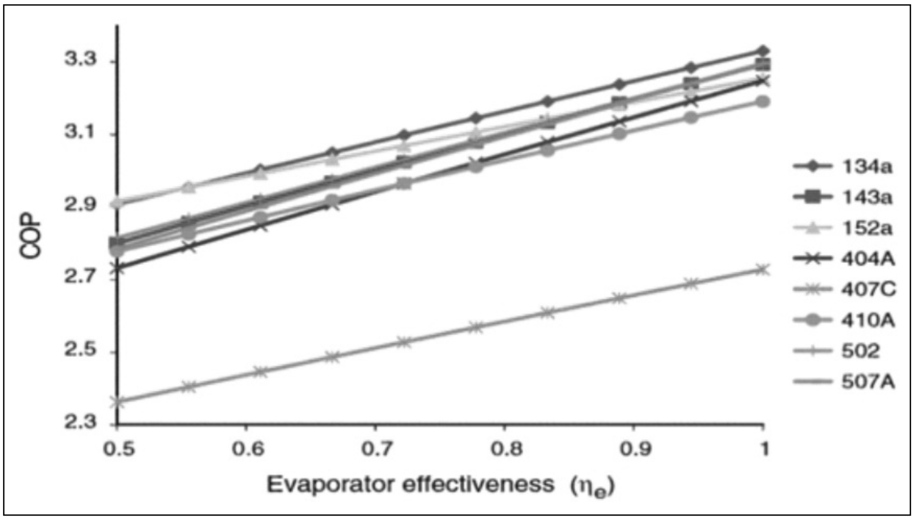


**Figure 7** Evaporator effectiveness versus COP [23]

"drop in replacement." This means that the original refrigerant can be drained and replaced with a newer refrigerant without changing the system. However, for most studies conducted, there are limited investigations into comparing non-organic and organic refrigerants [4]. A study conducted by Reddy (2012) compared similar third and fourth generation refrigerants in a similar sized air conditioning system. The system used in this particular study is a simple single staged vapour compression cycle and the refrigerants used are shown in Table 3.

The performance of the refrigerants was compared with the evaporator effectiveness as shown in Figure 7. The effectiveness of the evaporator varied between 0.5 and 1.0 and the COP of the refrigerant improved as the effectiveness increases. 1,1,1,2-tetrafluoroethane (R134a) was found to be the most effective refrigerant whereas 407c, a mixture of difluoromethane (R32), pentafluoroethane (R125) and 1,1,1,2-tetrafluoroethane (R134a) had a poor performance.

## 3 METHODOLOGY

This section provides an overview of the methodology used in the construction of the simulation models created using *Simsci PRO/II 9.0* software. Furthermore, the testing conditions and selected refrigerants are defined and discussed.

### 3.1 Simulation models

The simulation model was created using *Simsci PRO/II 9.0* which allowed investigation of refrigeration systems by changing the refrigerant used as well as the system characteristics. The advantage of using a simulation program is the amount of variations and alterations that can be conducted with ease.

The refrigeration system used for this simulation was the vapour compression cycle shown in Figure 8. The model is set up with two simple heat exchangers to represent the evaporator and condenser. The evaporator (E2) is set to 1 degree kelvin rise above dew point

**Table 3** Refrigerant properties [23]

| ASHRAE Number | Chemical formula | Molecular Mass | NBP (°C) | Tc (°C) | Pc (MPa) | ASHARAE Safety Code |
|---|---|---|---|---|---|---|
| R-134a | CH2FCF3 | 102.03 | -26.1 | 101.1 | 4.06 | A1 |
| R-143a | CH3CF3 | 84.04 | -47.2 | 72.9 | 3.78 | A2 |
| R-152a | CH3CHF2 | 66.05 | -24 | 113.3 | 4.52 | A2 |
| R-404a | R-25/143a/134a | 97.6 | -46.6 | 72.1 | 3.74 | A1 |
| R-407c | R-32/125/134a | 86.2 | -43.8 | 87.3 | 4.63 | A1 |
| R-410a | R-32/125 | 72.58 | -60.9 | 72.5 | 4.95 | A1 |
| R-502 | R-22/115 | 111.63 | -45.3 | 80.7 | 4.02 | A1 |
| R-507a | R-125/143a | 98.86 | -47.1 | 70.9 | 3.79 | A1 |

**NBP – Normal boiling point (°C), Tc – Critical temperature (°C), Pc – Critical pressure (MPa)**

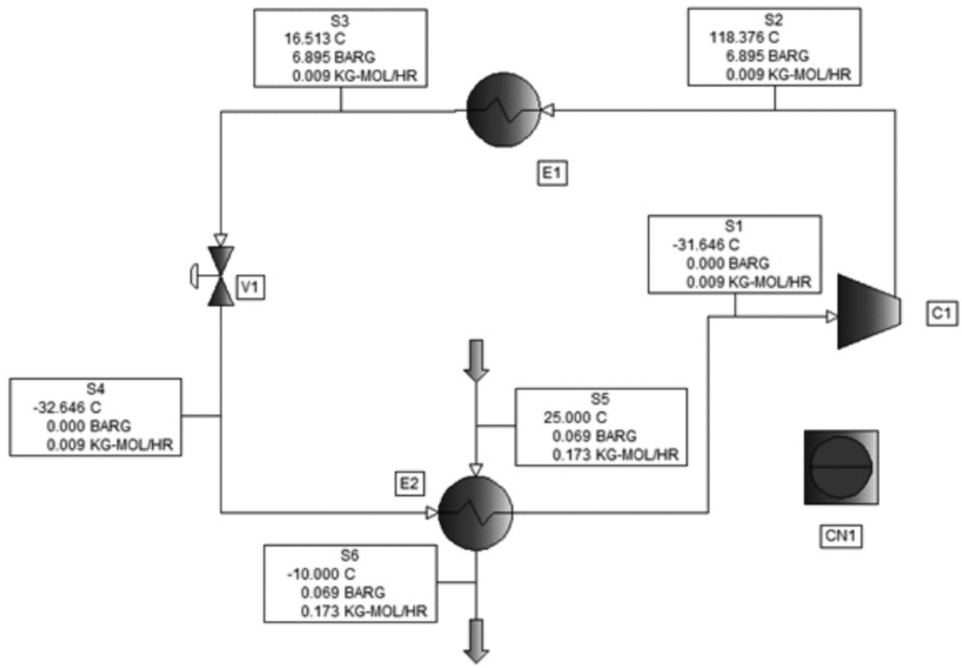


**Figure 8** Simulation model – vapour compression cycle

to ensure that the refrigerant was in vapour phase at the outlet. Similarly, the condenser (E1) is set to 1 degree kelvin drop below bubble point to ensure that the refrigerant was in liquid phase. The compressor (C1) has been set to have an exit pressure of 689.5 kPa-g while the throttle valve (V1) has an exit pressure of 0 kPa-g. The streams (S1 to S4) contain the refrigerant while stream (S5 and S6) contain air.

Two controllers are used in the simulation program. The first controller sets the order of the component calculations based on initial conditions set at stream 1 (S1). The second controller varies flow rate of the refrigerant until the duty value of the evaporator was reached. The duty valve of an evaporator is also known the cooling load. This is used for the sizing of the evaporator for a refrigeration system as well as calculating the coefficient of performance of the system. The selected system is for operating temperatures from -40°C to 0°C. Therefore the refrigerants used for this system must have an exit temperature below -20°C after the throttle valve. The selected refrigerants used include both a mixture of non-organic and organic refrigerants for a comparison in performance. The following refrigerants have been selected:

- Commonly Used
  - R-12
  - R-22
  - R-134a
- Future Refrigerants
  - CH4 (R-50)
  - C2H6 (R-170)
  - C3H8 (R-290)
  - $NH_3$ (R-717)
  - $C0_2$ (R-744)

The following assumptions have been made:

- No external heat losses (through pipes)
- Mass flow rate is consistence at all locations
- Compressor, condenser and evaporator efficiencies are set to 100%

### 3.2 Single temperature system

The aim of this test objection is to find the optimum COP for the delivery and suction pressures of 689.5 kPa-g and 0 kPa-g respectively. The room size has not been determined as the simulation program is a steady-state simulator and therefore no time estimate can be taken. The mass flow rate of air is set to 1 kg/hr. This allows scaling to be taken place as flow rate between the refrigerant and air is proportional at a 1.1 ratio.

### 3.3 Scaled system

The scaled system is derived from the single temperature system. However, the duty valve is calculated from the total product load and hence the system is scaled proportionally. The duty required to cool 1 tonne of tuna from 25°C to three different room temperatures (-25°C, -20°C and -15°C) can be obtain using the total product load. The total product load is the sum of sensible heat and latent heat of freezing [25].

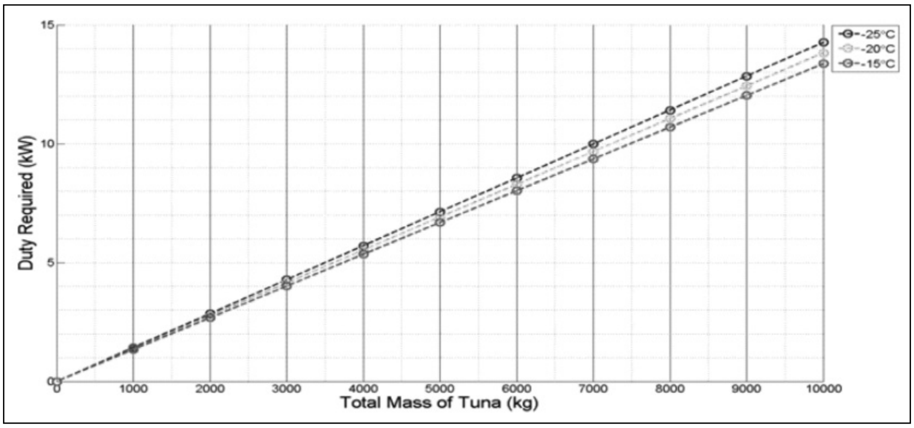


**Figure 9** Total duty required

The duty required by the evaporator and mass of tuna is shown in Figure 9. As the mass of tuna increases, the required duty is proportionally increased. Similar, as the set temperature is reduced, the required duty also increases. The values for duty are shown in Table 4.

**Table 4** Evaporator duty required

| Mass of tuna (kg) | Evaporator duty required (kW) | | |
|---|---|---|---|
| | -25°C | -20°C | -15°C |
| 1000 | 1.43 | 1.38 | 1.34 |
| 2000 | 2.85 | 2.76 | 2.67 |
| 3000 | 4.28 | 4.14 | 4.01 |
| 4000 | 5.71 | 5.53 | 5.35 |
| 5000 | 7.13 | 6.91 | 6.68 |
| 6000 | 8.56 | 8.29 | 8.02 |
| 7000 | 9.98 | 9.67 | 9.35 |
| 8000 | 11.41 | 11.05 | 10.69 |
| 9000 | 12.84 | 12.43 | 12.03 |
| 10000 | 14.26 | 13.81 | 13.36 |

## 4 RESULTS AND DISCUSSION

In this section the Coefficients of Performance (COP) for different refrigerants are compared as well as economic, environmental and general safety matters are provided.

The coefficient of performance of refrigeration (COP) for all tested refrigerants was recorded and shown in Table 5. The highest recorded COP are 3.84 and 3.46 for ammonia (R717) and carbon dioxide (R744) respectively. The lowest COP recorded is 2.67 for methane (R50). 1,1,1,2-tetrafluoroethane (R134a) performance is much greater than that of the selected hydrocarbons, methane (R50), ethane (R170) and propane (R290), with percentage differences of 24.72%, 10.63% and 11.74% respectively.

The mass flow rates of each refrigerant required to reduce the temperature of air from 25°C to the temperature set point varies greatly between the refrigerants as shown in Table 6. The mass flow rate of air remains constant at 1 (kg/hr) allowing a direct comparison between the sizes of the refrigeration plant at the same required evaporator duty. Dichlorodifluoromethane (R-12) requires the highest mass flow rate at 0.452 kg/hr whereas ammonia (R-717) only requires 0.043 kg/hr (percentage difference of 90.49% reduction). Comparing the flow rates to the refrigeration affect, this relation is apparent. A high refrigeration effect will yield a low mass flow rate of the refrigerant required (smaller system). Furthermore, the compressor power required is also greater for that of R-12 compared to R-717.

Ammonia (R-717), carbon dioxide (R-744), 1,1,1,2-tetrafluoroethane (R-134a) and chlorodifluoromethane (R-22) have shown to have high $COP_{REFRIG}$ whereas the hydrocarbons, methane (R-50), ethane (R-170) and propane (R-290), and dichlorodifluoromethane (R-12) have a poor performance in comparison. Dichlorodifluoromethane (R-12) has been phased out in Australia and a total phase out of chlorodifluoromethane (R-22) is to be completed by 2020. Possible options for a replacement for R134a are carbon dioxide (R-744) and ammonia (R-717).

### 4.1 Running cost

Using the required duty values calculated for 1 tonne of tuna stored at -25°C, the total input power of the compressor is determined as well as the running cost of the system. The running cost of 0.30 ($/kW-hr) is assumed. The true running cost is based on the setup of the fishing vessel with the generator brake specific fuel consumption (BSFC) and percentage of generator loading which will vary on trawler to trawler.

The running cost has been compared to that of 1,1,1,2-tetrafluoroethane (R-134a) as shown in Table

**Table 5** Coefficients of Performance (COP) for different refrigerants

| ASHRAE Number | Specific Enthalpy (kJ/kg) | | | | Adiabatic Compression (kJ/kg) | Refrigeration Effect (kJ/kg) | $COP_{REF}$ |
|---|---|---|---|---|---|---|---|
| | h1 | h2 | h3 | h4 | | | |
| R-12 | 142.47 | 179.26 | 31.53 | 31.53 | 36.79 | 110.94 | 3.02 |
| R-22 | 193.76 | 245.70 | 20.62 | 20.62 | 51.93 | 173.14 | 3.33 |
| R-50 | -154.95 | -3.71 | -559.37 | -559.37 | 151.24 | 404.42 | 2.67 |
| R-134a | 187.51 | 230.88 | 43.03 | 43.03 | 43.37 | 144.47 | 3.33 |
| R-170 | 234.90 | 358.47 | -136.43 | -136.43 | 123.57 | 371.33 | 3.01 |
| R-290 | 332.51 | 429.20 | 44.06 | 44.06 | 96.70 | 288.45 | 2.98 |
| R-717 | 1260.03 | 1566.23 | 82.89 | 82.89 | 306.20 | 1177.14 | 3.84 |
| R-744 | 217.19 | 309.54 | -102.44 | -102.44 | 92.35 | 319.63 | 3.46 |

**Table 6** Mass flow rate of refrigerants

| ASHRAE Number | Refrigerant Mass Flow Rate (kg/hr) for 1 (kg/hr) of air | | | | | |
|---|---|---|---|---|---|---|
| | T = -25°C | T = -20°C | T= -15°C | T = -10°C | T = -5°C | T = 0°C |
| R-12 | 0.452 | 0.407 | 0.362 | 0.316 | 0.271 | 0.226 |
| R-22 | 0.290 | 0.261 | 0.232 | 0.203 | 0.174 | 0.145 |
| R-50 | 0.124 | 0.112 | 0.099 | 0.087 | 0.074 | 0.062 |
| R-134a | 0.347 | 0.312 | 0.278 | 0.243 | 0.208 | 0.174 |
| R-170 | 0.135 | 0.122 | 0.108 | 0.095 | 0.081 | 0.068 |
| R-290 | 0.174 | 0.156 | 0.139 | 0.122 | 0.104 | 0.087 |
| R-717 | 0.043 | 0.038 | 0.034 | 0.030 | 0.026 | 0.021 |
| R-744 | 0.157 | 0.141 | 0.126 | 0.110 | 0.094 | 0.078 |

**Table 7** Running cost

| ASHRAE Number | Mass Flow Rate Refrigerant (kg/hr) | Input Power (kW) | Assumed Cost ($/kW-hr) | Running Cost ($) | | | | Difference (%) |
|---|---|---|---|---|---|---|---|---|
| | | | | hour | day | month | year | |
| R-12 | 231.43 | 2.365 | 0.30 | 0.71 | 17 | 511 | 6130 | 10.47 |
| R-22 | 148.29 | 2.139 | 0.30 | 0.64 | 15 | 462 | 5545 | -0.08 |
| R-50 | 63.49 | 2.667 | 0.30 | 0.80 | 19 | 576 | 6913 | 24.58 |
| R-134a | 177.72 | 2.141 | 0.30 | 0.64 | 15 | 462 | 5549 | - |
| R-170 | 69.14 | 2.373 | 0.30 | 0.71 | 17 | 513 | 6151 | 10.85 |
| R-290 | 89.01 | 2.391 | 0.30 | 0.72 | 17 | 516 | 6197 | 11.67 |
| R-717 | 21.81 | 1.855 | 0.30 | 0.56 | 13 | 401 | 4809 | -13.34 |
| R-744 | 80.33 | 2.061 | 0.30 | 0.62 | 15 | 445 | 5341 | -3.75 |

7. The most cost effective option is shown to be ammonia (R-717) and carbon dioxide (R-744) compared to R-134a with a reduction in running cost by -13.34 and -3.75%. Methane (R-50), ethane (R-170) and propane (R-290) will increase the running cost by 24.48%, 10.85% and 11.67% respectful and is not recommended as a replacement for R134a.

Although ammonia has the highest COP and the lowest running cost, it is not recommended for this system due to the toxicity of the gas. Refrigeration systems can leak and care must be taken when dealing with toxic refrigerants. Leakage of ammonia gas to into the frozen products via the evaporator can potentially cause harm to the consumers. However, ammonia has a unique odour that can easily be detected. Furthermore, carbon dioxide is an odourless gas which is difficult to detect although can be harmful depending on the concentration.

## 5 CONCLUSION

The *Montreal Protocol* has phased out the commonly used refrigerants in the marine industry such as R-12 and R-22. Replacement refrigerants included R-134a and R-717 with future research into natural refrigerants. With the use of PRO/II, a simulation program, a vapour compression cycle was constructed to test varies refrigerants to calculate the coefficient of performance for refrigeration. A second investigation was conducted to find a cost effective option for the replacement of R-134a due its global warming potential. A final consideration to safety was also conducted.

The highest performances for refrigeration were recorded at 3.84 and 3.46 for ammonia (R-717) and carbon dioxide (R-744) respectively.

1,1,1,2-tetrafluoroethane (R-134a) performance is recorded at 3.33 showing that two suitable cost effective replacements for R-134a are ammonia and carbon dioxide to improve running costs as well as a large reduction in global warming potential. As the initial cost of upgrading the system from one refrigerant to another has not been considered, only the running costs were compared. The safety consideration for the use of ammonia (R-717) and carbon dioxide (R-744) showed that carbon dioxide is the preferred refrigerant with a compromise on performance due to toxicity levels. The hydrocarbons have the lowest recorded performances at 2.67, 3.01 and 2.98 for methane (R-50), ethane (R-170) and propane (R-290), with percentage differences of 24.72%, 10.63% and 11.74% compared to R-134a respectively. Ethane and propane can be used for as replacement for R-134a at a reduced performance (higher running costs) as well as methane at a much larger reduction in performance. However, this is not recommended as it is not cost effective.

For new built refrigeration systems, carbon dioxide is recommended to be used to ensure a high performance and low global warming potential. Future work is recommended for future investigation into different refrigeration systems such as absorption refrigeration systems, multistage compression cycles, cascade systems etc. Initial cost estimates should be calculated for an overall cost effectiveness of replacing the refrigerants with rate of return.

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# TRAINING MARITIME SPECIALISTS FOR TRANSPORT SERVICE OF FISHING VESSELS

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**Abstract.** Training specialists in the Baltic Fishing Fleet State Academy (BFFSA) for organization of the maritime transportations includes studying the subject "Management of fleet operations". Cadets have to know and to use different approaches for managing, in particular, fishing fleet operations [4]. Fishery is a specific part of the maritime industry and one of organization forms is the fishing expedition when a fleet of fishing vessels is created. The expedition allows to exploit distant (ocean) fishing grounds. Receiving and transport vessels, floating bases (mother ships) are also included in the expedition in order to supply vessels with all the necessary, storage and processing of fish. An important task is optimization of the fishing vessels transport service. The transport service consists of the delivery on the fleet location such kind of objects as technical and technological supplies, food, products for the crew life support, fuel, fresh water, etc. Also it is necessary to provide unloading fish or finished fish products from fishing vessels and their transportation to the ports of destination. The efficiency of the fishing fleet is largely dependent on the level of the service logistics. Therefore, it is important to study so named "fishing logistics" as a part of the above mentioned subject. One of the goals of such kind of logistics is enhancing the efficiency of the fleet operations through the use of methods and models for optimization of the transport service [3]. There are the special conditions at fishing grounds: objects of fishery are inherently mobile; the weather is characterized with seasonality and "aggressiveness" (hydro-meteorological conditions); loading and unloading operations are carried out mainly at open sea; the regimes of maritime areas are governed by international laws and conventions. These conditions determine the character of the fishery and should be considered when designing logistics of the fishing fleet service by the transport fleet. A project-based approach and methods of the operations research are used as the methodological basis for training cadets to design the project of the fleet service. Basic principles of the project are the optimality and variability. Optimization of design solutions and plans of the fishing vessels service at ocean fishing grounds is based on mathematical and heuristic methods and practice-oriented models. Optimizing the vessels service is carried out according to the time criterion. The use of the project-based approach in the management of the transport service of the fishing fleet allows to improve significantly its quality as well as the fishery efficiency and the safety of fishing vessels. The paper describes an example (a case study) of the solution for one of specific/real problems.

**Key words:** training fishing fleet specialists, project-based approach, optimization of vessels transport service

# 1 THE STATEMENT OF THE PROBLEM

One of the important problems in industrial fishery is increasing the fishing time of vessels

and the volume of their catch respectively. Solving this problem, in particular, depends on the time, i.e. the speed of handling (servicing) the vessels at sea. In this regard, it is necessary to define the right order of the vessels handling by the servicing vessel (a floating fish factory or a transport vessel). The main condition is to minimize the total handling time of the group of fishing vessels as well as the downtime of the servicing vessel. A methodological basis for designing and planning the complex of the fish fleet servicing are the systematic approach and methods of the operations research.

## 1.1 A task of the transport service of fishing vessels

Let us suppose that fishing vessels operate at a fishing ground and have different distances to the servicing vessel: the refrigerated fish transport or the fish carrier (further – the transport vessel). The transport vessel has to handle these fishing vessels (unloading fish products/fish raw materials and loading some supply). We suppose that several fishing vessels: 1, 2, 3, ... $N$ work on catching at the fishing ground (the square). Each fishing vessel has to follow to the transport vessel with the full catch for handling and to return after handling at the fishing ground to continue fishing. The whole cycle performed by the vessel is shown schematically in Figure 1.

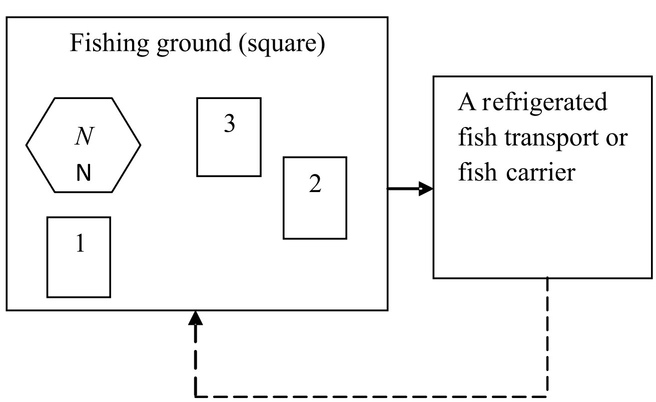


**Figure 1** Cycle of fishing vessels transport servicing

There are the following recurrence relations:

$$\left.\begin{aligned}
{}_1 &= t_1 \\
{}_2 &= \max\left(t_1 + t_2 - \tau_1 - X_1, 0\right) \\
{} + X_2 &= \max\left(t_1 + t_2 - \tau_1, t_1\right) \\
{}_3 &= \max\left(\sum_{i=1}^{3} \mathrm{t}_1 - \sum_{i=1}^{2} \tau_\mathrm{i} - \sum_{i=1}^{2} X_\mathrm{i}, 0\right) \\
{} + X_2 + X_3 &= \max\left(\sum_{i=1}^{3} \mathrm{t}_\mathrm{i} - \sum_{i=1}^{2} \tau_\mathrm{i}, \sum_{i=1}^{2} t_i - \tau_1, t_1\right)
\end{aligned}\right\} \qquad (1)$$

Then the following expressions are received using an induction:

$$\left.\begin{aligned}
&\sum_{i=1}^{N} X_i = \max, K_n \\
&K_n = \sum_{i=1}^{n} i - \sum_{i=1}^{n-1} \tau_\mathrm{i} \\
&1 \le n \le N
\end{aligned}\right\} \qquad (2)$$

Minimization expressions (2) is required to solve the given task of optimization of fishing vessels relocation. An algorithm for solution of this problem was developed by the dynamic programming method [1, 2].

## 1.2 Solution of the task by the dynamic programming method

Let us denote that the expression $\varphi(t_1, \tau_1, t_2, \tau_2, ..., t_n, \tau_n, T)$ is the time required to make a full cycle for $N$ number of fishing vessels. The handling process starts at the time $T$ when the $i$-th fishing vessel begins the trip from the fishing ground to the transport vessel, $t_i$ – the trip time, $\tau_i$ – handling time of the $i$-th vessel at the optimum relocation. Pairs of vessels are denoted by symbols $ij$ in order to identify their relocations. The functional equation:

$$\begin{aligned}
&\varphi(t_1, \tau_1, t_2, \tau_2, ..., t_n, \tau_n, T) = \\
&= \min\,[t_1 + \varphi(t_1, \tau_1, t_2, \tau_2, ..., 0, 0, ..., t_N, \tau_N, \tau_i + \\
&+ \max\,(T - t_i, 0)]
\end{aligned} \qquad (3)$$

is obtained when the i-th vessel begins the trip and the handling process.

The pair (0, 0) replaces the pair $(t_i, \tau_i)$ in the expression (3). The optimal relocation is obtained by replacing two vessels using the expression (3), i.e. the $i$-th vessel follows to the transport vessel first and then it makes the $j$-th vessel.

$$\begin{aligned}
&\varphi(t_1, \tau_1, t_2, \tau_2, ..., t_T, \tau_T, T) = t_i + t_j + \\
&+ \varphi(t_1, \tau_1, 0, 0, ..., t_N, \tau_N, T_{ij})
\end{aligned} \qquad (4)$$

where:

$$\begin{aligned}
T_{ij} &= \tau_j + \max\,[\tau_i + \max\,(T - t_i, 0) - t_j, 0] = \\
&= \tau_j + \tau_i - t_j + \max\,[\max\,(T - t_i, 0), t_j - \tau_i] = \\
&= \tau_j + \tau_i - t_i - t_j + \max\,[T, t_i + t_j - \tau_i, t_i)] = \\
&= \tau_j + \tau_i - t_j - t_i + \max\,[T, \max\,(t_i + t_j - \tau_i, t_i)]
\end{aligned} \qquad (5)$$

It is seen from the expression (5) that:

$$\max\,(t_i + t_j - \tau_i, t_i) < \max\,(t_i + t_j - \tau_j, t_j) \qquad (6)$$

It makes sense to relocate the $i$-th and $j$-th vessels. Their relocation is reasonable when:

$$\min\,(\tau_i, t_j) > \min\,(\tau_j, t_i) \qquad (7)$$

## 2 AN ALGORITHM FOR DETERMINATION OF THE OPTIMAL RELOCATION OF VESSELS

Results described by expressions (6, 7) allow to determine the optimum relocation of the fishing vessels using the following algorithm:

1) to obtain information about the state of fishing vessels and to fill Table 1;
2) to determine the list of fishing vessels to be handled by the transport vessel;
3) to define values of parameters $t_i$ and $\tau_i$ according to data in Table 1 and to fill Table 2;
4) to find the least among the values of $t_i$ and $\tau_i$;
5) if the least value would be one of the value $t_i$, this vessel begins first to make the trip to the transport vessel;
6) if the least value would be one of the value $\tau_i$, this vessel is the last handled by the transport vessel;
7) to delete values of $t_i$ and $\tau_i$ in Table 2;
8) to repeat this process with the $(2n - 2)$ remaining values;
9) to select the vessel with a lower number of priority if there are the several minimum valuesand to order vessels on the value of $t_i$ if $t_i$ is equal to $\tau_i$;
10) to calculate the schedule of handling (Table 3).

### 2.1 A practical example (case study) for planning the transport service of fishing vessels

Let us assume that the transport vessel works at sea with six fishing vessels. The conditions of fishing are relatively stable. At the beginning of the period the state of the vessels group is determined by the parameters given in Table 4.

**Table 1** Data on the location and catches of fishing vessels

| Parameters | | Data | | | |
|---|---|---|---|---|---|
| Hull number of the vessel | $N$ | $N_1$ | $N_2$ | ... | $N_n$ |
| Type of the vessel | | A | B | ... | ... |
| Coordinates of the vessel | Latitude $\varphi_i$ | $\varphi_1$ | $\varphi_2$ | ... | $\varphi_n$ |
| | Longitude $\lambda_i$ | $\lambda_1$ | $\lambda_2$ | ... | $\lambda_n$ |
| Distance to the transport vessel | $S_i$, miles | $S_1$ | $S_2$ | ... | $S_n$ |
| Speed of the vessel | $V_i$, knots | $V_1$ | $V_2$ | ... | $V_n$ |
| Catch | $Q_i$, tons | $Q_1$ | $Q_2$ | ... | $Q_n$ |

**Table 2** Values of fishing vessels parameters

| Parameters | Data | | | |
|---|---|---|---|---|
| Hull number of the vessel | $N_1$ | $N_2$ | ... | $N_n$ |
| i | 1 | 2 | ... | N |
| $t_i$ | $T_1$ | $T_2$ | ... | $T_n$ |
| $\tau_i$ | $\tau_1$ | $\tau_2$ | ... | $\tau_n$ |

**Table 3** Form of a schedule of fishing vessels handling by the transport vessel

| Parameters | | Data | | | |
|---|---|---|---|---|---|
| № of the order | | 1 | 2 | ... | $n$ |
| Hull number of the vessel | $N_i$ | $N_1$ | $N_2$ | ... | $N_n$ |
| Catch | $Q_i$, tons | $Q_1$ | $Q_2$ | ... | $Q_n$ |
| Period of working time | Start $T_{si}$ | $T_{s1}$ | $T_{s2}$ | ... | $T_{sn}$ |
| | Finish $T_{fi}$ | $T_{f1}$ | $T_{f2}$ | ... | $T_{fn}$ |
| Working time | $\tau_i$, hours | $\tau_1$ | $\tau_2$ | ... | $\tau_n$ |

**Table 4** Dislocation of fishing vessels at the fishing ground

| Parameters | | Data | | | | | |
|---|---|---|---|---|---|---|---|
| Hull number of the vessel | $N$ | 1 | 2 | 3 | 4 | 5 | 6 |
| Type of the vessel | | A | B | C | D | E | F |
| Coordinates of the vessel | Latitude $\varphi_i$ | $\varphi_1$ | $\varphi_2$ | $\varphi_3$ | $\varphi_4$ | $\varphi_5$ | $\varphi_6$ |
| | Longitude $\lambda_i$ | $\lambda_1$ | $\lambda_2$ | $\lambda_3$ | $\lambda_4$ | $\lambda_5$ | $\lambda_6$ |
| Distance to the transport vessel | $S_i$, miles | 7 | 10 | 5 | 12 | 5 | 6 |
| Speed of the vessel | $V_i$, knots | 7 | 9 | 10 | 10 | 7 | 10 |
| Catch | $Q$, tons | 5 | 10 | 7 | 15 | 8 | 12 |

**Table 5** Stepwise solution of the problem of determining the order of fishing vessels handling by the transport vessel

| i | $t_i$, hours | $\tau_i$, hours | On the first step | | | On the second step | | |
|---|---|---|---|---|---|---|---|---|
| | | | i | $t_i$, hours | $\tau_i$, hours | i | $t_i$, hours | $\tau_i$, hours |
| 1 | 1.0 | 0.7 | 3 | 0.5 | 0.9 | 3 | 0.5 | 0.9 |
| 2 | 1.1 | 1.0 | 1 | 1.0 | 0.7 | 6 | 0.6 | 1.0 |
| 3 | 0.5 | 0.9 | 2 | 1.1 | 1.0 | 1 | 1.0 | 0.7 |
| 4 | 1.2 | 1.1 | 4 | 1.2 | 1.1 | 2 | 1.1 | 1.0 |
| 5 | 0.7 | 1.2 | 5 | 0.7 | 1.2 | 4 | 1.2 | 1.1 |
| 6 | 0.6 | 1.0 | 6 | 0.6 | 1.0 | 5 | 0.7 | 1.2 |

**Table 6** The optimum order of the fishing vessels approach to the transport vessel

| i | $t_i$ | $\tau_i$ |
|---|---|---|
| 3 | 0.5 | 0.9 |
| 6 | 0.6 | 1.0 |
| 5 | 0.7 | 1.2 |
| 4 | 1.2 | 1.1 |
| 2 | 1.1 | 1.0 |
| 1 | 1.0 | 0.7 |

**Table 7** The schedule of handling vessels

| Parameters | | Data | | | | | |
|---|---|---|---|---|---|---|---|
| № of the order | | 1 | 2 | 3 | 4 | 5 | 6 |
| Hull number of the vessel | $N_i$ | 3 | 6 | 5 | 4 | 2 | 1 |
| Catch | $Q_i$, tons | 7 | 12 | 8 | 15 | 10 | 5 |
| Period of working time | Start $T_{si}$, hour$^{min}$ | $0^{00}$ | $0^{54}$ | $1^{54}$ | $3^{06}$ | $4^{12}$ | $5^{12}$ |
| | Finish $T_{fi}$, hour$^{min}$ | $0^{54}$ | $1^{54}$ | $3^{06}$ | $4^{12}$ | $5^{12}$ | $5^{54}$ |
| Working time | $\tau_i$, hours | 0.9 | 1.0 | 1.0 | 1.1 | 1.0 | 0.7 |

Parameters $t_i$ and $\tau_i$ for each fishing vessel are defined and Table 5 is formed.

The optimal order of the fishing vessels approach for handling by the transport vessel is obtained using further to the above algorithm (Table 6).

Then the schedule of handling vessels (Table 7) is calculated. An analysis of the sensitivity of the solution allows to determine the limits of the parameters variation where the found strategy of fishing vessels handling by the transport vessel remains optimal [6]. Thus, in this example, an increase of the catch of 20% does not change the order but the handling schedule requires adjustment on time.

## 3 CONCLUSION

The proposed mathematical model can be used as a simulation of the process of transport service of fishing vessels. It allows to study and to analyze the behavior of the system "fleet service" under its different initial data and parameters. Also the model gives a possibility to find the options for the system improving (for example, to improve the efficiency of loading and unloading operations).

The given above algorithm for determining the optimal handling of fishing vessels was tested in practice. The efficiency of the proposed method was verified by comparing the results of the implementation of the decisions taken by the traditional method with solutions based on the use of the algorithm for solving the problem by dynamic programming.

Thus, the result of 20-th realizations (under approximately the same conditions of the fleet operation) shows that the use of the optimization algorithm of the fishing vessels priority service minimized by 15-20% downtime of the transport vessel and the loss of fishing time by fishing vessels [5].

The fishing process has a probabilistic character; however the proposed method allows to find approximate strategies even in more complex models.

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# EDUCATING/TEACHING STUDENTS OF MARITIME STUDIES ABOUT MEDICINE FOR SEAFARERS

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**Abstract.** Life on board ships is very demanding. Seafarers live and work together in a confined and isolated environment and may be away from home for months at a time. Sailing increases the chances of sustaining serious injury or loss of health. Medical assistance on board is provided by doctors only on large passenger ships (transatlantic and cruise ships) and with the exception special purpose ships such as research ships or off-shore vessels designed for divers. Merchant navy ships do not have a doctor on board. There is often no immediate access to medical care. Therefore, according to international conventions, all crew members must know how to provide first aid. If the provision of medical care involves more complex procedures or if there are doubts as to proper treatment, the vessel may request radio medical advice or helicopter transport.

At the Faculty of Maritime studies in Split, Medical First Aid is mandatory for all graduate students (as a course on its own or as part of a course), while Medicine for Seafarers is a mandatory course for the students of Nautical Engineering, Marine Engineering, and Marine Electrical Engineering and Information Technologies. The course in Medicine for Seafarers includes Medical First Aid and Medical Care. During the course, it is very important to keep in mind that one is teaching medicine to lay persons with no medical background and with no or very scarce knowledge of medical issues.

**Key words:** education, first aid, medical care, students of Maritime studies

## 1 INTRODUCTION

Maritime professions have been considered dangerous since the beginning of sailing until today.

Throughout history, ships of various European navies often boarded physicians as crew members. However, physicians were rarely found on board merchant navy ships and the trend persists to this day.

Although injuries and poisoning account for most of the health problems on board merchant ships, contagious diseases may pose a serious threat, bringing into danger not only the health of other seafarers but also the safety of the ship and, where carried, passengers. It is particularly important that seafarers concerned with the preparation of food do not suffer from conditions which may be transmitted to others through their work. Therefore seafarers should know the basic concepts of how infectious diseases are transmitted.

Ships carrying 100 or more persons and ordinarily engaged on international voyages of more than three days' duration shall carry a qualified medical doctor who is responsible for providing medical care. According to the Maritime Labour Convention (MLC, 2006; Standard A4.1- Medical care on board ship and ashore), ships that do not carry a medical doctor shall be required to have either at least one seafarer on board who is in charge of medical care and administering medicine as part of their regular duties or at least one seafarer on board competent to provide medical first aid. Persons in charge of medical care on board who are not medical doctors shall have satisfactorily completed training in medical care. Hence, what must be made available is medical equipment, a person trained to use it and ready access to information on the prevention, diagnosis and treatment of a disease. Normally this is in the form of a manual and is supported by international arrangements for access to radio medical advice all over the world.

In the Republic of Croatia, according to the above Convention (MLC 2006) and national laws and regulations, all ships shall carry a medicine chest, medical equipment and a medical guide, the specifics of which shall be prescribed and subject to regular inspection by the competent authority; the national requirements shall take into account the type of ship, the number of persons on board and the nature, destination and duration of voyages and relevant nationally and internationally recommended medical standards.

## 2 ABOUT THE FACULTY OF MARITIME STUDIES IN SPLIT

The basic activity of the Faculty of Maritime Studies is the establishment and performance of university undergraduate, graduate and post-graduate studies in compliance with the Bologna declaration, as well as the organization and performance of highly professional and scientific research in the area of maritime affairs.

Undergraduate (Bachelor's Degree) and graduate (Master's Degree) university studies are: Nautical Engineering, Marine Engineering, Marine Electrical Engineering and Information Technologies, Maritime Management, and Maritime Yacht and Marina Technologies.

The study programmes of the Faculty belong to the scientific area of technical sciences, scientific field of traffic and transport technologies, under the branch of maritime traffic.

The programmes imply the study of basic and elective courses with the continuous updating of the process of education. The objective and the purpose of all study programmes is the education of maritime experts according to international standards and regulations as well as the implementation of the principle of life-long education as the basic element of European higher education.

A specific feature of the studies is comparability with study programmes of similar higher education institutions in the world and the European Union, significant multidisciplinarity and intertwining of science and profession.

The Faculty of Maritime Studies is equipped with the most sophisticated educational equipment that meets the requirements of world maritime organizations. There are the nautical, marine engine room and GMDSS simulators, well-equipped information technology rooms, an electrical engineering laboratory and a first aid room.

The Faculty staff also performs seafarer training for the certifications required on board. The teaching consists of theoretical and practical parts as well as special training programme on the most up-to-date training devices and simulators used worldwide.

There are around 1400 students enrolled at the Faculty in all of its programmes and undergraduate and graduate studies.

## 3 MARITIME LABOUR CONVENTION (MLC 2006)

The Maritime Labour Convention is a very important document with which we have to acquaint the students of the Faculty of Maritime Studies. The purpose of this Convention is to protect the health of seafarers and ensure their prompt access to medical care on board ship and ashore.

Contents of this Convention are:

- Minimum requirements for seafarers to work on a ship,

- Conditions of employment,
- Accommodation, recreational facilities, food and catering,
- Health protection, medical care, welfare and social security protection,
- Compliance and enforcement.

The Convention lays down that each Member shall ensure that all seafarers on ships that fly its flag are covered by adequate measures of health protection and that they have access to prompt and adequate medical care whilst working on board.

The protection and care shall, in principle, be provided at no cost to the seafarers.

Each Member shall ensure that seafarers on board ships in its territory who are in need of immediate medical care are given access to the Member's medical facilities on shore.

The requirements for on-board health protection and medical care set out in the Code include standards for measures aimed at providing seafarers with health protection and medical care as comparable as possible to that which is generally available to workers ashore.

In terms of medical care on board ships and ashore, the Convention lays down the following:

1. Each Member shall ensure measures to provide health protection and medical care, including essential dental care, for seafarers working on board a ship that flies its flag, which:
   (a) ensure the application to seafarers of any general provisions on occupational health protection and medical care relevant to their duties, as well as of special provisions specific to work on board ship;
   (b) ensure that seafarers are given health protection and medical care as comparable as possible to that which is generally available to workers ashore, including prompt access to the necessary medicines, medical equipment and facilities for diagnosis and treatment, and to medical information and expertise;
   (c) give seafarers the right to visit a qualified medical doctor or dentist without delay in ports of call, where practicable;
   (d) ensure that, to the extent consistent with the Member's national law and practice, medical care and health protection services while a seafarer is on board ship or landed in a foreign port are provided free of charge to seafarers; and
   (e) are not limited to treatment of sick or injured seafarers but include measures of a preventive character such as health promotion and health education programmes.
2. The competent authority shall adopt a standard medical report form for use by the ships' masters and relevant onshore and on-board medical personnel. The form, when completed, and its contents shall be kept confidential and shall only be used to facilitate the treatment of seafarers.
3. Each Member shall adopt laws and regulations establishing requirements for on-board hospital and medical care facilities and equipment and training on ships that fly its flag.
4. National laws and regulations shall as a minimum provide for the following requirements:
   (a) all ships shall carry a medicine chest, medical equipment and a medical guide, the specifics of which shall be prescribed and subject to regular inspection by the competent authority; the national requirements shall take into account the type of ship, the number of persons on board and the nature, destination and duration of voyages and relevant national and international recommended medical standards;
   (b) ships carrying 100 or more persons and ordinarily engaged on international voyages of more than three days' duration shall carry a qualified medical doctor who is responsible for providing medical care; national laws or regulations shall also specify which other ships shall be required to carry a medical doctor, taking into account, inter alia, such factors as the duration, nature and conditions of the voyage and the number of seafarers on board;
   (c) ships which do not carry a medical doctor shall be required to have either at least one seafarer on board who is in charge of medical care and administering medicine as part of their regular duties or at least one seafarer on board competent to provide medical first aid; persons in charge of medical care on board who are not medical doctors shall have satisfactorily completed training in medical care that meets the requirements of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended ("STCW"); seafarers designated to provide medical first aid shall have satisfactorily completed training in medical first aid that meets the requirements of STCW; national laws or regulations shall specify the level of approved training required taking into account, inter alia, such factors as the duration, nature and conditions of the voyage and the number of seafarers on board; and
   (d) the competent authority shall ensure by a prearranged system that medical advice by radio or satellite communication to ships at sea, including specialist advice, is available 24 hours a day; medical advice, including the onward

**Table 1** Medical training for seafarers

| Certificate of Qualification | STCW number | Hours | Mandatory participants |
|---|---|---|---|
| Basic First Aid | D2-STCWVI/4 | 8 | All crew members |
| Certificate on qualification to provide medical first aid | D19-STCW VI/4 | 21 | All crew members |
| Qualified to provide medical care on board ship | D19-STCW VI/4 | 45 | officers |

transmission of medical messages by radio or satellite communication between a ship and those ashore giving the advice, shall be available free of charge to all ships irrespective of the flag that they fly.

## 4 THE LEGISLATION AND EDUCATION IN CROATIA RELATED TO THE TRAINING OF SEAFARERS IN FIRST AID AND MEDICAL CARE

All national documents about maritime affairs are in accordance with the Maritime Labour Convention (MLC 2006) and international conventions. The *STCW Convention* from 1978 is a very important convention from the maritime health professional's point of view. It is the convention regulating the pre-sea medical and periodic examinations of seafarers, despite being very general in its approach. It also set up the standards for emergency medical training requirements for different groups of personnel on board. Training in medical emergency procedures and medical care is another very important issue for the STCW Convention. The training requirements differ according to position on board.

All ships shall carry a medicine chest, medical equipment and a medical guide. At national level there is the Ordinance on the minimum requirements and conditions for providing medical care on board vessels, boats and yachts (*Official Gazette of the Republic of Croatia*, No 14/2008) which takes into account the type of ship, the number of persons on board and the nature, destination and duration of voyages and relevant national and international recommended medical standards.

*The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers* (STCW) requires that all maritime officers get a certificate in *First Aid* and in *Medical Care on Board Ships*. The company designates the officer in charge of the ship's pharmacy and healthcare of the crew on board in line with its company policy. In practice, the level of knowledge acquired through seafarer training (Table 1) is often inadequate for any more complicated interventions or first aid treatment.

The training/education of students of the Faculty of Maritime Studies is in accordance with the most recent editions of the *International Medical Guide for Ships*, the *Medical First Aid Guide for Use in Accidents Involving Dangerous Goods*, the *Document for Guidance – An International Maritime Training Guide*, and the medical section of the *International Code of Signals* as well as similar national guides.

## 5 OUR EXPERIENCE

Undergraduate students are mostly focused on learning the necessary minimum in order to pass the exam and obtain a certificate at the end of the course. Students who work and study have shown a much greater interest in the material presented since they are aware of the fact that they will sooner or later need to be able to apply it in practice.

It takes vast amounts of experience and effort to bring medical topics closer to students of technical sciences and to make them interested in the field. At the same time, it is very important to keep in mind during the course that one is teaching medicine to laypersons with no medical background and with no or very scarce knowledge of medical issues.

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# ENVIRONMENTAL EDUCATION FOR THE MARINER

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**Abstract.** Under the STCW[1] code all of are charged with teaching Pollution Prevention, Environmental Ethics and Environmental Regulations. We are also directed to teach about overall health and safety. The overarching charge to a mariner is to protect Human Life, The Environment and Property. The compliance of environmental regulations beyond MARPOL is further complicated by differing regulations amongst flag states as well as different areas of said flag states.

This paper will discuss the importance of Incorporating Environmental Management in perspective officer's curricula. At SUNY Maritime we offer a class, Environmental Management that is relevant to both deck and engine students. I would like to present the elements of the class and their relevance to Voyage Planning, Energy Efficient Voyage Planning, Environmental Awareness and Sustainability. The paper will go on to discuss the criminalization of the profession as well as the recommended steps to take to continually prove one's self and vessel in compliance.

The paper and talk will present tools available to assist the mariner in the understanding of his/her responsibilities, references on regulations available and a short film. Penalties for non-compliance will be discussed from a United States Department of Justice point of view. Much of the content was developed with help from a grant by the United States Fish and Wildlife Foundation to further mariner environmental education. The deliverables from the grant included the film as well as a website marinedefenders.com.

My intent would be to present a paper then do a presentation using PowerPoint and a short film. I would like to make my course curricula freely available to any interested member institution.

**Key words:** culture and communication, human element, maritime education, environmental responsibilities

[1] Tables A II/1, A II/3, A III/7, A V/1-2-2, A V1-1-2, etc. STCW Code

## 1 INTRODUCTION

The purpose of this paper is to present an example of a stand-alone environmental course for mariners, both deck and engine. This was developed in 2007 as an elective credit bearing course. Given the importance of the subject it is now mandatory in several deck and engine license curricula.

Under the STCW[2] code all of us are charged with teaching Pollution Prevention, Environmental Ethics and Environmental Regulations. We are also directed to teach about overall health and safety. The overarching charge to a mariner is to protect Human Life, The Environment and Property. Compliance with environmental regulations beyond MARPOL is further complicated by differing regulations among flag states as well as within different areas of said flag states.

In the latest iteration of the STCW code the teaching of environmental awareness, regulations and responsibilities are mandated. The purpose of this class is to makes students aware of the enormous responsibilities they hold with respect to environmental issues, the compliance with ever changing regulations and the legal ramifications of non-compliance.

In 2010 I applied for and was subsequently awarded a grant of $325,000 USD by the United States Fish and Wildlife Foundation. The purpose of the grant was to develop a comprehensive set of tools that were to be used for Mariner Environmental Education. In executing the grant, several components were developed. These included:

A web site (www.marine defenders.com[3]) containing educational material suitable for mariners of every level, from casual through commercial. The website also contains reference links for International, Federal, State and Local regulations. The site includes a direct link for reporting pollution.

A video: “Oil in our Waters”[4] is a 22-minute documentary about the illegal dumping of oil from ships. This film explores the extent of the problem, the impact of oil on the marine environment, the creation of MARPOL, the rewards for whistleblowers, and the penalties faced by polluters caught in the United States.

An iPhone app to be used in reporting spills/incidents to the National Response Center, which is the clearinghouse in the United States for the investigation of marine reporting incidents.

All of the material on the web site, as well as the film are in the public domain of the United States. This material is freely available to any person or institution, provided it is properly attributed.

[2] Tables A II/1, A II/3, A III/7, A V/1-2-2, A V1-1-2, etc. STCW Code

[3] http://marinedefenders.com/

[4] http://marinedefenders.com/video/

The class is given over a standard fourteen-week semester and has three credit hours attached to it. The objective of the class is to give the students a thorough understanding of the current environmental laws effecting vessel operation and management. The class will equip students with the knowledge required to operate vessels in full compliance and to reduce individual and corporate legal exposure. The class will also focus on topics such as fuel and waste efficiencies and how they can affect the bottom line of a business or vessel. The class is not exclusive to mariners seeking a license. It is also valuable to both undergraduate and graduate students seeking a thorough understanding of environmental issues and the management of them shore-side.

Key themes throughout the course are:

- Environmental Awareness
- Environmental Responsibilities
- Environmental Appreciation/Stewardship
- Environmental Implications and Impact of Shipping
- Sustainability in Shipping
- Legal Exposure of the Mariner

## 2 CURRICULA

### I Oil Pollution

- MARPOL Annex I[5]

Discussion of the need for MARPOL[6] due to the Torry Canyon disaster of 1967 and other subsequent tanker disasters.

- Oil Pollution Act of 1990 and amendments (OPA-90)[7]
  This was enacted in response to the Exxon Valdez grounding and defines financial penalties as well as transparency in the tanker trade.
- Clean Water Act (CWA)[8]
  The clean water act applies to all vessels within three nautical miles of the United States Coastline as well as all vessels in US inland waters.

[5] http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Documents/Air%20pollution/Resolution%20MEPC.176%2858%29%20Revised%20MARPOL%20Annex%20VI.pdf

[6] http://www.imo.org/OurWork/Environment/PollutionPrevention/OilPollution/Pages/Background.aspx

[7] http://www.epw.senate.gov/opa90.pdf

[8] http://www2.epa.gov/laws-regulations/summary-clean-water-act

The CWA has been strengthened to include the Vessel General Permit Program[9,10](VGP). This is required of all vessels calling in US waters. It mandates more stringent effluent limits for oil to sea interfaces and exhaust gas scrubber wastewater. This program allows for electronic recordkeeping, requiring an annual report of all vessels.

– State Statutes which exceed CWA and OPA-90
A number of coastal states have emission caps as well as liabilities exceeding US federal standards. Amongst those are California, Washington and Alaska.

– Discharge Log Requirements and Audits
All discharge logs are introduced as well as the proper way to make entries. Audit as well as Port State Control supervision is emphasized in the proper method of recordkeeping.

– The Oil Record Book (ORB)
MEPC and industry guidelines for ORB entries as well as the correct codes are demonstrated. This is very important as the ORB is essential in proving a mariner innocent. Usually this is the first time a deck officer cadet sees and understands how the ORB relates to his/her function on the ship.

– Bilge and Oil/Water Separators
The bilge systems as well as the types of separators are presented in depth. Proper logging of the operation and discharge limits are explained.

– Legal Exposure, Fines, Accountability, Case Studies
A mariner in today's regulatory climate is arguably the most legally exposed profession. This is demonstrated by introducing case studies of mariner prosecution. Errors of commission and errors of omission are discussed. Errors or crimes of commission are the illegal violation of one or more laws. Resultant jail time or significant fines can be levied against the company and/or individual mariners. Errors of omission are where mariners may be prosecuted for improper documentation of emissions. These errors include improper filling out of logs, ORB's, etc.

## II Sewage Discharges

– MARPOL Annex IV
The difference between black water and gray water is discussed as well as the discharge areas and limits by coastal states. The impact of sewage pollution is presented from a scientific standpoint.

– Marine Sewage Treatment Plants (Marine Sanitation Devices or MSD's)
Different types of MSD's are introduced as well as the use of them. The differences between sewage demands of vessel types are explained. A normal cargo vessel, which may have a crew of 25, would have a plant vastly different from a passenger vessel that may have a combined passenger and crew capacity exceeding 6000 people.

– Documentation and Discharge Logs
The logs and documentation are less onerous than the Annex I responsibilities, but are still important. These insure the vessel is following proper procedure in the discharge of sewage waste.

– Legal Exposure, Fines, Accountability, Case Studies

## III Garbage – Chemical Management – Hazardous Waste

– Waste Identification
All waste falls into several categories. Amongst those are hazardous waste, universal waste, biomedical waste (Red Bag), food waste, United States Department of Agriculture defined food waste, plastics and general trash. Each waste stream requires a different method of proper legal storage, disposal and accounting.

– MARPOL V
Recent changes in Annex V[11] are explained as well as strategies for waste reduction and recycling. Costs associated with disposal are explained as well as how recycling and waste minimization are effective strategies for both individual vessels and fleets. Types of incinerators as well as proper documentation are presented.

– Resource Conservation and Recovery Act[12] (RCRA)
This is a US law that mandates the proper identification, storage and disposal of hazardous waste. It applies penalties for improper handling of the waste.

– Garbage Logs
Under MARPOL V the accounting of waste is done through the garbage log. The log is also subject to inspection by Port State Control. On many vessels a junior officer maintains the log. The proper ways of categorizing, as well as the importance of acute receipts/manifests are explained as well as possible penalties.

[9] http://water.epa.gov/polwaste/npdes/vessels/upload/vgp_fact_sheet2013.pdf

[10] http://water.epa.gov/polwaste/npdes/vessels/Vessel-General-Permit.cfm

[11] http://www.imo.org/OurWork/Environment/PollutionPrevention/Garbage/Documents/Annex%20V%20discharge%20requirements%2001-2013.pdf

[12] http://www.epa.gov/agriculture/lrca.html

– Vessel Sanitation
  Responsibilities regarding vessel sanitation are discussed. Vessels calling in United States Ports are subject to inspection by two additional agencies. The United States Department of Agriculture[13] (USDA) is charged with protecting the United States from food born pathogens originating from different countries. In the US, disposal of all food waste from other countries is required to be processed via high temperature incineration and therefore needs to be landed to a sealed container. The USDA is also charged with the inspection of any imported foodstuffs as well as bulk grain being exported.
  The United States Public Health Service [14](USPHS) is the agency that will conduct sanitation inspections of vessels with emphasis on food preparation areas and potable water. All cruise vessels are inspected twice a year on average. USPHS is also required to investigate any disease outbreaks on vessels and issue quarantine where necessary. This may be done in coordination with the Center for Disease Control (CDC).

– Hazardous Material (HAZMAT)
  The stowage, disposal and personal protection requirements of hazardous material and chemicals are covered. This segment introduces "best management practices" and how proper understanding can result in fewer injuries and deaths.

– Legal Exposure, Accountability
  The improper understanding of chemical and physical material by ships supervisory personnel have resulted in convictions and jail time for involuntary manslaughter in the United States.

– Case Studies
  "Green" alternatives as well as successful waste reduction strategies are discussed.

## IV Air Pollution

– MARPOL VI
  MARPOL Annex VI is perhaps one of the most contentious areas of discussion at the IMO-Marine Environmental Protection Committee. The UN, through various conferences and instruments has mandated a reduction of green house gasses worldwide. Shipping as well as aviation are regulated transnationally and come under these auspices.[15] This annex is continually updated in order to reduce emission of GHG's including Carbon Dioxide ($CO_2$), Nitrous Oxide (NOx), Methane ($CH_4$), Sulfur Dioxide (SOx) and Particulate Matter (PM) especially in the form of Black Carbon. Black Carbon is damaging to the planets albedo in the arctic.[16]

– California Statutes[17]
  Due to the nature of California's coastal geography, the state has the most restrictive air emissions standards within the United States. The standards are aggressively enforced throughout the state. The ports of LA-Long Beach and Oakland are the gateway ports for US Asian Trade and have the largest number of vessels calling. These ports are the largest sources of air pollution in the state.

– Alaska Statutes[18]
  These pertain to vessels, in particular cruise ships operating in Alaskan waters.

– Low Sulfur Fuel Areas
  The North American Emission Control Area[19] (ECA) mandates Low sulfur fuel within 200 miles of the coastline as well as US possessions. Marine fuels in this area are not to exceed a Sulfur content of 0.10%. Strategies of fuel switching and recordkeeping are introduced. The North American ECA will be the forerunner of ECA's introduced through out the world. It is perhaps the major driver in the search for cleaner fuels in shipping.

– Montreal Protocol[20] and the ship owner/operator
  The Montreal protocol regulates ozone gasses in the atmosphere and is of particular interest due to refrigeration gasses and legacy firefighting systems. This calls for recapture of refrigeration gasses and the documentation of the proper disposal of refrigeration equipment onboard ships. The proper filling out of the associated logbooks is explained.

– Alternative Fuels[21,22]/Cold Ironing[23]/Slow Steaming[24]
  The marine industry is transitioning away from bunker fuel. It has been the fuel of choice due to its low comparative cost versus distillates, etc. The current tide of air and pollution regulations are

[13] http://www.aphis.usda.gov/library/forms/pdf/449_Instructions.pdf
[14] http://www.cdc.gov/nceh/vsp/
[15] http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Greenhouse-Gas-Studies-2014.aspx
[16] http://phys.org/news/2013-08-arctic-sensitive-black-carbon-emissions.html
[17] http://www.arb.ca.gov/ports/marinevess/marinevess.htm
[18] http://dec.alaska.gov/water/cruise_ships/cruise_air.htm
[19] http://www.imo.org/MediaCentre/PressBriefings/Pages/28-eca.aspx
[20] http://ozone.unep.org/new_site/en/montreal_protocol.php
[21] http://www.dnv.com/binaries/PositionPaper_AltFuels_280214_tcm4-592866.pdf
[22] http://www.gastechnology.org/Training/Documents/LNG17-proceedings/7-1-Frederick_Adamchak.pdf
[23] http://www.martrans.org/docs/theses/papoutsoglou.pdf
[24] http://cleantech.cnss.no/best-practices/slow-steaming-to-stay/

making the use of bunkers prohibitive in many areas as more and more ECA's are being introduced.
Cold ironing as a strategy for air pollution has been introduced in many ports. Students are made aware of the benefits as well as the costs.
The concept of "slow steaming" is discussed as a fuel saving/emission reduction strategy.

### V Bulk and Packaged Shipments

– MARPOL Annexes II[25] and III
The discussions of Annexes II and III center around how these work with the IMDG[26] code as well as applicable areas of the Safety of Life at Sea Code [27] relate to environmental protection.

### VI Ballast Water Management[28]

This newly added set of regulations governs the treatment and release of ballast water. These regulations were needed in order to prevent the spread of invasive species. Invasive species in the United States introduced by shipping have caused Billions of dollars of damage. Treatment methods are explored as well as ballast water exchange. There are differing standards amongst Port States, such as Brazil for example[29], as well as States in the United States[30]. Regulations differ for vessels entering North America's Great Lakes[31] as well. These differing regulations can cause confusion to the ships crew as well as the owners. This segment looks at ways of identifying unique regulations in order to prevent fines or operational delays.

### VII Special Area Restrictions[32] and Particularly Sensitive Sea Areas[33] (PSSA)

The process of voyage planning is one of the most important tasks of a mariner. In this process may of the concepts taught in this class come into play as a voyage may pass through one or more special discharge areas under MARPOL. In addition to discharge areas, other factors such as fuel efficiency during the passage, weather, biota and other variables pertaining to proper environmental stewardship are encountered. In sailing through designated PSSA's and Special Areas all of the aforementioned regulation and annexes may come into play. A thorough understanding of the regulations and restrictions makes for a more robust voyage plan. Amongst the areas discussed are:

– Hawaiian Waters[34]
This area has required ship-reporting areas
– Mediterranean
Restrictions relation to Annex's I and V. Also Marine protection areas.[35]
– Wider Caribbean
An ECA restricting Sulfur Dioxide, Nitrous Oxide and Particulate Matter
– Right Whales[36] – US East Coast
This section demonstrates the importance of sharing the seas with other species. The whale regulations are enforced along the US East Coast and serve as a model for speed restrictions, operational awareness and reporting. The dangers of Whale strikes are explained as well as a mariner's obligation under the United States Endangered Species Act[37]. These regulations regarding our obligations to other species serve as an introduction to other areas with similar protections worldwide.
– Polar Areas
Vessels operating in Antarctic waters are under numerous restrictions. These waters are regulated under both MARPOL and the Antarctic treaty[38]. Arctic areas may hold the potential for massive oil and mineral extraction. In response to that, the IMO-MEPC has adopted the International Code for Ships Operating in Polar Waters (Polar Code)[39]. Upon its implementation it will place stricter discharge regulations on vessel operations within the defined waters. These are in addition or other Port State regulations in place.

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25 http://www.imo.org/OurWork/Environment/PollutionPrevention/ChemicalPollution/Pages/Default.aspx

26 http://www.imo.org/KnowledgeCentre/IndexofIMOResolutions/Documents/MSC%20-%20Maritime%20Safety/328%2890%29.pdf

27 http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-%28SOLAS%29,-1974.aspx

28 http://www.imo.org/OurWork/Environment/BallastWater-Management/Pages/Default.aspx

29 https://exchange.dnv.com/Documentation/DNVExchange/Fleet/Downloads/Brazil_Ballast%20Water%20Management.pdf

30 http://www.invasivespeciesinfo.gov/aquatics/ballast.shtml

31 http://www.greatshipsinitiative.org/GLC_BW_Summary_2013.pdf

32 http://www.imo.org/OurWork/Environment/SpecialAreasUnderMARPOL/Pages/Default.aspx

33 http://www.imo.org/OurWork/Environment/PSSAs/Pages/Default.aspx

34 http://www.papahanaumokuakea.gov/

35 http://www.cetaceanalliance.org/download/pdf/MedMPA_Hoyt.pdf

36 http://www.nmfs.noaa.gov/pr/shipstrike

37 http://www.nmfs.noaa.gov/pr/laws/esa/

38 http://www.ats.aq/documents/recatt/Att011_e.pdf

39 http://www.imo.org/blast/blastDataHelper.asp?data_id=29985&filename=A1024%2826%29.pdf

**VIII International Safety Management Code[40] (ISM) and Auditing**

The ISM code as a tool for environmental compliance is introduced. This sets the stage for the importance of ISM, Class and Port State Control audits of a vessel in continually complying with ever-changing regulations.

## 3 CONCLUSION

The material presented above is of vital importance to both the mariner and the ship owner. A good understanding of these concepts can prevent fines, detentions, illegal discharges and even incarceration. Criminal charges are not limited to mariners but in many cases the ship owner is held criminally liable [41]. The student taking this class will come away with a thorough knowledge of:

- Environmental Awareness
- Environmental Appreciation/Stewardship
- Environmental Responsibilities
- Environmental Implications and impact of shipping
- Sustainability in Shipping
- A Mariners Legal Exposure
- An understanding of Domestic/International/Regional regulations
- How to ensure compliance via logging/reporting/maintenance requirements
- The importance of environmental aspects of voyage planning
- Penalties for non-compliance including Vessel Detention, Criminal and Financial Liability

It is the author's contention that any curricula for mariners, whether deck, engine or management needs to include a stand-alone course on environmental management/ regulations. The Marine Industry has much at stake in the stewardship and protection of the environment and this necessitates having a full and open discussion with future leaders in the field.

**Author's note:**

We as a society/industry are relying much more on digital media. All of the texts used in the course are in digital form. Many of the footnotes herein are required reading for student.

[40] http://www.imo.org/OurWork/HumanElement/SafetyManagement/Pages/ISMCode.aspx

[41] http://www.marinelog.com/DOCS/NEWSMMIV/MMIVNov26.html

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# THE CONTINUING CHALLENGE OF MARITIME PIRACY: WILL WHAT WORKED IN SOMALIA WORK IN THE NEW PIRACY "HOT SPOTS"?

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**Abstract**. Up until very recently, the focus of the international maritime sector has been on the prevention and protection against maritime piracy off the coast of Somalia. However, beginning in 2014, pirate attacks tended to be concentrated more in the Strait of Malacca region and the Gulf of Guinea. This paper addresses the efficacy of the measures adopted to deter and prevent pirate attacks in the Horn of Africa, and assesses their transferability to other parts of the world. The paper concludes that many of the measures that were successful against Somali piracy will be problematic if implemented in other parts of the world.

**Key words:** maritime piracy, task forces, PCASPs, armed guards, best management practices

# 1 INTRODUCTION

For nearly all of the past ten years, the focus of the global maritime security community has been on challenge of maritime piracy off the coast of Somalia. With attacks committed by Somali pirates reaching an all-time high in 2011 (with over 160 attacks directly attributed to Somali pirates), the numbers have since dropped dramatically to the point where there have been almost no successful attacks committed by Somali pirates in the first months of 2015.

Regrettably, the decline of Somali piracy has not meant that global piracy is on the decline in every other region of the world. Rather, we have seen a significant rise of maritime piracy in the region of the Strait of Malacca, and piracy in the Gulf of Guinea and off the coast of Nigeria remains a significant concern – not only for regional maritime shipping (and fisheries) but for offshore energy infrastructure as well, as seaborne exploration and drilling continues to develop and expand.

The essential question is this: Are the programs and procedures that worked so well in reducing Somali piracy *transferable* to other parts of the world? This paper argues that the political and legal climates are different in the Gulf of Guinea and the Malacca region, and that this will make the implementation of the solutions that worked so well in reducing Somali piracy extremely difficult, if not impossible.

## 1.1 The current state of maritime piracy

Global maritime piracy has fluctuated in a cyclical pattern from 2002 (when records first began to be kept by the International Maritime Bureau) through 2014. As can be seen by the figures presented in Figure 1, we are currently in a period of low numbers of maritime attacks globally, with 245 attacks reported in 2014, the second lowest year since records have been kept (Table 1).

Table 1, however, shows that while global attacks may be in a period of decline, there have actually been rises in the number of attacks in some regions of the world.

During this time, attacks by Somali pirates dropped by 95%, from 237 in 2011 to only 11 reported attacks in 2014. At the same time, attacks in and near the Strait of Malacca rose from a low of 60 in 2010 to more than

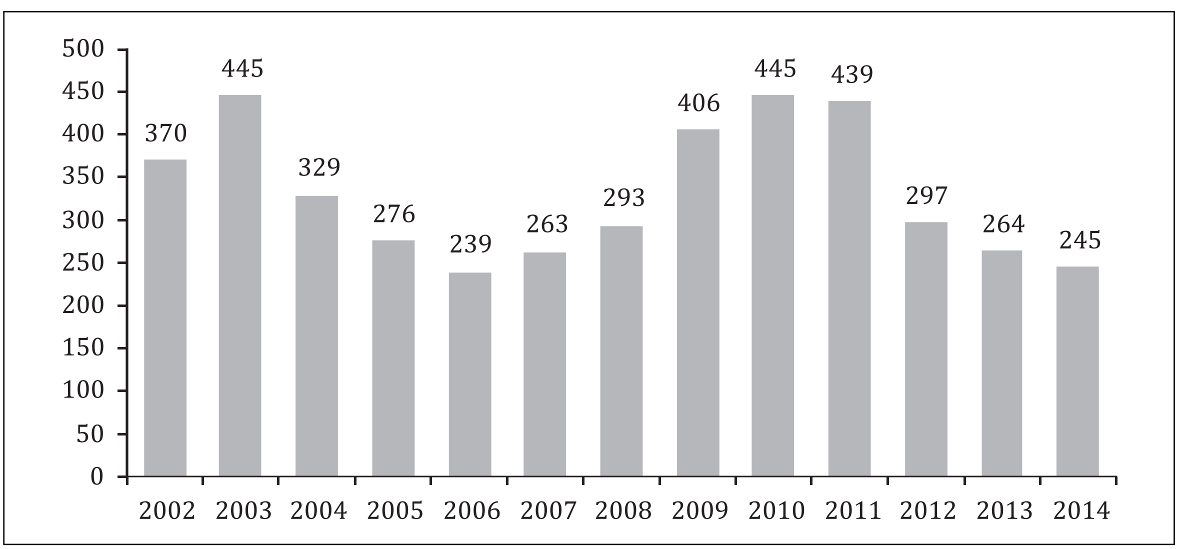


**Figure 1** Global Maritime Piracy: 2002-2014 [1]

**Table 1** Attacks by Regional "Hot Spot": 2010-2014 [1]

| Year | Attacks by Somali Pirates | Attacks in the Gulf of Guinea | Attacks in the Malacca Region |
|---|---|---|---|
| 2014 | 11 | 18 | 133 |
| 2013 | 17 | 31 | 125 |
| 2012 | 75 | 37 | 95 |
| 2011 | 237 | 33 | 63 |
| 2010 | 219 | 28 | 60 |

double by 2014, with 133 attacks. And during the same time, while Nigerian piracy seems to have declined, it is well-known that pirate attack statistics in Gulf of Guinea are generally (and often substantially) under-reported and are, therefore, less reliable.

Given the dramatic decline in the number of attacks by Somali pirates, the potentially disturbing rise of attacks in the Strait of Malacca, and the continued threat from Nigerian pirates, it is important to know how and why such dramatic declines were achieved in Somalia, and whether there are lessons learned that can be applied to other "pirate hot spots" of the world.

## 2 THE DECLINE OF SOMALI PIRACY IN THE HORN OF AFRICA

How global shipping and the international community were able to force this reduction in Somali piracy is an impressive success story. More than a dozen nations contributed to the international task forces operating off the coast of Somalia; also, many nations individually deployed naval assets to the Horn of Africa region to protect the merchant ships flying their own flags. Additionally, many ships and shipping companies developed and implemented "best management practices" (BMPs); the use of these most successful strategies culminated in *BMP4: Best Management Practices for Protection against Somalia Based Piracy, Suggested Planning and Operational Practices for Ship Operators and Masters of Ships Transiting the High Risk Area.* Lastly, many shipping companies began to deploy armed security teams on their vessels; to date, no ship deploying these "privately-contracted armed security personnel" (PCASPs) has been successfully captured by pirates.

### 2.1 International task forces

On June 2, 2008 the UN Security Council unanimously adopted Resolution 1816 authorizing foreign military vessels to enter Somalia's territorial waters to use "all necessary means" to combat maritime piracy "in a manner consistent with international law" [2]. Soon afterwards, three separate naval task forces operated in the Gulf of Aden with the mission of combating maritime piracy: Combined Task Force 151, the European Union's Operation Atalanta, and NATO's Operation Ocean Shield. At the same time, the naval forces of additional countries operating independently from the task forces have offered significant and cooperative anti-piracy support in the region as well. These include naval deployments from Russia, India, China and Iran.

CTF 151 was established in January 2009 to "disrupt piracy and armed robbery at sea and to engage with regional and other partners to build capacity and improve relevant capabilities in order to protect global maritime commerce and secure freedom of navigation" [3]. It is a multinational force operating to protect merchant vessels in over one million square miles off the coast of Somalia in the Gulf of Aden and Indian Ocean; in conjunction with the European Union Naval Force Somalia (EU NAVFOR), the North Atlantic Treaty Organization (NATO), and together with independently deployed naval ships, CTF 151 helps to patrol the Internationally Recommended Transit Corridor (IRTC) in the Gulf Aden.

EU NAVFOR's Operation Atalanta was formed in December 2008, with the initial objective of protecting the relief vessels of the UN World Food Programme. Additional mission components have included: 1) The protection of shipping in support of the African Union Mission in Somalia (AMISOM); 2) The deterrence, prevention and repression of acts of piracy and armed robbery at sea off the Somali coast; 3) The protection of vulnerable shipping off the Somali coast on a case by case basis; and 4) Monitoring of fishing activities off the coast of Somalia.

Working alongside CTF 151 and Operation Atalanta, NATO's Operation Ocean Shield (formed in 2008) was the third leg of the multi-national counter piracy mission and has provided "naval escorts and deterrence capabilities, while increasing cooperation with other counter-piracy operations in the area in order to optimize efforts and tackle the evolving pirate trends and tactics" [4].

In addition to the multi-national task force efforts, several countries independently contribute to the global fight against Somali piracy. These include China, India, Russia and Iran. Working in communication and cooperation with the task forces, the navies of these countries have also been responsible for a number of successes against Somali pirates; including the capture and arrest of pirates and rescue of ships under attack.

In early 2014, the near unanimous conclusion reached by the international community has been that the task forces and independent navies have made a significant dent in the success and will of the Somali pirates. Several high profile rescues – including that of the Maersk Alabama – have made it clear that engaging in piracy has increasingly high costs – from being arrested, tried and imprisoned, to loss of life.

### 2.2 Best management practices

The currently-recommended best management practices contain three fundamental requirements for vessels transiting the Horn of Africa region: 1) Ships should register with the Maritime Security Centre – Horn of Africa (MSCHOA) prior to entering the High

Risk Area;[1*] 2) upon entering they should report to the United Kingdom Maritime Trade Operations (UKMTO) located in Dubai, and 3) during transit they should implement Ship Protection Measures (SPMs) [5].

While an essential component of BMP4 is that merchant ships transiting the High Risk Area liaise with naval and military forces operating in the region, it is well-understood that the SPMs are integral to the deterrence and prevention of successful pirate attacks. While specific SPMs will vary from ship to ship, general recommendations detailed in BMP4 include: 1) Watchkeeping and enhanced vigilance; 2) enhanced bridge protection; 3) control of access to bridge, accommodation and machinery spaces; 4) the use of physical barriers, water spray, alarms and foam monitors to deny access; 5) maneuvering practice; 6) CCTV and upper deck lighting; 7) denial of the use of ship's tools and equipment, and protection of equipment stored on the upper deck; and 8) safe muster points/citadels [5].

The objective of these measures is to "avoid, deter and delay" successful pirate attacks [5] More specifically, ships are urged to take action to ensure they: 1) are not alone when transiting high risk areas; 2) are not detected by pirates; 3) are not surprised by pirates; 4) are not vulnerable to attack; 5) are not boarded; and 6) if boarded, are not controlled [5]. Contacting regional authorities prior to, and during transit ensures that ships are not alone during transit of high-risk areas. Being aware of the latest reports of pirate activity and details of where pirates are operating reduces the risk of detection by pirates. The use of good watchstanding practices, radar, CCTV and other detection aids, reduces the risk of surprise if pirates are targeting the vessel. "Hardening" the vessel with razor wire, water cannons and similar anti-boarding measures makes the ship appear less vulnerable, and therefore less likely to be attacked as pirates are known to target less visibly prepared vessels. If the ship is targeted, increasing to maximum speed and performing evasive maneuvers can significantly reduce the likelihood of an actual boarding. Lastly, the use of citidels and safe rooms, and denying the pirates the use of key tools, machinery and equipment can help make it less likely that the pirates will actually be able to control the vessel.

The practiced use of these and similar measures have helped to mitigate the chances that pirates will be able effectively to seize control of the vessel and sail it to a pirate safe haven, even if the pirates are able to detect the ship and are successful in boarding.

[1] An area bounded by Suez and the Strait of Hormuz to the North, 10 °S and 78 °E

### 2.3 Armed security teams

To provide an additional degree of security, some shipping companies are now deploying private armed security teams on their vessels during transits of high-risk areas. Also known more formally as "privately-contracted armed security personnel" (PCASPs), they are very expensive to deploy and as such outside the reach of many shipping companies. This said, the effectiveness of these teams is not in dispute as no ship to date has been successfully captured when an armed security team has been onboard the vessel.

The goal of the PCASP teams is very straightforward: If there is fear of imminent attack by pirates, the armed teams take all necessary measures – up to and including lethal force – to repel the attack and if the attack cannot be prevented, to ensure pirates do not seize control of the vessel. While pirates have managed to board some ships deploying security teams, the teams have always been successful in denying control of the vessel to the pirates.

It must be noted that international law is not entirely clear-cut on the use of PCASP teams, even in international waters, as details of liability should someone (ship crew, security personnel or pirate) be injured or killed. And while it is clear that the master of the ship has full command and authority over the vessel at all times, it is the PCASP team leader – and not the ship's captain and master – that makes the strategic and tactical decisions regarding the operational details of the PCASP team, including the decision to use armed and lethal force. It is important to reiterate that these "grey areas" of authority and responsibility have yet to be worked out fully in domestic and international law. However, these legal ambiguities have not prevented the use of PCASP teams, primarily because their use almost guarantees that the ship will not be captured successfully.

The combination of these three global efforts – the international task forces, best management practices, and the deployment of PCASPs – is widely agreed to be the primary reason for the dramatic decline of maritime piracy off the Horn of Africa.

## 3 THE TRANSFERABILITY OF SOMALI SOLUTIONS

According to the International Maritime Bureau [1], six countries accounted for 75% of all global attacks in 2014:

| | | |
|---|---|---|
| Indonesia: 100 | Bangladesh: 21 | India: 13 |
| Malaysia: 24 | Nigeria: 18 | Singapore Straits: 8 |

The question, then, is are the practices and operations that worked in Somalia transferrable to these areas of the world where attacks by maritime pirates are either persistent or increasing?

### 3.1 International task forces

The success of the international task forces in Somalia rested on both the will to operate in the region, and the capacity to operate in both territorial and international waters. While nearly all attacks by Somali pirates occurred in international waters, in most cases the majority of attacks in 2014 in the current hot spots occurred in *territorial waters* while berthed or at anchor [1]:

| | | |
|---|---|---|
| Indonesia: 72% | Bangladesh: 85% | India: 100% |
| Malaysia: 46% | Nigeria: 60% | Singapore Straits: 0% |

UN Resolution 1816 gave the task forces permission to operate in Somali territorial waters only; they cannot be deployed legally to the territorial waters of other regions of the world unless specifically invited to do so by the state(s) in which the attacks are occurring. For a number of reasons beyond the scope of this paper, it is highly unlikely they would be given permission to do so, even if the nations contributing to the current task forces were willing to commit to anti-piracy operations in other parts of the world.

### 3.2 Best management practices

While many of the best management practices outlined above would be essential to the safety and security of vessels operating in the Gulf of Guinea and Strait of Malacca regions, some would be problematic. The use of good watchstanding practices would continue to be critical in these regions in ensuring that any pirates attempting attack are spotted when there is still sufficient time for effective vessel response. Hardening options, as detailed above, could still be useful as pirates are known to target vessels that seem less well protected, than those appearing less vulnerable. The use of citadels and other safe areas on the ship would also be important to reduce the risk of injury or death to the crew, should the vessel be successfully captured. This is important to note as deaths and injuries do occur in the Gulf of Guinea and Strait of Malacca regions, and the waters off the coast of Nigeria have been known as “the most dangerous in the world” for mariners.

However, it is the recommendation that if the ship is targeted, it should increase to maximum speed and perform evasive maneuvers that will be problematic in areas where piracy is currently concentrated. There is little to no room for maneuver or increased speed in the Strait of Malacca, or even in waters in or proximate to Nigeria where ships are heading towards anchorage. Ships transiting Somali pirate areas were in transit only, and in nearly all circumstances had the seaway to outrun pirate attacks, and perform effective evasive maneuvers.

### 3.3 Armed security teams

The use of privately contracted armed security personnel (PCASPs), while expensive, have proven to be a near perfect deterrent against a successful vessel capture by pirates. While pirates may be able to board the vessel, there are no known instances where they were able to take the vessel hostage when a security team was onboard. However, the use of armed guards is likely to be extremely problematic, absent significant changes to littoral state and port-state domestic law, given that the presence and use of armed guards on merchant vessels may be illegal under many circumstances in the territorial waters of many countries in the world.

For example, in October 2013, the crew and 25 guards aboard the *Seaman Guard Ohio,* an armed ship operated by a US maritime security firm, were arrested for failing to produce papers authorizing it to carry weapons in Indian waters [6]. While the charges were subsequently dismissed in July 2014, on the grounds that the ship was in Indian waters “out of necessity” [7] as it was seeking to avoid Cyclone Phailin, this in no way has created a precedent for the use or presence of armed teams within the territorial waters of India.

Additionally, in June 2014, a vessel sailing within Nigerian territorial waters was arrested by the Nigerian Navy for employing armed guards provided by the Nigerian Police. There are significant jurisdictional issues between the Nigerian Police and the Nigerian Navy, and vessels have been warned that they “may be at risk of potentially significant liabilities and delays if they employ armed guards on board their vessels who are sourced from the Nigerian Marine Police, the Nigerian Police or the ‘Joint Task Force’” [8].

## 4 CONCLUSION AND RECOMMENDATIONS FOR THE FUTURE

Given some of the problems outlined within this paper, the global shipping community must develop new and *regionally-specific* strategies to protect their ships and maritime trade from pirate attacks in *all* parts of the world. Furthermore, it is incumbent on the world’s MET institutions to ensure future mariners are prepared to deal with piracy (within the context of STCW and the Manila Amendments) no matter where in the world it should occur.

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# DEVELOPMENT OF QUALIFICATIONS AND INNOVATIVE METHODS OF COMPETENCE ACQUISITION IN LOGISTICS AND MARITIME TRANSPORT – KIKLOP

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**Abstract.** Globalization and technological development are radically changing the higher education environment. In the future, an exponential increase in demand for higher education is expected globally. University of Rijeka, Faculty of Maritime Studies educates students for specific maritime related jobs, which for the most part belong to the Transport and Logistics sector (which employs 10 million people and accounts for about 5% of GDP in the EU), the Mechanical engineering/Metallurgy sector, and Electrical Engineering/Computer Science sector, all of which are marked as very dominant sectors. The demand for occupations in maritime transport and logistics is relatively increasing, and new skills and professions that are not systematized at Croatian national level are appearing in the maritime market in recent years. The competencies for those new qualifications are neither recognized nor included in the existing curricula. Furthermore, although the environment for e-learning in higher education exists, it is not sufficiently functional for all learning activities. For reasons of better time utilization and enhanced cooperation, it is necessary to develop the e-learning environment which will involve the use of browser-based mobile technologies, modeling and the development of specialized applications that will allow the retrieval, visualization and interaction with e-environment independent of location, time and space. The continuous improvement of competence of teachers is also of great importance. Since the education at the Faculty of Maritime Studies is not entirely adapted to the national and international market needs, teachers have to continuously monitor the development of modern technologies and technological achievements in order to ensure higher quality education. The purpose of this paper is to present a project aimed at development of qualifications and innovative methods of competence acquisition in Logistics and Maritime transport – KIKLOP, which was designed with the aim of researching and recognizing the real needs of the labor market in the field of maritime transport and logistics and the needs for new skills and professions, developing occupational standards and qualifications standards in accordance with the principles of Croatian Classification Framework (HKO), developing an environment for e-learning, improving teacher competences and adapting the curriculum of undergraduate university studies in accordance with market needs The final aim of the project is to offer high-quality, efficient and innovative higher education based on the SMART learning outcomes, while retaining the flexibility to adapt to constant and rapid changes in the wider social context. Above mentioned goals will be met by Faculty of Maritime Studies (a leading higher education institution in the Republic of Croatia in the field of education in maritime studies) in cooperation with the project partners; other educational institutions and prominent companies from the maritime industry.

**Key words**: KIKLOP project, Croatian Classification Framework, maritime education, innovative education

## 1 INTRODUCTION

The trends point to an exponential increase in demand for higher education in the next twenty years; from the existing 99 million students to 414 million by 2030 worldwide. Although the Republic of Croatia in 2005 adapted its higher education system according to the principles of the Bologna Declaration, a number of weaknesses have been noted. When introducing new study programs, some output parameters such as learning outcomes of students were not fully defined. With rare exceptions, the study programs were devised within the framework of higher education without specific consultation with other important stakeholders such as employers, relevant national authorities and others. The result is, as pointed out by the Ministry of Science, Education and Sports [1], a notable unevenness in the quality of various study programs, problems in their acceptance by the labor market as well as in their general contribution to society.

The Republic of Croatia established the legal framework of quality assurance in higher education by passing the Law of Croatian Qualification Framework [2], which defined the main tools for the equalization of study programs quality. According to that, a need to audit their structure and learning outcomes, as well as the means of carrying them out arose. Croatian Qualification Framework (HKO) has been established as a key reform instrument governing the qualification system, with the advancement of educational programs that comply with the standards of qualifications and their components – learning outcomes, with a goal of raising the quality of education and its alignment with the needs of the labor market and lifelong learning. Study programs must ensure the acquisition of learning outcomes, with an effective way of checking these outcomes. A part of higher education institutions has not yet shifted from classical "knowledge transfer" to the development of competencies, and only evaluates the contents which students memorized instead of evaluating the acquired knowledge and skills.

Maritime studies present a complex multi-disciplinary scientific field based on activities with various technological and economic and legal characteristics. Croatian higher education and research institutions in the broad field of maritime affairs have to continually adjust their educational programs that are related to the needs of the domestic and international labor market, and at the same time be recognizable within the European Higher Education Area and comply with all the requirements of the Ministry of Science, Education and Sports, Ministry of Maritime Affairs, Transport and Infrastructure, the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, etc.

From the need for constant improvement of the teaching process, a project aimed at development of qualifications and innovative methods of competence acquisition in Logistics and Maritime transport – KIKLOP was devised [1]. University of Rijeka, Faculty of Maritime Studies, as the leading Croatian higher education institution in the field of maritime education, in cooperation with the project partners will research and identify the actual needs of the labor market in the field of maritime transport and logistics, identify new skills and professions, develop occupational standards and qualification standards in accordance with the principles of HKO, develop the environment for e-learning, improve teacher competencies and adapt the undergraduate university studies in accordance with market needs while offering high-quality, efficient and innovative higher education based on the SMART learning outcomes while retaining the flexibility to adapt to constant and rapid changes in the wider social context.

KIKLOP project partners are: University of Rijeka, Faculty of Maritime Studies, University of Split, Faculty of Maritime Studies, Croatian Association of Ship Agents, Jadrolinija (passenger shipping company), Autotrolej (municipal transport), Zorović Maritime (ship agent) and Panalpina Croatia (logistics operator). The project is financed by the European Social Fund [3]. The project began in June 2015, with set duration of 15 months.

In order to achieve the project objectives, will be necessary to carry out the following activities:

1. **Development of occupational standards and competencies**, based on the analysis of current and f uture labor market needs (cross-sector analytical background) and the development of **complete qualification standards** in logistics and maritime transport.

2. **Improvement of undergraduate university studies** (Seafaring and Transport Technology, Marine Engineering, Electronics and Communications in Shipping, Logistics and Management in Maritime Traffic, Transport Technology and Organization) that are structured in sets of appropriate level learning outcomes, stated in ECTS credits provided for the acquisition of these outcomes, and are consistent with the relevant qualification standards.

3. **Development of e-learning environment** that will enable advanced and adaptive learning and will support the planning of teaching processes in higher education and lifelong learning.

4. **Upgrading teacher competencies** through continuous implementation of professional development programs for teachers.

The project is in line with the strategic documents at the EU, national, regional and local levels regarding the maritime sector and transport sector in general, and in line with improving the quality of higher education. The European Commission identifies three priorities of smart, sustainable and inclusive growth in its **Europe 2020 Strategy** [4]. The project will increase the performance and international attractiveness of University of Rijeka, Faculty of Maritime Studies and will raise the overall quality of higher education and training in the field of maritime transport while promoting the principles of sustainable development. The project will also enable smart specialization and facilitate the entry of young people into the labor market. The **program framework Horizon 2020** [5] defines smart, green and integrated transport as one of the social challenges of Europe. The project is aligned with Croatian **Strategy for Education, Science and Technology** [6] in the part of improving academic programs with consistent implementation of the Bologna reform and redefinition of acquired competencies. The project is aligned with the other objectives of the said strategy: establishment of the quality binary system of higher education in line with national needs, ensuring adequate information and communication resources of higher education institutions, and integration into European and global higher education space. The project is also aligned with the **Strategy of maritime development and integrated maritime policy of the Republic of Croatia 2014-2020** [7] defining clear targets for development of maritime affairs as one of the most important industries in Croatia, where it stimulates development and promotion of Croatia as an international center of excellence for the training of seafarers with continuous improvement of the system of education and training of seafarers. The project contributes to the fulfillment of certain objectives of the **University of Rijeka, Faculty of Maritime Studies Development Strategy 2011-2016** [8], **University of Split, Faculty of Maritime Studies Development Strategy 2012-2017** [9], **University of Rijeka e-learning development strategy 2011-2015** [10], **University of Rijeka development strategy 2014-2020** [11]. Some of the goals from above mentioned strategies are: to increase the proportion of e-learning in study programs, capacity-building in teaching in higher education, development of study programs based on the development of qualifications, especially for interdisciplinary studies, etc.

## 2 PROJECT DEVELOPMENT AND IMPLEMENTATION METHODOLOGY

Methodology for the development and implementation of Work Packages includes specific and joint activities of the applicant and the project partners. In joint activity partners will mutually exchange knowledge and experience to contribute to the fulfillment of the project objectives.

The methodological approach to project design consists of three key actions, with the goal of increasing quality of maritime education. The first logical step is labor market analysis and identification of market requirements through occupation descriptions, job (task) description and activity description.

Competence development stems from the previous step, and includes the development of qualifications through measurable learning outcomes and assessment methods. Harmonization of education structure, through curriculum development for education in the maritime and logistics occupations, includes definition of courses, modules and complete curricula for undergraduate university studies. These three elements must be harmonized in order to ensure that education or training programs are in line with the requirements of the labor market.

Methodology for the development and implementation of Work Packages is shown in Figure 1.

Project implementation, other than the realization of individual methodological components, necessarily involves the development of multimedia laboratories, the development of e-learning modules and professional development of lecturers in order to improve the quality of maritime higher education as a multidisciplinary sector. The development of standards of complete qualifications, development of occupational standards with analytical background, adjustment of study programs, the development of e-learning environment and the improvement of lecturers' competence will be a continuous process, and set tasks and indicators will in fact be the performance indicators and benchmarks for project management.

## 3 WORK PACKAGES

In accordance with the proposed methodology developed within the specified project Work Packages that include activities within the Work Packages, methodology, roles of the applicant and all partners in Work Package implementation, measurable outputs and a time frame, the structure and links between Work Packages can be seen in Figure 2.

Work packages **Project management and administration** (WP – PM) and **Promotion and visibility**

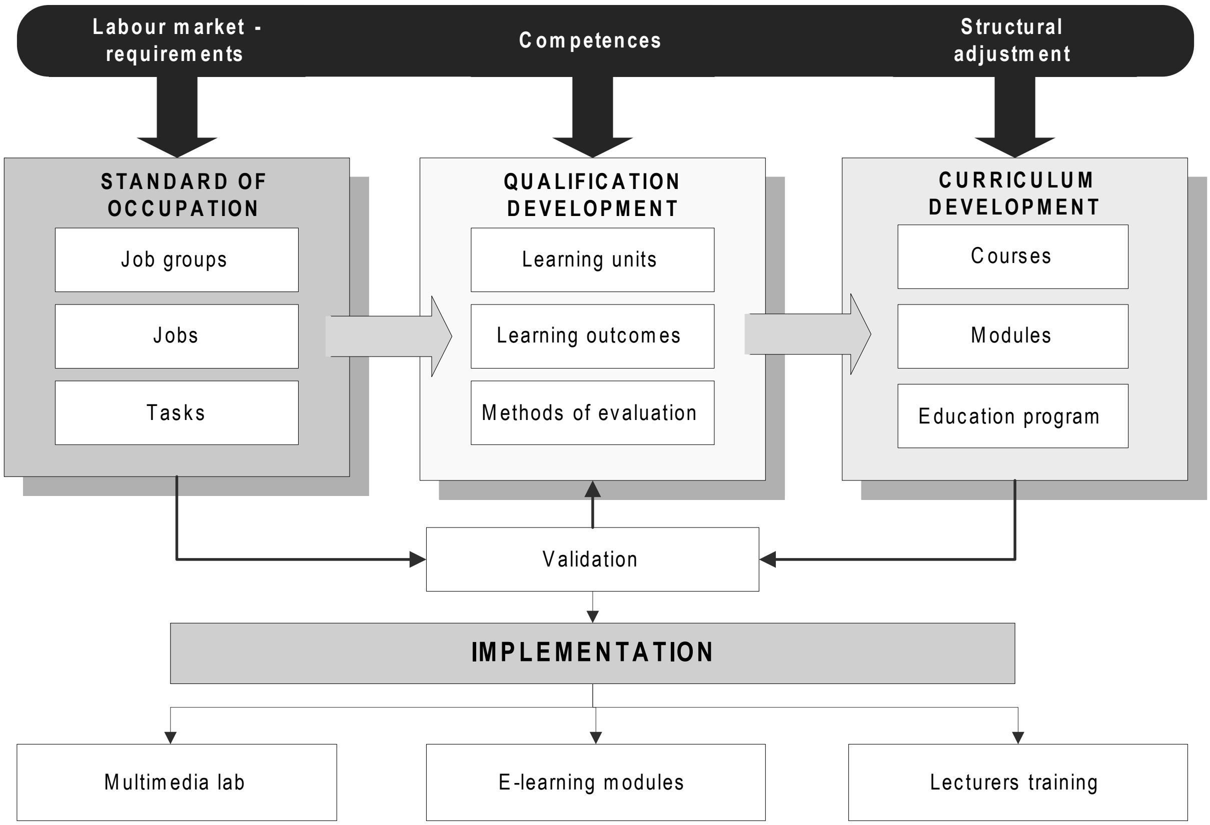


**Figure 1** Methodology for the development and implementation of Work Packages

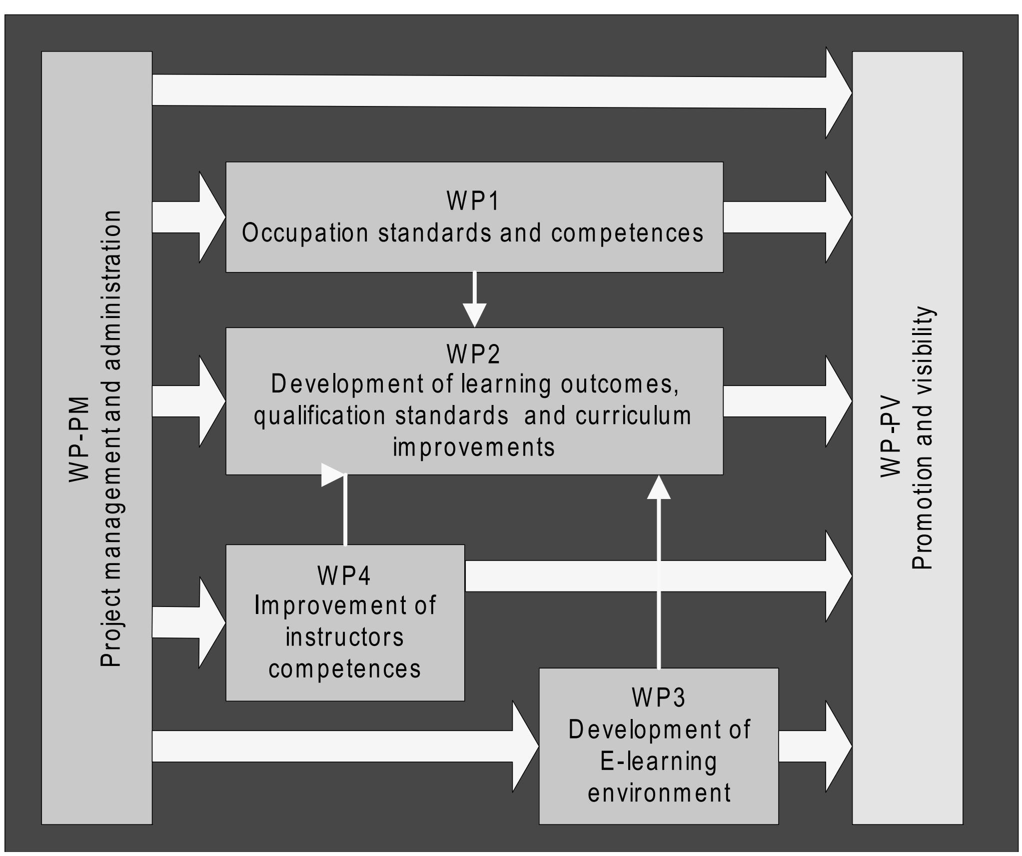


**Figure 2** The structure and links between Work Packages

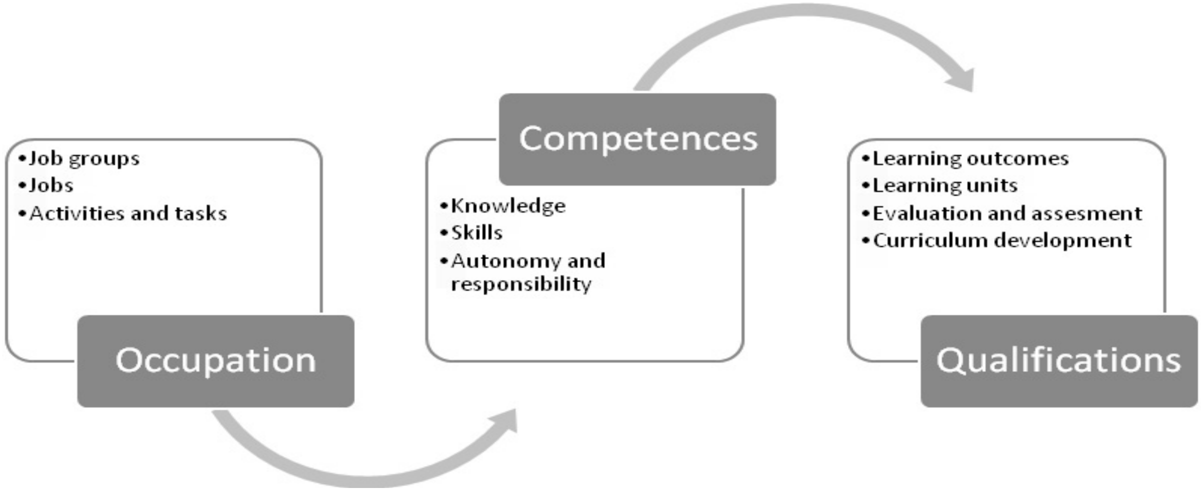


**Figure 3** The structure and links between WP1 and WP2

(WP – PV) last for full 15 months, and are the main project support activities for implementation, feasibility and dissemination. Central Work Packages: **Development of occupation standards and competencies** (WP1), **Development of learning outcomes, qualification standards and curriculum improvements** (WP2), **Development of e-learning environment (**WP3) and **Improvement of lecturers competences** (WP4) are defined below.

### 3.1. Development of occupation standards and competencies (WP1)

Creating standards for specific occupations in maritime sector will be based on the **analysis of current and future labor market needs in the maritime economy and logistics – Cross-sector basis (background).** In accordance with the relevant strategic documents, sector profile and analytical indicators the demand for occupations will be determined for a minimum period of 5 years. The planned methodology for the analysis of sector background includes trend analysis and assessment of the sector growth (in Republic of Croatia it includes the following sectors: Logistics and Transport sector, Mechanical Engineering, Shipbuilding and Metallurgy sector and Electrical Engineering and Computer Science sector). It also includes the trends analysis of key occupations within maritime activities (navigation, marine engineering, marine electronics, transport technology and organization, logistics in maritime transport), the analysis of knowledge and skills needed for a particular occupation and plan to adapt qualification standards and training programs. A special emphasis in the analysis of market needs will be the need for occupational standards that are projected to appear and exist in both immediate and lasting future. Furthermore, **competences for developed occupational standards will be defined** in accordance with the HKO principles (which are displayed through achieved knowledge and the application of such knowledge). Research results will be obtained based on the expertise of applicants and partners, desktop analysis, online questionnaires circulated among stakeholders, employers, employer representatives, alumni, etc.

### 3.2. Development of learning outcomes, qualification standards and curriculum improvements (WP2)

Competence matrix for similar occupations will be defined based on the following: analysis of the complexity of individual competencies; factual and theoretical knowledge; cognitive, psychomotor and social skills; the associated autonomy and responsibility that a person must acquire through learning and prove in the process of learning. Based on that, measurable indicators of learning outcomes (or level of learning outcomes) will be defined. Learning outcomes will be structured according to the SMART principle: specific, measurable, agreed, purposeful and timely. The link between WP1 and WP2 is shown in the following figure.

In the second work package, a minimum of 5 complete qualification standards will be defined. Developed qualification standards for employment in the maritime sector mark the content and structure of a certain qualification, including all the information necessary to determine the qualification level, qualification volume and qualification profile, as well as the data required for quality assurance and improvement of qualification standards. With the aforementioned activities, as well as with the analysis of existing study programs, recommendations will be provides for improvement of 5 existing undergraduate university studies at University of Rijeka, Faculty of Maritime Studies:

– Navigation and Transport technology,
– Marine Engineering,
– Marine Electronics and ICT,
– Logistics and Management in Maritime Transport,
– Transport technology and Transport Organization

Above mentioned studies are structured in sets of learning outcomes of appropriate level, stated in ECTS points provided for the acquisition of these outcomes, and are consistent with the relevant qualification standards. Also, where applicable, it is necessary to ensure alignment with the STCW Convention in order to obtain the highest positions aboard vessels.

### 3.3. Development of e-learning environment (WP3)

Activities under Work Package 3 include planning, modeling, development, implementation and testing of the environment for e-learning that will enable advanced and adaptive learning and will support the planning of the teaching process in higher education and lifelong learning. All the specifics of maritime profession will be taken into account, including the possibility of e-learning implementation on board the ship/offshore platform with time-limited access to the Internet.

Due to the increased accessibility of mobile devices, time utilization and enhanced cooperation, the environment for e-learning will be developed, which includes, in addition to the use of browser-based mobile technologies, modeling and development of specialized applications that will allow the retrieval, visualization and interaction with the e-learning environment, regardless of location, time and space, which is extremely important given the specifics of maritime professions.

The e-learning environment will have the appropriate software to automate and administer educational events and to create, store, collect and execute the educational content. The elements of e-learning 3.0 based on linking technology and knowledge by means of social interaction among users will be included in the e-learning environment through learning templates with pre-defined rules, user interfaces and associated modules. E-learning environment will be implemented through the server system that requires a multi-user client/server software architecture where the application server supports mobile and stationary clients. In order to prepare the multimedia educational content of a better quality, which requires a multidisciplinary approach (graphic design, audio-visual applications, simulators…), an e-learning multimedia lab will be equipped with accompanying multimedia equipment (hardware and software).In order to optimize the user experience of e-learning environment (including students and teachers) 5 user tests for certain areas or courses at selected study programs will be conducted.

### 3.4. Improvement of lecturers' competences (WP4)

In order to train the teachers in higher education (professors, lecturers), which is one of the most important determinants of quality, recognized within the framework of the Standards and Guidelines for Quality Assurance in the European Higher Education Area [13] it is necessary to educate teachers through additional programs for training and upgrading. Accordingly, 15 faculty members from University of Rijeka, Faculty of Maritime Studies and University of Split, Faculty of Maritime Studies will participate in various programs for training and improvement during the duration of the project, namely in:

– **Training of lecturers in the learning and teaching program** in higher education and the planning and programming of the teaching process through a formal program of lifelong education with associated ECTS credits. 3 lecturers will be trained in order to be able to design and plan learning activities and develop a program course, while creating a stimulating environment for learning and supporting students.
– **Training of lecturers to work with specialized software platforms** used within the curriculum (such as CAD/CAE programs, modeling and optimization programs, simulation and/or optimization tools, GIS tools, design and modeling software, marine engineering and nautical simulators, radar plotting aids, electronic chart systems, etc.). 6 professors and assistants will be trained to work with the above mentioned platforms.
– **Training of lecturers in innovative teaching methods in e-learning field**; creating the educational content, managing the e-learning environment, the use of multimedia elements, etc. 6 professors and assistants will be trained to apply the above mentioned innovative teaching methods.

Activities within the Work Packages **Improvement of lecturers' competences** enrich the teaching process and accordingly improve its quality and contribute to the development and implementation of competence approach that puts students at the center.

## 4 CONCLUSION

University of Rijeka, Faculty of Maritime Studies, as the leading Croatian higher education institution in the field of maritime education, recognized the trends imposed by the market. The main trend is: constantly improving the educational process and the quality of education. Along with numerous continuing activities that the Faculty carries out in order to raise the quality of education, the implementation of the KIKLOP project presents great challenges.

The collaborative KIKLOP project will explore and identify the actual needs of the labor market, develop occupational standards which are recognized in Croatian labor market, and also provide the new occupation proposals, define 5 qualification standards in accordance with the principles of HKO and adapt the undergraduate university studies at the Faculty of Maritime Studies in line with market needs.

The development of e-learning environment contributes to the development of innovative teaching methods, the development and improvement of existing teaching and didactic materials, audio-visual and interactive materials, e-learning tools and other content suited to on-line use. By improving competences in the field of teaching and learning, by working with specialized software platforms and by using innovative teaching methods in the field of e-learning, it is certain that high-quality, efficient and innovative higher education based on the SMART learning outcomes can be offered to students, while retaining the flexibility to adapt to constant and rapid changes in the wider social context.

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# ADVANTAGES OR DISADVANTAGES? FOREIGN−BORN PROFESSORS TEACHING AT MARITIME INSTITUTIONS IN USA

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**Abstract.** As the world has become increasingly integrated, more and more foreign-born scholars receive faculty jobs at universities and colleges, including maritime institutions in the USA. These foreign-born professors have been through vigorous training in the USA including doctoral programs in their respective fields. This is in addition to recognition and acclamation for their international vision, work ethic and solid knowledge. However, as professors from abroad, they have invariably pronounced disadvantages that largely stem from cultural differences and the accents of those for whom English is a second language.
The paper presents an empirical analysis of the advantages and disadvantages facing foreign-born professors teaching at maritime institutes in the USA. Applying a case study methodology and drawing on school-wide questionnaires from students, peer faculties, and administrators, the paper examines the scope and scale of differences of foreign-born or domestic-born professors measured by teaching effectiveness and learning outcomes. The paper also looks into actions that would heighten the advantages and mitigate the disadvantages of foreign-born professors if such issues arise.
The findings indicate that it is generally agreed that there is not a notable difference between foreign-born or domestic-born professors per se, but rather it is personal teaching styles, academic approaches and genuine enthusiasm about subject matter that are the key elements affecting evaluations. Respondents believed that foreign-born professors brought with them international perspective which inspired cadets to think about questions in unprecedented and innovative ways. Some cadets suggested specific courses like Chinese Economy or Japanese Law Systems be given to professors who came from the countries of the origin, while assigning more general courses like Calculus to domestic-born professors. By doing so, they claimed, professors would be teaching to their strengths and offering a unique educational perspective.

## 1 INTRODUCTION

As the world becomes increasingly interconnected, a growing number of foreign-born scholars receive faculty positions at universities and colleges in the United States, including American maritime institutions. These scholars earned 40 percent of U.S. doctoral degrees in science and engineering in 2003. In 2001, according to the Commission on Professionals in Science and Technology, 38.0% of engineering faculty members in U.S. institutions of higher education were foreign-born, as were 35% of medical scientists, and 29.2% of mathematical science faculty (Lowell, Babco, & Ellis, 2010). These foreign-born professors have been through intensive western training which include doctoral programs, as well as receiving recognition and acclamation for their international vision, work ethic and solid knowledge. However, as professors from abroad, they have invariably pronounced disadvantages that largely stem from cultural differences and the accents of those for whom English is a second language.

The paper presents an empirical analysis of the advantages and disadvantages facing foreign-born professors teaching at maritime institutes in the USA. Applying a case study methodology and drawing on school-wide questionnaires from students, peer faculties, and administrators, the paper examines the scope and scale of differences of foreign-born or domestic-born professors in regards to teaching effectiveness and learning outcomes. The paper also looks into methodology that would heighten the advantages and the mitigate disadvantages of foreign-born professors if issues were to arise.

The paper is structured as follows: Section II identifies advantages and disadvantages foreign-born professors might face. Section III presents possible resolutions to tackle the problems and ways to enhance the advantages. Section IV offers a conclusion.

## 2 ADVANTAGES AND DISADVANTAGES OF FOREIGN-BORN PROFESSORS

It has become a recent development that increasing numbers of foreign-born professors find work at American universities and colleges, including maritime institutions. At Massachusetts Maritime Academy (MMA), we have 13 foreign-born professors out of 82 full time faculty, which accounts for about 16% of the all faculty members at the school. A questionnaire was conducted the spring semester of 2015 at MMA and 33 cadets participated in the survey. The purpose of the survey was to investigate how often a typical cadet has a foreign professor each semester, the advantages and disadvantages of a foreign professors from the students' point of view, and any differences the impact of American professors versus foreign professors would impose on their education.

Table 1 shows clearly that for cadets at MMA, it ranges one out of five to one out of three classes being taught by foreign-born professors. Table 2 supports a similar ratio of foreign-born professors for all the semesters that the cadets have spent at MMA.

### 2.1 Advantages of foreign-born professors

It is generally agreed that their work ethic, international vision and productivity are common attributes of foreign-born professors. According to a study published in the Journal of Higher Education in November of 2011, foreign-born faculty members in the USA are more productive than their American born peers; they produced one peer-reviewed paper a year, compared to their American-born colleagues that produced an average of 0.60 articles annually. Two hypotheses stand as follows: firstly, foreign-born professors must be exceptional students in order to be accepted by American schools for graduate studies. Following graduate school, the most promising are invited to stay as

**Table 1** Answers to the questions: how many classes are taught by foreign professors the Spring Semester of 2015 at MMA

| Number of cadets | 5 | 11 | 1 | 2 | 5 | 2 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|---|
| Classes taught by foreign-born professors Spring term of 2015 | 1out of 6 | 1out of 5 | 1out of 4 | 2out of 7 | 1out of 3 | 2out of 5 | 1out of 3 | 3out of 6 | 2out of 3 |
| Percentage of surveyed cadets | 15% | 33% | 3% | 6% | 15% | 6% | 12% | 6% | 3% |

**Table 2** Answers to the questions: What is the average number of classes being taught by foreign professors for all the semesters at MMA

| Number of cadets | 1 | 1 | 7 | 12 | 1 | 2 | 4 | 2 | 1 | 1 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Classes taught by foreign-born professors for all semesters | 1out of 12 | 2out of 15 | 1out of 6 | 1out of 5 | 1out of 4 | 2out of 7 | 1out of 3 | 2out of 5 | 1out of 3 | 2out of 7 | 3out of 5 |
| Percentage of surveyed cadets | 3% | 3% | 21% | 36% | 3% | 6% | 12% | 6% | 3% | 3% | 3% |

**Table 3** Answers to the question: Advantages of foreign-born Professors (May 2015)

| Categories of answers | Answers |
|---|---|
| Qualification | knowledgeable, strong educational background, very qualified, |
| Different perspectives | good for students to expand their minds, increase knowledge on different things, |
| Teaching approaches | Take students more seriously, move slower over topics, more passionate about the subject matter. make class more interesting, Expect students to study more |
| Global vision | Different perspective on global issues |
| Bring different culture to class | to experience cultural diversity, |

faculty afterwards. Secondly, foreign–born professors adopt the resolute mindset of immigrants in a new country. They are more motivated and more enthusiastic to face challenges and prove their capability. As a result, they tend to work harder and longer than their American-born counterparts.

The advantages of foreign-born professors, as reported by a survey taken of cadets at MMA, are listed in the following categories shown in Table 3.

The students are highly aware of the qualifications and training foreign-born professors possess, and all agree that the biggest advantage of foreign-born professors are the unique angles they bring to the issue at hand. One student wrote, "some foreign-born professors bring a different set of skills and knowledge that we are not used to seeing. If they match the class, they are good". Another student said that "foreign born professors can help give another look at what is being taught." One student even wrote that "they are very qualified and set higher standard". The President of MMA, Admiral Gurnon, said that foreign-born professors are "valuable assets of our faculty body. They are very well trained, very knowledgeable, extremely dedicated, and helping tremendously our cadets expand their international visions and global perspectives."

## 2.2 Disadvantages of foreign-born professors

Disadvantages of foreign-born professors could also be identified. They include the obvious such as thick accents and cultural barriers, and the less openly admitted issues of racial tension and ethnic discomfort. According to the paper by Lee in 2004, foreign born professors are more productive and yet they reported lower levels of job satisfaction. Table 4 sums up the disadvantages MMA surveyed cadets would see.

The students still focus very much on the "foreign" aspects of the professors and the inconveniences, even misunderstandings as a result of this fact.

Table 5 gives the answers to the question, "Do you prefer American professors to foreign professors?" About three quarters of the students reported not having any preferences between American and foreign-born professors. As one student put it, "it boils down to the quality of the teachers, not where they are from. There are good teachers from US, and there are good teachers from other countries." Another student said that they prefer to have American professors, as they might understand material better for "more career based courses like engineering classes, which will be preparation for Coast Guard License Examination." One

**Table 4** Answers to the question: disadvantages of Foreign –born Professors (May 2015)

| Categories of answers | Answers |
|---|---|
| Command of English | Sometimes difficult to understand, speak with strong accents, hard to follow |
| Cultural barrier | Have trouble relating to students culturally, not being acquainted with the society that much |
| Teaching Method | Not understand the way they explain concepts, have trouble sometimes to engage in discussion and communication |

**Table 5** Do you prefer American professors to foreign-born professors

| Answers | Prefer American Prof. | Prefer Foreign Prof. | No Preferences |
|---|---|---|---|
| Number of cadets out of 33 | 6 | 3 | 24 |
| Percentage | 18% | 9% | 73% |

**Table 6** Does your study outcome impact if you have American *vs* foreign professors

| Answers | No negative impact | Negative impact | No difference |
|---|---|---|---|
| Number of cadets out of 33 | 5 | 3 | 25 |
| Percentage | 15% | 9% | 76% |

student wrote that they "prefer foreign-born professors as they can always relate better to low-income students vs American professors, and they take students more seriously than American professors. More thought-concentration is required for language barriers and higher expectations".

Table 6 shows the answers to the question of if foreign-born professors might impact the learning outcome of the students. 76% of the participating students believe that there is no difference in their study outcome if the class is taught by an American professor or a foreign professor. 15% of students prefer American professors to foreign ones, as they would "understand better". 9% prefer foreign-born professors to American ones. That is because, as one student put it, they "would study more and work harder as foreign-born professors set higher standards and expect you to accomplish more for the class". Another student wrote, "It makes my study outcome a bit better from hearing how they do things. It is good to learn the different approaches."

## 3 MEASURES TO ENHANCE ADVANTAGES AND MITIGATE DISADVANTAGES

As foreign-born professors have certain advantages and disadvantages in fulfilling their teaching responsibilities, it is important to search for measures which could help increase the advantage and overcome the difficulties. Several approaches are proposed and examined in this section to utilize the advantages and make up the disadvantages of foreign-born professors.

### 3.1 More Specific Courses at undergraduate level

Most of the surveyed students believe that foreign-born professors are particularly skilled if they teach the classes related to their countries and cultural background. One student said that they found the foreign teachers are interesting to learn from when the classes can relate to their original country. Another student agreed that foreign-born professors are "better for specific courses relating to their background/ethnicity, because they add experience and flavor from their personal experience".

In regards to teaching a country specific class by a foreign-born professor, a case study is offered here. I was assigned to teach Chinese Economy for the spring term of 2014. On the first day of the class, one questionnaire was conducted just to see how much the students, mostly seniors and a few juniors, knew about the country. On the last day of class, another questionnaire was done to see how much they learned and how they felt having a foreign-born professor teach the course in which their personal experiences were utilized. The following two tables sum up the answers from 20 participating cadets.

The answers to the question "Please list five things you know about China" can be put into five categories,

**Table 7** Answers to the question: list five things you know about China (March 2014)

| Categories of answers | Answers |
|---|---|
| Politics | communist government, internet control |
| Economy | fast economic growth, high ranking in merchant fleet, big trading partner of US, big shipping industry |
| Society | long history, rich culture, lots of ethnic minorities, good food, most populated country, 2008 Olympics, small families |
| Geography | capital is Beijing, the Great Wall |
| People | Confucius, Mao Ze Dong |

**Table 8** Answers to the questionnaires ( June 2014)

| Questions: | Positive | Negative | Neutral |
|---|---|---|---|
| Has the class met your initial expectation? | 100% | 0% | 0% |
| Prefer to have a China-born professor for the class? | 70% | 10% | 20% |

politics, economy, society, geography and people as shown in Table 7. It tells that MMA cadets had some general information about China, such as political structure, rapid economic growth, maritime industry in China, culturally rich society and good food, not much in of details.

All of the students agreed that the class had met their expectations—to learn more about China and its economic growth. The great majority of the students are welcome to the idea of having a China-born professor teach the course, as she could "add her personal experience and insights". Another student said that they could get "much more in depth with specific courses from foreign teachers, often times, they (foreign-born professors) are better than domestic professors". Some other students disagreed with the idea; they were of the opinion that American professors might have interesting point of view looking objectively at the Chinese economy from outside.

### 3.2 More things to learn by living across culture

Foreign-born professors can gain English proficiency and cultural adaption simply by living immersed in American culture and holding faculty jobs. Gary Ferraro explained that it is crucial to understand the cultural differences, value norms and language styles, even some non-verbal communications skills like body posture, hand gestures and facial expression between negotiating parties, because "when entering international negotiation, there are no longer shared values, interests, morals, behaviors and linguistic styles, all of which can greatly affect the process and outcome of the negotiation". The proposal of cultural submersion is applicable to American higher education where foreign-born professors will face American-born students. In order to be effective, it is important for foreign-born professors to pay particular attention to the new environment, cultural norms, history, and traditions of their adopted land.

In addition to learning outside the classroom, foreign-born professors could also try educational diversity to enhance teaching effectiveness. Tools including handouts, chapter summaries, etc. offer a visual medium so that students can receive the pertinent information in another form.

## 4 CONCLUSION

Looking at data, it is clear that foreign-born professors contribute greatly to American higher education. Hard-working and productive, they bring unique international perspectives to their classrooms and American students. However, foreign-born professors also have some inherent disadvantages which may negatively impact the effective learning of their students, such as speaking accented English, cultural barriers, and possible deviation in thoughts and behaviors from American norms. As long as the foreign-born professors focus on and enhance their numerous advantages and work to overcome the cultural and language barriers, they are highly appreciated and make unmeasurably tremendous contributions to American higher education.

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# THE FIREARMS SAFETY TRAINING PROGRAM AT MASSACHUSETTS MARITIME ACADEMY AND ENHANCEMENT OF SAFETY IN MARITIME TRANSPORT

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**Abstract.** Since the spring term of 2009, the Center for Maritime and Professional Training of the Massachusetts Maritime Academy (MMA) has been conducting a Firearms Safety Training Program. The program has evolved into a course that is designed to be a proactive measure to impart MMA students with a basic knowledge and proficiency in the use of firearms. The class has been well received by faculties, students and administrators at the academy, especially after April of 2009 when the seized Maersk Alabama off the Somalian coast was successfully rescued, and courageous Captain Richard Phillips instantly became a national hero. It so happens that Captain Richard Philips was a graduate of the academy in 1979. The critical issue was once more heatedly debated within the academy, as well as in the maritime industry and the country: how to enhance the safety in the maritime transport, and whether merchant mariners should carry firearms to defend themselves in case of attack.

The paper aims to present the discrepancies between the laws in the USA that allow civilian mariners to carry guns with permits and weapon registrations in American and international waters, and the practice that virtually no shipping companies provide weapons to their own crews, preferring instead to employ professional guards. The paper examines the hurdles and concerns that prevent shipping companies from equipping their vessels with weapons in the USA, particularly after the passing of the Coast Guard Authorization Act in 2010 and then makes comparisons to cases of other countries.

The study will certainly shed light on the issues facing the maritime industry urgently---what maritime institutions and international organizations like IMO can do to enhance the safety and security of maritime transport. The research will also help Massachusetts Maritime Academy optimize the setup and content of the Firearms Safety Training program and better prepare MMA cadets in possible future assignments with the companies like the U.S. Military Sealift Command.

**Key words:** enhancing safety in maritime industry, maritime education and training, research in MET

# 1 INTRODUCTION

Since the spring term of 2009, the Center for Maritime and Professional Training of the Massachusetts Maritime Academy (MMA) has been conducting a Firearms Safety Training Program. The program has evolved into a course that is designed to be a proactive measure to impart MMA students with a basic knowledge and proficiency in the use of firearms. The class has been well received by faculties, students and administrators at the academy, especially after April of 2009 when the seized Maersk Alabama off the Somalian coast was successfully rescued, and courageous Captain Richard Phillips instantly became a national hero. It so happens that Captain Richard Philips was a graduate of the academy in 1979. The critical issue was once more heatedly debated within the academy, as well as in the maritime industry and the country: how to enhance the safety in the maritime transport, and whether merchant mariners should carry firearms to defend themselves in case of attack.

The paper aims to present the discrepancies between the laws in the USA that allow civilian mariners to carry guns with permits and weapon registrations in American and international waters, and the practice that virtually no shipping companies provide weapons to their own crews, preferring instead to employ professional guards. The paper examines the hurdles and concerns that prevent shipping companies from equipping their vessels with weapons in the USA, particularly after the passing of the Coast Guard Authorization Act in 2010 and then makes comparisons to cases of other countries. The paper also explains the call for US federal officials to work through the International Maritime Organization (IMO) to seek agreements establishing similar legal protections of seamen for foreign waters.

The paper is structured as follows: Section II presents the laws and regulations in regards to carrying firearms in commercial ships in the USA, and looks into the reasons behind the fact that almost no companies allow crew to bear guns on board vessels. Section III explains the Firearms Safety Training Program at MMA. Section IV offers a conclusion.

# 2 DISCREPANCIES BETWEEN LAWS IN USA AND THE PRACTICE OF MARITIME COMPANIES

Based on the second amendment to the United States Constitution that protects the right of the American people to bear arms, the relative freedom to carry guns extends to civilian mariners in American and international waters. Commercial shipping mariners can bring “defense materials” abroad their vessels so long as they previously obtain the permission of the owner or master of the vessel, and register the weapons under the US Department of State’s International Traffic in Arms Regulation (ITAR). However, almost no shipping company allows crew members to carry firearms on board vessels.

## 2.1 Laws for carrying firearms in commercial shipping

It is the law of the ship’s flag of origin that is enforced on commercial ships when the ships enter international waters. In other words, a vessel flying the United States flag of stars and stripes or any other recognized U.S. maritime flag are subject to the laws of the United States. The international waters are defined as anything beyond 12 miles from the nearest coastal point of a nation, but more clearly as anything beyond 24 miles of the nearest coast. Thus a vessel flying the American flag in international waters may carry any firearm allowed by U.S. federal law as well as legal ammunition to go with it as long as they have the permission from US authorities.

Obviously, a ship must go to port sometime. Then knowledge of the laws of the areas you'll be going to and from, as well as all points between is important and is what makes things so very complex. A firearm may be legal in one area, but you may pass through other areas where it's illegal in order to get there. A good example is on our other coast up north, where travelers from the U.S. mainland to Alaska pass through Canadian jurisdiction and thus must declare weapons on board or face harsh consequences if caught.

Inside USA, there might be some state-specific laws regulating firearms abroad. Firearms must be declared on entry. All military-type firearms (greater than .22), machine guns, pistols, revolvers, ammunition, as well as flick knives and knuckledusters are prohibited imports, and will be sealed on board or taken into custody at the first port of entry. Arrangements can be made to transport them to the port of departure if sufficient notice is given of that port and the date of departure. Sporting rifles and shotguns may be kept on board if a permit is obtained from the police law changes as you leave and enter each states' jurisdiction. The firearms laws here in Florida, for example, are far more lax than are the laws in New York. While enforcement may be more or less lax along the way as well, the law is the only thing that can be truly counted on when moving from one jurisdiction to the next.

## 2.2 The Practical Obstacles in equipping vessels with weapons

In practice, however, almost no shipping companies provide weapons to their own crews, except ship captains, preferring to hire professional guards. There are many hurdles and difficulties to carry firearms abroad vessels. The most commonly cited ones are liability, different regulations by countries for vessels entering their ports, and potential dangers involved when crew members get access to weapons.

The biggest concern of shipping companies is the liability when they consider to arm the crews with weapons. Ship owners believe few merchant sailors have combat training and because pirates with deep pockets from ransom payments will always be able to buy larger weapons than ship owners in any maritime arms race. Also, mariners can face charges if they incur damage or injury though their use, an especially shaky situation when in foreign waters.

Section 912 of the Coast Guard Authorization Act of 2010 removes liability for monetary damages for injury or death caused by the use of force to defend a U.S.-flag vessel against acts of piracy if the force was used consistent with "Standard Rules for the Use of Force for Self-Defense of Vessels of the United States". However, the worry over liability still is lingering in the mind of shipping companies.

Because a commercial vessel might stop in a dozen countries during a voyage, it would be hard for it to carry weapons if any port along the route forbade that. In fact, almost all the countries have more or less strict restrictions on carrying weapons aboard, and to change those regulations in each country would be difficult, if not impossible. For instance, an American vessel entering the coastal waters of Mexico, the vessel, despite the U.S. flag, is now subject to the laws of Mexico.

International regulation of shipping has shifted heavily away from the countries that register vessels and toward the local and national governments at the ships' ports of call. This has made it even more complicated to come up with common international standards, because so many countries are involved. Table 1 offers more details of laws and rules by country as the following.

In addition, there is the potential dangers imposed on crew members when firearms are allowed abroad. Captain John Dooley at MMA, who has over thirty years of experience on the sea and twenty years as captain, explained to me that crewmembers are not trained in using weapons and they are overloaded with their seamen's job already. Also the ship captains may not have access to the backgrounds or criminal histories of his or her seafarers, and providing a weapon to a mariner with a felony would be a criminal act and could imperil the crew. There might also the worries that crewmembers might use weapons to solve their personal dispute on board.

## 3 THE FIREARMS SAFETY TRAINING COURSE AT MMA

The Basic Firearms Safety Training Program has been conducted by the Center for Maritime and Professional Training at MMA since April of 2009. It has been increasingly popular after April of 2009 when the seized Maersk Alabama off the Somalian coast was successfully rescued and Captain Richard Phillips,

**Table 1** Firearms regulations by country

| Countries | Laws and regulations |
|---|---|
| Australia | Firearms must be declared on entry. All military-type firearms (greater than .22) are prohibited imports, and will be sealed on board or taken into custody at the first port of entry. Arrangements can be made to transport them to the port of departure if sufficient notice is given of that port and the date of departure. |
| Canada | Firearms are strictly controlled. As of January 1, 2001, visitors bringing firearms into Canada, or planning to borrow and use firearms while in Canada, are required to declare the firearms in writing using a Non-Resident Firearm Declaration form. |
| France | As a rule, firearms which have no legitimate sporting or recreational use are not permitted entry into France. |
| Egypt | A list of firearms, with their type and details, must be handed to the authorities on arrival. |
| India | Certain firearms and weapons are prohibited, and those permitted require a Possession License. All arms and ammunition will be sealed by customs and treated as bonded goods onboard the vessel. |
| Italy | Firearms must be declared on arrival. The penalty for non-declaration is imprisonment. |
| Mexico | Vessels entering Mexican waters with firearms or ammunition on board must have a permit previously issued by the Mexican Embassy, or a Mexican consulate. Violations have resulted in arrests, convictions, and long prison sentences. |
| South Africa: | Firearms will be sealed by customs on board if this is possible. Otherwise firearms will be removed and bonded until departure. |
| Spain | Firearms must be declared. |
| United Kingdom | Firearms and ammunition, including gas pistols and similar weapons, may not be imported. |

**Source:** May, Firearms Regulation by Country, http://www.thecoastalpassage.com/guns_aboard.html

MMA alumni of 1979, was greatly applauded for his heroic action. The story was also circulated that while being held in a small lifeboat with three pirates, Captain Phillips could have gotten hold of an AK-47. Because Captain Phillips did not know where the safe was, he let a self-saving opportunity go. The subsequent nation-wide debate over weapons on board and safety enhancement in maritime transport further stimulated the desire of MMA cadets to take the class.

### 3.1 Course Purpose

The goal of the Basic Firearms Safety Course is to teach the basic knowledge and skills, and to explain the attitude necessary for the safe handling and storage of firearms in the home. In this course, students will receive the NRA's Home Firearm Safety handbook, pamphlets on safety and terminology, and lessons on the rules of safe gun handling, identifying and unloading various firearms, ammunition, cleaning, and storage. Students will also get hands-on experience with the most common types of handguns, rifles and shotguns. In order to satisfy the additional training requirements particular to the State of Massachusetts, Massachusetts laws pertaining to permit application, firearms storage and transportation rules will also be covered.

Captain Lima, the academic dean and the instructor of the class, explained the purpose of the course, which was to "let the students be familiar with the firearms and feel comfortable using them. If they got into a situation when weapons were put in their hands, they would know what to do with them. " Also "each year we have some students go to the company like US Military Sealift Command, they will be required to go through one week of training to learn how to fire guns."

Table 3 shows the number of cadets went to join the military upon graduation, including US Navy, from year of 2012 to the years of 2014.

The Military Sealift Command is the transportation provider for the Department of Defense with the responsibility of providing strategic sealift and ocean shipping for US Navy and other government agencies. MSC has been the biggest employer of MMA cadets for years.Table 4 shows the cadets who got hired by Military Sealift Command from 2013 to 2015.

### 3.2 Course setup

The class generally runs for six hours, and over the course of two consecutive evenings. It requires the registered students to be 21 years or older and class cap is fifteen. At this point, the class is offered six times a year: three times in the fall semester, in September, October and November, and three times in the spring semester, in March, May and June respectively.

## 4 CONCLUSION

Though it is still a heated debated issue whether to allow firearms abroad on merchant vessels, both sides agree that it is crucial to enhance the safety in maritime transport. The Firearms Safety Training Program is certainly set up to achieve that goal—to improve the security in shipping around the world.

**Table 3** The cadets go to join the military upon graduation 2012-2014

| Year | 2012 | 2013 | 2014 |
|---|---|---|---|
| Number of cadets going to Military | 7 out of 206 | 2 Out of 208 | 9 Out of 231 |

**Data source:** Professional and Career Development Office at MMA

**Table 4** The cadets hired by Military Sealift Command upon graduation 2013-2015

| Year | 2013 | 2014 | 2015 |
|---|---|---|---|
| Number of cadets going to Military | 25 out of 208 | 13 Out of 231 | 23 Out of more than 200 |

**Data source:** Professional and Career Development Office at MMA

**Table 5** Cadets Enrollment in the Firearms Safety Training class (2012-2015)

| Year | 2012 | 2013 | 2014 | 2015 (half year) |
|---|---|---|---|---|
| Enrollment | 42 | 34 | 63 | 28 |

**Data source:** The Center for Maritime and Professional Training at MMA

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# TEACHING THE 'CROWN' OF MARINE ENGINEER KNOWLEDGE
## Case study

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**Abstract**. Educating marine engineers for their future job is quite a challenge for their professors respecting the changes occurred in shipping in past few decades. In some cases the approach is still focused on teaching the facts in the same way they were taught long time ago. But today's students have changed and so has technology. Advances in educational technology are transforming the learning and teaching processes. Consequently, the education system must adjust to better accommodate the way students learn.
The method of teaching based on real practical problems (faults, failures) seems to be giving an opportunity for students to be creative, to understand a specific problem and find a solution for it. To understand the process of decision making or risk assessment presents a real challenge. The students have been working in several teams sharing the information among the members, discussing and competing. Collaborative communication and interpersonal skills of students were developed, a collaborative environment for enhancing student team working (important for 'on board' safety) was created.
Different approaches to teaching the same known things presented through the case study in this paper resulted in better student class attendances, their successful efforts and increased motivation when dealing with tasks, and finally higher exam grades.

**Key words:** maritime education and training, teaching marine engineers, failure diagnosis

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## 1 INTRODUCTION

Learning the facts for 'today's students' is something that they perceive boring because there are many easily available data sources for obtaining such facts. Also, they are a 'generation of gamers' familiar with computers, and any failures a teacher might place on the computer based simulator is easily detected and solved especially by excellent students, so such an approach for them presents no challenge, and 'the best students' are expected to become good marine engineers, superintendents or future experts that are going to be able to solve the problem. Here, an opinion is that they have to be prepared for such career in a different way.

This case study is based on the current course: "Failure diagnosis" at the Faculty of Maritime Studies in Rijeka. Only one practical problem is presented. It demonstrates an example of teaching method in case of main engine starting failure during maneuvering that is not unusual to happen on board. The real situation was explained and the students were asked to detect the cause of failure. In detecting problems and finding solutions there were several checks to be done, but they had to deal with safety, time and cost (delay) restrictions.

Such a way of teaching is in accordance with theoretical teaching principles, as well as with STCW Convention (Manila 2010) requirements, modern practicing and engineering education, [1-5]. To understand the importance of such an approach it is necessary to realize that it is based on practical needs and relevant to competences required for the future marine engineer that students can recognize easily. It will encourage and motivate them to learn as well as leads to verifiable outcomes.

## 2 BASIC CONDITIONS

The "Failure diagnosis" course requires good background knowledge of many other disciplines (i.e. diesel engines, turbines, steam generators, auxiliary machineries, electrical, hydraulic or pneumatic systems or different on board piping systems, etc.), so it might be called "the 'crown' of marine engineer knowledge" especially taking into consideration the real on board situation where students (or 'future marine engineers') will be expected not only to detect the problems but to solve them. In many cases it cannot be done without good theoretical knowledge and 'the database of facts' they have to build during study. From the perspective of today's students, the theory and the facts can be obtained easily on the Internet, from books or instruction manuals, so they always ask for more practical issues to be included in lectures. It is often justified, but in the real situation on board, this is not always the case.

It is not to be expected that all issues regarding 'on board' failures might be covered through classroom instruction at the Faculty, but the main aspects and approaches could be taught. One of the most important aspects usually highlighted by experienced marine engineers and experts is: "there is nothing more practical than a good theoretical knowledge". So, on board problem detection and problem solving have 'to begin' and 'to end' with knowing the theory and the facts.

## 3 THE CONCEPT OF TEACHING METHOD

To optimize learning objectives, at the very beginning of the course, the teacher might be challenged to compromise the level of difficulty of the problem that could be assigned in accordance with the students' background knowledge, so assessment diagnostic test is a prerequisite for the success of the course.

During the lecture, the students are allowed to use any source of information they find necessary to solve the problem (books, the Internet, instruction manuals …)

The students (53 in total) were divided in teams (5-7). Each team had to elect the 'Team leader' and the 'Team leader' was allowed to select his assistant.

When teams were set up, the basic conditions were presented:

- Ship with fixed propeller under maneuvering on departure
- Propulsion – M/E: two-stroke, 6 cylinder, reversible diesel engine with T/C,

The lecture was divided into **three different levels**: basic knowledge, thorough understanding of the systems (working principles) and thorough understanding of the safety, time and cost aspects.

**1. Level**

*Failure*: **M/E Start failure**.

*Teams' task*: **to specify possible reasons of the failure and their indication**.

The teams were given ten minutes to discuss and specify possible reasons and their indication that upon collection of team member opinions had to be presented and explained by each team leader. All teams were invited to discuss different opinions and to question each team leader after presentation. As it was the first level that represents 'activation of background knowledge', the teacher's role is to moderate the discussion as necessary and give the feedback as a conclusion.

**2. Level**

*Failure:* **the failure of only one starting air valve on the cylinder head**.

*Teams' tasks*: **to explain in given situation (maneuvering): 'Is it possible to detect quickly that failure is on the one of the starting air valve?' and 'How they can be sure which one is faulty?' and 'What possible mitigation options are?'**

The teams were given fifteen minutes to discuss and express different opinions that were collected and presented by each team leader. All teams were invited to discuss different opinions and to question each team leader after presentation. As it was the second level that requires thorough understanding, the teacher's role was to moderate the discussion, to challenge the teams by asking provocative or supportive questions, and to give feedback as a conclusion.

**3. Level**

*Failure circumstances:* **safety, time and costs aspects**

*Teams' tasks:* **to specify: 'Who has to be informed firstly upon detection of the problem and why?', 'What should be informed about and why?', 'Which restrictions they have to be aware of?', 'What are the possible mitigating solutions and who has to make decision about what to do?', 'What is the safety procedure that has to be followed when replacing the faulty starting air valve?' and 'What is the procedure of starting air valve replacement?'**

The teams were given twenty minutes to discuss and specify opinions that were collected and presented by each team leader. All teams were invited to discuss different opinions and to question each team leader after the presentation. As it was the third level that requires thorough understanding of safety issues and time and costs restrictions, the teacher's role was to moderate the discussion, to challenge the teams by asking provocative or supportive questions, and to give feedback as a conclusion again.

## 4 LEARNING OUTCOMES

*The first level tasks* should be easily solved by teams and it represents 'the activation of background knowledge' they had to gained from other courses (marine diesel engines, marine engine simulator training, etc.). In example the students explain the causes for the failure such as:

- M/E interlock engaged – indication: interlock signal lamp (engine control room – ECR console) – ( i.e. turning gear engaged, aux. air blowers not in AUTO mode, ...)
- starting air master valve failure – indication signal lamp ECR console
- starting air distributor failure – indication signal lamp ECR console
- starting air valve on the cylinder head failure – no indication on ECR console, etc.

*The second level tasks* require thorough understanding of working principles of the M/E. The students have to demonstrate understanding of working principles, because they have to know that (in given basic conditions with reversible engine) it is possible just to reverse the engine trying to start it in opposite direction. Doing so, the camshaft will be positioned on the other cylinder to start, and the other starting valve is to be engaged. But, before reversing the engine, the students have to check the mark on the flywheel (or on the HP pump) to detect which cylinder was at the start position when starting failure happened. If the engine was started in the opposite direction, the one detected was the failed one.

*The third level tasks* require thorough understanding of the safety issues and time and cost restrictions that are to be considered in such circumstances. When maneuvering the ship, before trying to reverse the engine, the Master should be informed about the failure immediately because he had to be aware of the problem regarding the M/E. The Chief engineer (C/E) has to explain where the problem is (i.e. starting air valve on cylinder No. 3) and what the possible options to solve the problem are. There are several things to be discussed among them:

- if there is a possibility for stoppage of M/E (mooring, anchoring) to replace the failed valve, the Master should inform the C/E about
- if there are tugs engaged to assist the maneuvering, there are restrictions that should be considered as: delay of ship departure, costs connected with tugs and mooring payment, possible port traffic congestions, etc.
- if the ship is in the position where there is no possibility for stoppage and replacing the failed valve, the Master should be informed that maneuvering is possible to continue but with a possibility of delay in responding to the command from the engine room (i.e. if cylinder with failed starting valve comes to the starting position again which will require reversing to turn the engine on the other position to start), as well as of the fact that if stopping during maneuvering might be avoided than ship can proceed with maneuvering and the failed valve can be replaced afterward;
- both of them (the Master and the C/E) as well as other crew members have to be aware of the possi-

ble risks if continue with maneuvering, but the Master is the one who has to decide what should be done.

The last part of the third level tasks is connected with the safety procedures that need to be followed when replacing the failed starting air valve with the spare one. The students are required to demonstrate thorough understanding of safety precautions and measures to be applied in preventing of engine starting during replacement (i.e. informing each crew member about work in progress, closing the starting air master valve and releasing the pressure in starting system, engaging the turning gear, putting the visible warning signs that engine should not be started, etc.). Also they have to demonstrate understanding of the replacement procedure (i.e. 1. dismantling of connection piping and failed starting valve, 2. cleaning the valve seat in the cylinder head, 3. testing the spare one before mounting and applying anti-seizure compounds on sealing surfaces, and 4. mounting the spare valve and connection piping). Testing of M/E is to be done after replacement.

## 5 METHOD BENEFITS AND OBSERVATIONS

The teaching method used in this case study is based on the real practical problem that might happen on board, so the students can realize that it is *based on their needs* and *relevant* to their future jobs, so usually they are *highly motivated*. The similarity in grouping with on board engine crew organization (Chief engineer, 2nd Engineer...) is obvious. By working in groups, 'peer to peer' *interactive* learning is achieved which is the most comfortable for the students as they are not afraid to be mistaken and corrected by the peers. Stimulating the discussion after presentation of each team leader, the learning becomes *interactive* between the groups and it *promotes reflection* and *feedback* from the peers themselves. The teacher is in a position that allows him to moderate the discussion in an appropriate way, to challenge the teams and collect findings (i.e. on the blackboard) for each level of the lecture which finally presents the *verifiable learning outcomes* and *promotes teacher's feedback* to the students for that specific lecture.

The teacher's observations also should cover the behavior of students within the team and attitudes of team leaders. It is to be noted that the students when asked to elect the team leader usually elect the best student among themselves and they are quite confident about his/her knowledge. The best students are also to be future on board leaders. But some of the elected team leaders did not want to be elected, so it seems helpful to encourage the leaders by allowing them to elect the assistants of their own choice.

The task of the leader upon presentation was also to evaluate the participation of each team member of his team when discussing and solving problems. This is a common practice and an obligation for on board leaders (i.e. 'appraisal form' at the end of the contract) which for students is especially hard to accept. They perceive such obligation as a peer evaluation. The teacher has to explain the reasons for such a decision because they are expected to be on board leaders and fair and honest evaluation is necessary. The message they are sending across is that each member of the team is equal regarding relationship within the team, but they might not participate in solving problems equally. The member of the team, who participates more than others when solving problems, expects that his/her efforts should be recognized within the group as well as by the leader. If the leader fails to do that (i.e. giving equal parts of credit to every member of the team) he/she has to be aware that there will be a member who will not be happy with the evaluation. Also, if there is a member who didn't participate at all, by giving him/her a credit for nothing, the leader sends a 'wrong message' to the team. To encourage honest evaluation, the teacher should explain the fact that if the team leader wants to improve the results, it should be started with improving the performance of the weakest member of the team. So, the role of the leader is to lead the team, to run team discussion, to assign the tasks, to motivate, to help and to raise awareness among the members that participation of each member is important if they want to obtain better results.

The students might ask the teacher to advise them in advance of the failure that will be assigned as a task during the next lecture, with the explanation that they want to be better prepared. But on board, the failure will happen without notice. So, the teacher might suggest the system that will be failed only, but not the failure itself. In some cases it might be considered 'to trade' such students request by giving them more complex failure if known system (i.e. "you are going to be better prepared, so the problem can be more complex"). Regarding complexity, the teacher should be aware that if assigned problem is too easy to solve, the students will not be so motivated. In case of a too difficult one, they will be demoralized. So, it should be just a little bit above their knowledge as a group but solvable if they function as a good team which is quite a challenging task for the teacher. In that manner the students will obtain experience of working together and collaborating, the skills so required on board.

## 6 CONCLUSION

It is not to be expected that all issues regarding on board failures might be covered within the course at the Faculty, but the main aspects and approaches could be taught. The students should be aware that on board problem detection and problem solving had 'to begin' and 'to end' with knowing the theory and the facts. The teacher might support that by assigning the real practical tasks (faults, failures, problems) complex enough and in such a manner that the students have to search for the information by themselves within all available sources (books, the Internet, etc.) or by holding the team discussions, when they become aware why they have to know some theory or facts.

Such a way of teaching seems to be giving an opportunity for students to be creative, to understand a specific problem and find a solution for it, to understand the process of decision making or risk assessment and this presents a real challenge. They have been working in several teams sharing the information among them, discussing and competing with each other. So, they worked in close collaboration, a skill essential for onboard safety as well.

Different approach of teaching the same known things presented through the case study in this paper resulted with better student class attendances, their successful efforts and increased motivation when being allocated a tasks, and finally their academic performance was improved.

To conclude, such an approach is not widely published, thus we were not able to compare the outcomes of other case studies. Also, there are some observations that might be considered in different conditions, but the results of this case study were too interesting and important, and worth sharing.

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# ON IMPORTANCE OF NONVERBAL COMMUNICATION IN MARITIME ENGLISH TEACHING

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**Abstract.** The present paper deals with the importance of the nonverbal communication provision in Maritime English teaching at Higher Maritime Institutions. Requirements related to the verbal communication teaching are clearly stated in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 as amended, which directly requires "adequate knowledge of the English language to enable the officer to use charts and other nautical publications, to understand meteorological information and messages concerning ship's safety and operation, to communicate with other ships, coast stations and VTS centres and to perform the officer's duties also with a multilingual crew, including the ability to use and understand the IMO Standard Marine Communication Phrases (SMCP)" [2]. The IMO SMCP provide verbal ship to ship, shore to ship and vice versa communication and cover the most important cases of routine and emergency contact.

At the same time, seafarers actively use nonverbal communication which also plays significant role in ship routine and emergency activities and procedures. Taking into consideration the above mentioned conventional requirements, the authors propose a model of inclusion of the above stated components into Maritime English teaching.

**Key words:** nonverbal communication, Maritime English, safety, STCW, IALA signs

## INTRODUCTION

Onboard nonverbal communication is related to different aspects of shiphandling, such as passage course plotting, lookout and watchkeeping, cargo loading and discharging, mooring and towing operations, repair works, etc. Nonverbal communication is typically provided by different means, such as symbols and abbreviation used on analog and electronic nautical charts, navigation lights and shapes,

Morse code, the International Maritime Signal Flags, signing used during cargo loading and discharging operations, cargo identification labels and dangerous goods signs under the classification of The International Maritime Dangerous Goods (IMDG) Code, uniform components, ship hull signs and other elements which are the integral parts of provision of safety of navigation. International Convention for the Safety of Life at Sea (SOLAS), 1974 and the International Life-Saving Appliance (LSA) Code, require signs to identify the locations of life saving equipment in accordance with recommendations of IMO.

Accordingly the IMO signs are presented by departmental signage, direction signs, EEBD pictograms, fire control symbols, fire equipment signs, hazard signs, immersion suit pictograms, IMO fire control symbols, IMO lifesaving appliances symbols, mandatory signs, port terminal signage, prohibition signs, safety awareness & training posters, and safety signs. The goal of the presented paper is to propose a sample of a teaching data compilation designed in a form of a coursebook unit (aimed at non-native English students of Sea Navigation Specialty) to meet the revised STCW 78/95 requirements regarding the English Language competence and proficiency of bridge team applied to the latest changes introduced by the International Association of Marine Aids to Navigation and Lighthouse Authorities.

The frames of the present paper do not give possibility to discuss all types and kinds of nonverbal communication used at sea, that is why we present only thetype of such kind of communication based on the use of the AtoNs (Aids to Navigation) which include any device or system, external to a vessel provided to help a mariner to determine position and course, to warn of dangers or of obstructions, or to give advice about the location of a best or preferred route. Visual Marks can be natural or man-made conspicuous objects such as mountain-tops, rocks, churches, towers, minarets, monuments, chimneys, etc.

Purpose-built AtoNs include lighthouses, beacons, leading (range) lines, lightvessels, buoys, daymarks (dayboards) and traffic signals. Visual marks can be provided with a light or left unlit. The effectiveness of a visual AtoN depends on its type, location, distance and atmospheric conditions.AtoN distinguishing features include the location, type (fixed structure, floating platform) and characteristics (shape, size, elevation, color, lit/unlit, light intensity, signal character, construction material, names, letters and numbers). The IALA MBS consists of the following marks that may be used in any combination: Lateral Marks, Cardinal Marks, Isolated Danger Marks, Safe Water Marks, Special Marks and the Emergency Wreck Marking Buoy (New Danger Mark). The marks have easily recognizable elements. All marks within the IALA MBS are distinguished by: shape, color, topmark, light, location, markings (name, number: etc) and auxiliary features such as sound signals: whistles, bells and gongs.

Taking into consideration the critical importance of these signs (actually they are used at sea as the means of nonverbal communication between the port authorities/VTS Centres and the seafarers, which at the same time should be transferred into the verbal communication between the lookout, OOW and the helmsman) we used these signs as the background for the model presented below. The goal of the presented sample unit is to provide the nautical students with adequate competence and proficiency to enable them to use specific nautical nonverbal communication and to develop oral communication skills by means the individual project work motivation.

### Sample Unit: English for Bridge Watchkeeping Skills – The Lateral Marks, Regions A and B: features and function

Lateral Marks (signs) indicate the port and starboard hand side of a safe water channel. The lateral signs in the Regions A and B are different; the other marks are common for these both regions. If marks at the sides of a channel are numbered or lettered, the numbering or lettering shall follow the “conventional direction of buoyage” which may be:

Local Direction of Buoyage is the direction taken by the Mariner when approaching a harbor, river, or other waterway from seaward. General Direction of Buoyage is the direction determined by the buoyage authorities is based, whenever possible, on the principle of following a clockwise direction around continents and is usually given in Admiralty Sailing Direction and, if necessary, indicated on charts by the appropriate symbol.

Description of Lateral Marks used in Region A:

| | **Port hand Marks** | **Starboard hand Marks** |
|---|---|---|
| Color | Red | Green |
| Shape (Buoys) | Cylindrical (can), pillar or spar | Conical, pillar or spar |
| Topmark (if any) | Single red cylinder (can) | Single green cone, point upward |
| Light (whenfitted) | | |
| Color | Red | Green |
| Rhythm | Quick Flashing, Flashing, Long Flashing, Group Flashing | Quick Flashing, Flashing, Long Flashing, Group Flashing |

At the point where a channel divides when proceeding in the "conventional direction of buoyage", a preferred channel may be indicated by a modified Port or Starboard lateral mark/junction buoy/bifurcation mark which usually indicate a deep water channel, suitable for commercial traffic, with a secondary channel suitable for shallower draught vessels as follows:

Description of Modified Lateral Marks used in Region A:

| | **Preferred channel to Starboard** | **Preferred channel to Port** |
|---|---|---|
| Color | Red with one broad green horizontal | Green with one broad red horizontal |
| Shape (Buoys) | Cylindrical (can), pillar or spar | Conical, pillar or spar |
| Topmark (if any) | Single red cylinder (can) | Single green cone, point upward |
| Light (whenfitted) | | |
| Color | Red | Green |
| Rhythm | Composite group flashing (2+1) | Composite group flashing (2+1) |

The Lateral Marks, Region B, different features and the same function:

| | **Port hand Marks** | **Starboard hand Marks** |
|---|---|---|
| Color | Green | Red |
| Shape (Buoys) | Cylindrical (can), pillar or spar | Conical, pillar or spar |
| Topmark (if any) | Single green cylinder (can) | Single red cone, point upward |
| Light (whenfitted) | | |
| Color | Green | Red |
| Rhythm | Quick Flashing, Flashing, Long Flashing, Group Flashing | Quick Flashing, Flashing, Long Flashing, Group Flashing |

At the point where a channel divides, when proceeding in the "conventional direction ofbuoyage", a preferred channel may be indicated by a modified Port or Starboard lateral mark as follows:

Description of Modified Lateral Marks used in Region B:

| | **Preferred channel to Starboard** | **Preferred channel to Port** |
|---|---|---|
| Color | Green with one broad red horizontal | Red with one broad green horizontal |
| Shape (Buoys) | Cylindrical (can), pillar or spar | Conical, pillar or spar |
| Topmark (if any) | Single green cylinder (can) | Single red cone, point upward |
| Light (whenfitted) | | |
| Color | Green | Red |
| Rhythm | Composite group flashing (2 + 1) | Composite group flashing (2 + 1) |

**To the Examinees and Instructors – Communicative Competence Tasks:**

**The principles of assessment include Speech Fluency Development:** pair work discussions; presentations of individual project works; presentations of the illustrations in Blind Formatand the tests, based on the illustrations used in the text, e.g.:


– Danger (depth unknown) – Leading line, Region A

– Obstruction, least depth known – Leading Line, Region B

**Individual work/Presentation:** be ready to comment upon the presented illustrations in their blind formats.

**Pair Work:** Be ready to ask and answer the text related questions;

**Individual Project Work:** Skim and scan the presented text and conclude, why the transformation of nonverbal communication into verbal one is important for a seafarer: don't simply copy the contents, put appropriate word combinations into the given sentence models, motivate your answer in the form of a short summary:

| | | | | | |
|---|---|---|---|---|---|
| to comply with:<br>the COLREG rules;<br>the STCW requirements;<br>the SOLAS requirements;<br>the MARPOL requirements;<br>the IALA recommendations | to steer;<br>to manoeuvre;<br>to alter the course to starboard;<br>to alter the course to port;<br>to operate astern propulsion | to become: a rating forming part of a navigational watch;<br>an officer in charge of a navigational watch;<br>a Master | to perform:<br>watchkeeping duties;<br>the Master's orders; the<br>pilot's advice;<br>VTS; instructions | a vessel engaged in dredging or underwater operation;<br>a vessel engaged in fishing | a vessel restricted in her ability to manoeuvre;<br>a power-driven vessel engaged in a towing operation |
| to maintain:<br>a proper lookout;<br>shiphandling | to proceed at a safe speed | to prevent: the risk of collision;<br>striking with another vessel | in narrow channel;<br>in congested waters;<br>in Head-on situation | to obtain:<br>an early warning of the risk of collision;<br>a watchkeeping license | not to run aground;<br>not to impede the passage |

Of course, I naturally agree that ……………………………… ……………………………………………… is/are important for future seafarers. Let me present a set of arguments clearly proving my point of view: Firstly, ……………………………… is/are necessary (compulsory/obligatory) for/to ……………………………………………… .

Similarly, there is no doubt, that ……………………………… ……………………………………………… essential to/for ……………………………………………………………… .

So, as I think (in my opinion/as to me), it is for sure, that every cadet should ……………………………… ……………………………………………………………… .

In other words, it is obvious, (clear) that …………… ……………………………………………………………… .

Let's use this illustration as an example: (use any of the presented sketches): ……………………………… ……………………………………………………………… .

Finally, as the conclusion, if one wants to become a seafarer, he should ……………………………………………… ……………………………………………………………… .

## CONCLUSION

The expected outcome of selected data and communicative competence tasks covers the fluent use of adequate speech act modeling, self-representation and critical thinking development.

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# DELIVERING AND ASSESSING A CROSS-CULTURAL MODULE FOR SEAFARERS AND MARITIME UNIVERSITY STUDENTS

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**Abstract.** How can maritime educators and trainers meet the communicative and cultural awareness needs of current and future seafarers who will be part of diverse multicultural crews and business teams? This question is becoming increasingly important in today's rapidly globalizing maritime industry, and must be met head-on by maritime educators, trainers, and industry administrators in order to ensure continuing success and improved safety in the maritime sector. One method of addressing this issue is through the development and implementation of a cross-cultural module designed specifically for seafarers and maritime university students. This paper will outline the development, implementation, and evaluation of a short Maritime International Exchange (MIX) that was created to assess the cultural awareness needs of maritime university students and address them via a cultural exchange and reflection project. After taking part in the exchange project, student reflections showed that the participants experienced an increased in cultural awareness, not only of other cultures, but their own as well.

**Key words:** cross-cultural learning, cultural competency, maritime education and training, communication, e-learning

# 1 INTRODUCTION

The importance of cross-cultural awareness has been highlighted during the last decade (e.g. Progoulaki, et al., 2012; Progoulaki & Roe, 2012; Javidan, et al., 2006; Chen, et al., 2010; Kahveci, Lane, & Sampson, 2002; Progoulaki, 2008; Rooks, 2008a; Rooks, 2008b), due to the dynamics of cross cultural teams in the different shipping and maritime environments that may jeopardize team cohesion, safety and other aspects of ship's operation and maritime business management (Javidan & Dorfman, 2006; Parsons, Potoker, & Progoulaki, 2011). Since maritime regulatory organizations have not yet developed a common standard for cross-cultural learning and development, cross-cultural competency development for maritime professionals and the delivery of such education and training programs rely on the training needs of the participants and the specific goals of the education and training provider (i.e. maritime institutions, private MET sector, and others (Parsons, Potoker, & Progoulaki, 2011). In response, a Maritime International Exchange (MIX) (Szwed & Rooks, 2014) was developed as a maritime education and training (MET) program designed, in part, to improve cross-cultural learning and competency by promoting meaningful opportunities for foreign language communication and intercultural exchange (e.g. Carney, 2006; Thorne & Payne, 2005; Okubo & Kumahata, 2001), which helps them succeed in a global environment and successfully cope with unfamiliar situations (Bachner & Zeutschel, 1994). The cross-cultural learning module, which is based on proven methodology (see Parsons, Potoker, & Progoulaki, 2011; Parsons, et al., 2010; KNOWME, 2015), is delivered in an interactive, online cross-cultural learning mode. This paper shares the delivery and assessment of that cross-cultural learning module to a cohort of maritime university students from Japan, China, and U.S.A.

In order to maximize the potential for intercultural exposure, the MIX program puts maritime students into global virtual teams (Phadnis, et al., 2013). To develop participants' cross-cultural competency (Koester & Lustig, 2012), the MIX program relies on activities that explicitly promote meaningful opportunities for foreign language communication and intercultural exchange (e.g., Carney, 2006; Thorne & Payne, 2005; Okubo & Kumahata, 2001) with the added objective of training them to succeed in a global environment and successfully cope with unfamiliar situations (Bachner & Zeutschel, 1994). The authors developed a prototype module of the MIX program and deployed it using based on Schwald's 2012 pilot study framework. At the core of the module was a battery of cultural exchange and reflection activities that were created in order to make participants more aware of their own cultures, knowledge gaps or incorrect stereotypes they may have of other cultures, and finally as a means to spur further cross-cultural learning even after the module ended (Bachner & Zeutscheul, 1994). The authors realize that designing, planning, and implementing such exchanges can be a time-consuming, difficult task, which is why the logistics of a shorter, online-based group project were so appealing.

# 2 MARITIME INTERNATIONAL EXCHANGE (MIX) PROGRAM

The Knirk and Gufstason instructional design model (Knirk & Gufstason, 1986) was used as an organizing frame for developing the MIX program. The Knirk-Gufstason model is comprised of three phases: problem identification (assessing skills, creating goals, and organizing instruction), design (developing objectives, specifying strategies and context), and development (selecting materials, implementing instruction, analyzing results, revising materials). As Szwed and Rooks' 2014 paper described the first two phases of this program in detail, this paper will focus on the third phase after giving a brief overview of the first two in regards to the development and implementation of the MIX program. It is envisioned that additional evaluation, analysis, revision, and adaptation will continue as additional modules are integrated into MIX.

## 2.1 Problem Identification

The initial step in developing MIX was creating an instrument that could function as both a needs analysis tool and a way for students to track their own cultural competency development. After evaluating various cultural competency tests outlined by Matsumoto & Hwang (2013), the authors decided to make a new instrument that specifically addressed the key points of MIX by adapting Earley & Ang's Cultural Quotient (CQ) test (2003), which measures self-reported assessments of student motivation, cognition, metacognition, and behavior via a five-point Likert scale. The newly-adapted test was coined the Cultural Awareness Test (CAT), and it consists of five target areas of cultural competency, some of which retain the CQ's original aims but have been slightly changed and simplified in order to increase comprehensions levels of non-native English speaking participants (Figure 1).

For the initial pilot of the MIX project, 3 small groups of 3 students were chosen: 3 Americans, 3 Chinese, and 3 Japanese (n=9). This enabled the authors to keep the administrative logistics manageable, and also retrieve a practical size of data for quantitative and qualitative analysis. See Figure 2 for the full version of CAT prompts; see the figures details the results of 2015 MIX participant CAT.

| CAT: Survey Domains | | | | |
|---|---|---|---|---|
| Motivation: enthusiasm construct | Knowledge: cognition construct | Strategy: metacognitive construct | Communication: intercultural competence construct | Needs: Behavioral construct |

**Figure 1** The Five Prongs of CAT

Figure 1 illustrates some encouraging data, as there were no "disagree" answers from the Chinese, Japanese, or American participants regarding their motivation towards interacting with and learning about new cultures.

In Figure 2, we start to see some diverging trends in how the MIX participants viewed their own cultural knowledge. While the Chinese and American students seemed to have some relative confidence in their knowledge of other cultures, the Japanese students were much more diverse with their self-assessments, with some showing very little confidence in their knowledge of other cultures, and others showing much more self-assuredness.

The strategy section of CAT shows us more variance in participant self-assessments, with China and Japan showing neutral or positive awareness of cultural learning strategies, while the Japanese students again seem to be more dynamic according to individual answers.

Interestingly, the Chinese and Japanese MIX participants seem to be more sure of their cultural communication skills, specifically vocabulary and grammar, which are specifically mentioned in CAT, than the American participants are. Although the Japanese group appears to have some members who are less sure about their communicative abilities than their counterparts, the Chinese group seems quite sure of their foreign language abilities and communication skills.

Another strong piece of evidence for the validity of MIX is found in the needs awareness section of CAT, which is the where all participants did not answer negatively for a single prompt, and the overwhelming majority agreed or strongly agreed that they needed more exposure to foreign cultures, and see the need for increased cross-cultural awareness.

Figure 6 illustrates the Likert score response means (on the five-point Likert scale) for all three participating groups of students in each of the five prongs of CAT. With the exception of communication, US students generally assessed themselves higher on all skill levels of cultural awareness. The Japanese students rated their cultural knowledge the lowest out of each group, while the Chinese students' self-reported motivation

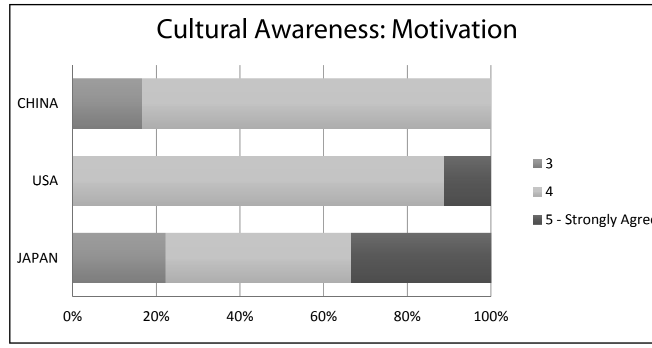


**Figure 2** Cultural Awareness: Motivation

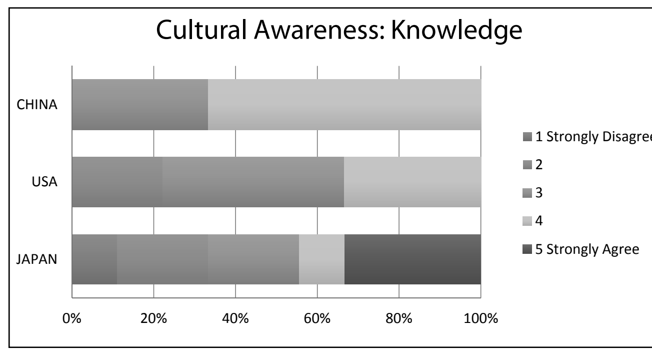


**Figure 3** Cultural Awareness: Knowledge

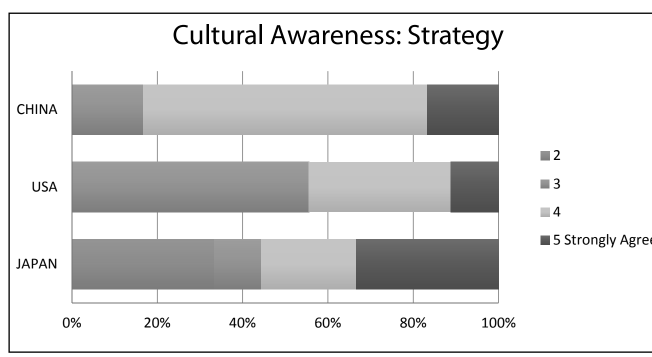


**Figure 4** Cultural Awareness: Strategy

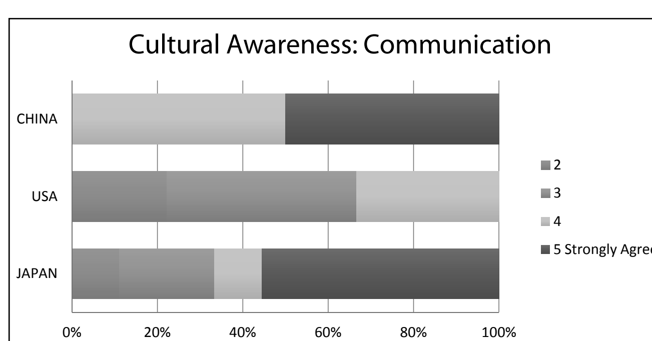


**Figure 5** Cultural Awareness: Communication

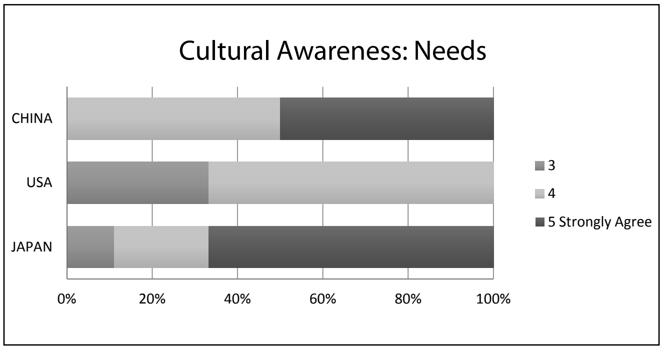


**Figure 6** Cultural Awareness: Needs

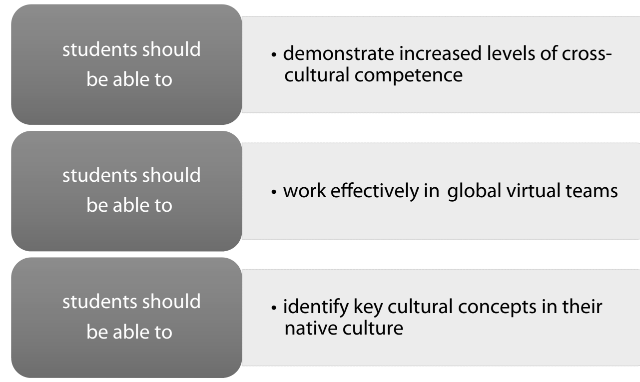


**Figure 7** MIX learning objectives

was slightly lower than the other participants. Interestingly, Japan and China both reported a strong awareness that they needed to further develop their cross-cultural awareness, and while the USA participant scores were not as high, at a 3.7 means, they were still well above the neutral score of 3.

**Table 1** Comparison of self-reported cultural awareness using CAT

| | Japan | USA | China |
|---|---|---|---|
| Knowledge | 3.3 | 4.1 | 3.8 |
| Strategy | 3.6 | 3.6 | 4 |
| Communication | 4.1 | 3.1 | 4.5 |
| Motivation | 4.1 | 4.1 | 3.8 |
| Needs | 4.6 | 3.7 | 4.5 |

The needs analysis provided by CAT painted a clear picture: students are aware of their needs as future seafarers to further develop their intercultural competency. The next step of the process was to design MIX to meet these needs in an efficient, adaptable methodology that can be flexible to suit the needs of various educational and training situations.

## 2.2 Program Design

After CAT identified the problem that needed to be addressed (i.e., insufficient cultural awareness and a need to improve competency), the authors confirmed that the underlying objectives of MIX, namely improving cultural competence, was valid. The next phase entailed designing the actual program via learning objectives, learning activities, and assessments.

These learning objectives were created to meet the needs of the particular students involved in MIX vis-à-vis their respective institutions, although they were created with the pre-conceived notion that they could easily be adapted to suit the specific needs of virtually any institution or group of students who may want to take part in the MIX program. Retaining flexibility for a wide range of cultural and training needs is one of the strong points of MIX, as the potential for modules that can be plugged into it are virtually endless.

Through this design, the MIX program was shaped into a blended-learning program that joins maritime students from MET institutions in different nations for engaged cultural exchange and learning by bringing together various student groups and cultures both online, and then ideally in person in order to offer real-life cultural exchange for participants. This aspect of the program design takes advantage of both distance learning (with a specific focus on explicit cross-cultural/language learning) and problem-based learning (including working in global virtual teams and in-residence maritime consulting).

Although the initial pilot module only focused on an intensive 3-week cultural exchange process, in the future the authors hope to expand the MIX program to include wider-reaching learning activities. As MIX continues to grow and mature, various aspects can be measured by a variety of pre-existing instruments: virtual learning (Rovai, Wighting, Bake, & Grooms, 2009); team performance, conflict, and satisfaction (De Dreu & Weingart, 2003); trust and behaviors of the global virtual team (Phandis, Perez-Franco, Caplice, & Sheffi, 2013); language-learning (Allen, 2010) and cultural awareness using CAT (Szwed & Rooks, 2014).

# 3 METHODOLOGY

The MIX pilot module took place over 3 weeks. Figure 8 outlines the flow of the module.

During the first week of MIX, each respective group of participants first took part in the CAT assessment outlined in section 2 of this paper. In week 2, the respective Chinese, American, and Japanese groups proceeded to identify 3 stereotypes and 3 hidden aspects of their own native culture which they then made into short 3-5 minute video presentations to share with the other cohort groups. After watching the other groups' videos via online downloads, the participants were in-

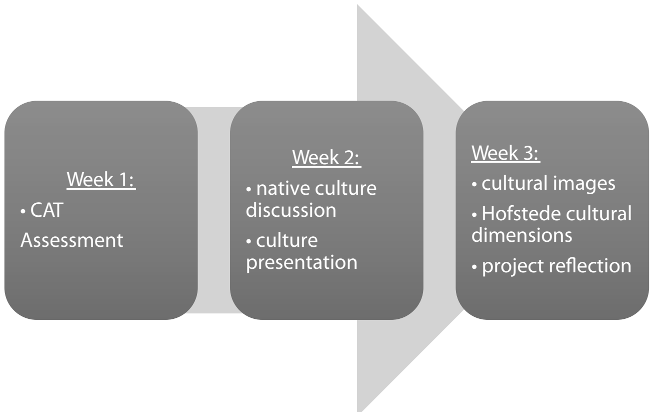


**Figure 8** MIX pilot module flow chart

structed to think about their impressions of the videos, along with any other individual images and preconceptions of the other two cohort groups' cultures, and write up an essay outlining their cultural view or image of each other cohort group culture. Finally, in week 3, all participating students watched a short video outlining Hofstede's (1997) cultural dimensions theory (specifically: Power Distance, Individualism vs. Collectivism, and Masculinity), then read the official Hofstede cultural profiles (via the Hofstede Centre website) for each cohort culture before writing a final reflection paper noting how their cultural perceptions had changed during the course of the project.

## 4 RESULTS

An analysis of the student reflections showed that all participating students noticed a change in their cultural awareness. A majority of reporting students mentioned a noticeable change in not only how they viewed the other cohort cultures, but their own culture as well. All participants wrote that their preconceptions of the other participating cultures had changed. Student D from China wrote in her reflection paper "I realize there are several differences between the lives we have watched on TV series or news and the lives we really undergo in that culture." Surprisingly, some participants discovered negative aspects of their own culture that they had not noticed before. Student A from the USA group noted "I learned that my culture is often time conceited, proud, and more direct."

Other students reported that they had begun to see how stereotypes were often incorrect, as Student B from the USA group writes: "Most of all I learned that you can't judge an individual on their background, but how they interact and live their life on a daily basis." Interestingly, the Japanese reflections placed a particular emphasis on the difference in communication styles that were evident through the culture videos that were shared online: Student H writes: "The American and Chinese presentations are good because they talk freely and in an interesting way," while Student I from Japan noted "I should try to give presentations in a similar style" [to the Americans and Chinese]. Both the American & Chinese student presentations focused on what they wanted to say naturally, while we Japanese students read a lot from the scripts we prepared.

## 5 SUMMARY

The importance of developing cross-cultural competency for maritime students, seafarers and maritime professionals is an area of increasing importance due to rapid globalization. Crew cohesiveness and clear communication amongst multicultural crew members aboard maritime vessels is essential both for safe navigation and maximizing business potential. In this regard, the development and implementation of education and training programs that can meet the cross-cultural needs of current and future seafarers is a fundamental requirement of current MET practices. Alarmingly, the current overarching educational climate in which maritime regulatory organizations have failed to develop common standards for cross-cultural education.

The results of evaluation and validation of this MIX learning module can serve as an important feedback for improvement of the MIX module, as well as input to future such efforts for development of new courses in other maritime institutions or other industry stakeholders. The benefits of cross-cultural training for seafarers and maritime professionals are acknowledged at the industry level (Progoulaki, Theotokas, & Iakovaki, 2012), (Progoulaki, Potoker, & Parsons, 2013), (Progoulaki, 2008), however, based on this study, online cross-cultural learning might serve as an important supplement to shipboard and working experience, and should be explored further in order to give future seafarers and business workers a great chance of succeeding in the global workplace. Given these challenges and opportunities, it is envisioned that the MIX program will serve as a beneficial and economical way to help maritime students develop their cross-cultural awareness and maritime competencies.

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# E-LEARNING INNOVATIONS IN MASTER OF MARITIME TECHNOLOGY EDUCATION – LEARNING AND WORKING EFFICIENTLY WITHOUT INTERRUPTIONS

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**Abstract.** Satakunta University of Applied Sciences (later SAMK) started a Master´s programme for bachelor level Master Mariners 2006. The idea of this Master of Maritime Technology program is to produce leaders, experts and researchers for the maritime industry with a seagoing background of at least three years. The studies consist of 60 credits and half of this is studies mainly conducted through e-learning and video seminars and video lectures.

After nine years of experience several different e-learning platforms have been tested and used. Even more versions with their new and different qualities have also been tested. Methods of teaching maritime management, contracts, international treaties, insurance, risk management have been developed – All these in dept for future leaders or experts in shipping companies.

Technology in e-learning is a critical tool. It has to work, but it doesn't help if it works if the students are not learning by using it. The article envisages how the students get involved with a problem based learning which makes them solve problems by learning by doing. Master Mariners have good technical skills, but also those persons need to get pass the technology itself by multiple, different and changing practical problems which is closely related to their work but creates more and more learning on top of the knowledge already built during the bachelor studies and at sea.

Since the first developments in e-learning there has been a huge growth in the ability what the technology can do. The analyzes what the masters can now do from the vessel through internet envisages that the situation is very different than five-six years ago. The bandwidth has been reduced to make a living picture possible to both directions and participation in a real classroom situation from sea is no more just a dream in the future, but a reality.

The Master of Maritime Management program is built to start from the fact that bachelor is already a Master Mariner who has a at least 3 years working experience at sea and who wishes to enter into land based organization. Therefore it concentrates in the topics, which are not in depth covered by the STCW education. It closes the STCW topics out and develops the skills in economics, insurance, law, leadership, risk management etc. which are needed in Shipping company´s land organization.

The best practices in e-learning in developing these skills will be collected and presented in this paper and in the seminar.

**Key words**: IT and modern technology in maritime studies, maritime education and training (MET), maritime law, economics, insurance and management

## 1 INTRODUCTION

Globalization emphasizes the role of maritime management. Ship owners' land-based facilities function as part of international transportation companies or in co-operation with them. The international agreement system develops rapidly especially because of new regulations concerning environment protection and safety and increasing technical requirements. Changes in operational environments required by the shipping industry, risk management and complex agreement system and contracts in shipping companies are special challenges in this field that call for our attention.

Students are responsible for their own learning. However, SAMK and its staff are responsible for providing tuition, guidance and a e-learning environment that support students' opportunities for constructivist learning, and challenging students to develop themselves into experts that master their own professions. A central task consists of supporting the student's willingness to learn. The learner is seen as a self-directing individual who seeks personal development – an individual with his or her unique prerequisites for becoming educated, growing as a human being, developing mentally and becoming a full member of society.

The constructivist approach to learning focuses on the notion that views are never directly transferred from tuition or teaching material into students' skills; what happens in students' thoughts and mind is essential. Learning is always constructivist, happening through formation of a new, individual view of the studied matter or phenomenon, and never through direct transfer of an existing view.

The approach to studying the skills needed in maritime management has been based on a solution that students need to be able to study mostly through distant learning. They have to be able acquire the information from the vessel anywhere in the globe and they have to be able to participate the classes and deliver their own presentations anywhere and anytime.

After 9 years experimenting a combination of distant learning and 2-3 or 5 days seminars in Helsinki and London every other month has proved to be most productive solution.

## 2 TECHNOLOGY AND E-LEARNING DEVELOPMENT

The bachelor level students who have graduated and fond work, are not easily induced to carry on their studies to the Master degree. This applies especially to Maritime sector where Master Mariners already have studied for 4-4,5 years at the University for their degree which gives them competence together with practice at sea to work as Master Mariner as a captain without any limits in size of a vessel.

The studies have therefore been directed to those who aim to enhance their expertise and move on in their carriers and start to work in a land based organization. The problem is that most of them are still at sea and their work is usually organized in a very different way. Some work on a passenger vessel 7 days and stay home seven days, some work in ten days shifts, but many of them work in 4/4, 6/6 weeks shifts and some even 3/3 months shifts. This makes the organization of the studies quite demanding for the University. After experimenting different models it has become self evident that most of the studies has to be organized through e-learning and videoconference connections. 2006-2009 this was not possible for one third of the students as the use of broadband was limited. However the situation has changed dramatically 2010-2012 when only under ten percent of students did have problems to participate. Since 2013 there has been only some exceptions who face the similar difficulties.

Internet connections on vessels have become more freely available and there are very seldom problems in organizing their use for studying. Most ship owners already have a policy that internet is primary used for working, secondly for studying and thirdly for other leisure time activities.

SAMK master program for mariners has since 2011 been based on a model that lectures are held in Helsinki or London every second month. These lectures are held by teachers: Professors, lecturers or industry experts and they can also be recorded so that the students who cannot participate have an access to the lecture afterwards through a link which is placed in the e-learning platform together with the power point presentations and the other e-learning materials. Each of the courses starts with a 2-3 days lecture period where most of the students are present, but which can be participated through internet or which can be later studied as recorded. The rest of the contact studies during the course is online during the next 8-weeks period. During this period the student study the materials independently, prepare their presentations individually and present the presentations in different topics on-line to the other in small groups when the teacher is always present. They are able to reserve the group and time for their presentation electronically in the e-learning platform. All students are able to participate in all sessions, but all the presentations are also recorded and a link to the presentations is also added to the e-learning platform so that the presentations are available for all the students during the whole course. Before the topics and individually chosen assignments are delivered to the students they are forced to study documents which enhance their theoretical skills in the subject. This makes the use of the individually chosen material easier and also prepares them to a better position to bring their individual working experience available to others. This is more closely explained below when the teaching of different topics is more closely explained.

The students presentations are evaluated in e-learning platform and they form part of their grade. The grades consist of different kinds of assignment, both common to all students and individual assignments as well as group assignments, which are carried out in small groups through e-learning platform. The different courses can evaluated in very different ways. Some courses are only bases on assignments, which are either electronically evaluated or manually evaluated by teacher with individual feedback to the student. Most courses still have exams which can be either based on time control only (performed from a specified address) or performed in a "exam aquarium" where the teacher is able to supervise the student and his/hers computer screen through video connection.

## 3 METHODS OF LEARNING AND TEACHING

The essential element of learning in the Master program is to understand the roles of the students and the teachers in a new manner. Carefully chosen students represent different shipping sectors. The study group, which has started their studies January 2014 can be used to emphasize this. Student work as deck officers in cruise industry, yachts, ice breakers, multipurpose vessels, RoRo-vessels, tankers, salvage tugs, passenger ferries, container vessels etc. some of them already work in land based organization after serving at least 3-5 years in one or several groups mention above. They form a group of twenty professionals together with more than 150 year of expertise from seafaring.

The studies are planned in a way that all this information and experience can be efficiently delivered to the others and combined with the theoretical knowledge from the University which they need to further develop in their working career. This needs careful planning by the teachers who need to plan the individual assignments in a way that the student is able to bring his expertise into the studies and deliver it efficiently to the other through electronic means despite the fact that he or she is somewhere far a way in vessel working either for example in the arctic or red sea. In this process the teachers role is crucial. He must have the needed theoretical knowledge and enough practical knowledge but he is also a consultant for the student in delivering his/hers knowledge (combined with theoretical knowledge) to the other students. The core of the method is to form a process where the student becomes a teacher of others assisted by a teacher who takes partly a role of an assistant in delivering the knowledge to the other students. Responsibility for delivering the knowledge is divided by the student and the teacher and the students takes the responsibility for teaching his or hers fellow colleges usually with pride and the result is usually excellent when the student experiences that he has delivered information to the other which is valuable and which he has already developed through studying more the theory behind his practical skills.

This method can be illustrated by following example. Teaching contract in shipping is usually difficult and boring. The legal regime and vocabulary is difficult for maritime lawyers. However the master mariners who know the practice in their specific field of transportation have a lot of practical knowledge. The teacher delivers them two cases during a specific course and they have to familiarize themselves carefully with the facts of the case which they will present to the others. The 40 cases are selected by the teacher in way that they form an entity, which gives all the students the information on the topic they need in their further careers. After having received both the theoretical and practical knowledge on 40 different kinds of situations hoe the law and practice solves the problems they have expertise, which is difficult to beat. During the presentations the students are able to ask questions and comment – and again bring their own expertise to the other students. The teachers role is to plan this process carefully in a way that all this forms an entity which develops the students knowledge in way that the outcome is the best possible. This same method can be used in different areas of law and contracts and we call it law and practice method.

Very much the same method can be used in risk management and insurance as well as chartering and safety issues. All these topics can be taught through the same method.

More commonly used method is presenting the articles of maritime economics. In this program the practice of using article presenting and analysis is made in a way that the student analyze the articles related to their own fields of shipping which they represent.

The learning results are tested electronically in the e-learning platform. The testing can be made in different ways. The presentations are connected to the further assignments which will be open only after the presentations have been delivered and while they have been available for all for an agreed period of time as recordings. The two ways which we have used are multiple choice questions assignments and PBL-problems based on the idea that the student have to apply the information to similar kinds of problems which they will solve either individually or in small groups. In some courses the multiple-choice assignment prepare the students for problem bases learning type assignments.

All this demands a lot of preparatory work from the teacher but it also rewards the teacher with excellent feedback and good results. But it also helps the teacher in further developing his own expertise and maintains his own skills with practical information from working life.

## 4 CONCLUSIONS

Developments in e-learning can be summarized in two most important sectors. Firstly, the e-learning platforms used by the Universities have become more and more open source based platforms, which makes the development easy and it is no longer tied with the requirements of the platform developer. Participation in the development is the essential element. Use of open source based platform is has been crucial for developing our system of e-learning. Without it the innovations would not have been possible. The teacher are now able to develop their own learning strategies depending on their topics. Problem is no longer if you can do it but to decide how you can do things in most efficient way to save your own and your students time. Innovations in e-learning need to be efficient also in relation to the time used by those who participate as they are participating while in working life or in their own time while the studies compete of their leisure time with their friends and family. They have to make the studies easy and lucrative.

Secondly, the development of videoconference systems needs to make the participation easy and they need to make the participation feel comfortable. SAMK has used previously AC Adobe but has now adopted a new system, which make it possible that all the students see each other constantly. The lectures can be participated in the classroom or through the video connection while every student is able to see all in the screen of the class or at their own screen on the different side of the world. Everybody is able to ask questions and get answers either in class or online. All this can and will be recorded. This practice will in my view be a revolutionary change in teaching and learning in the years to come and it will really for the first time make the learning available from every parts of the world when the student can really feel that they are learning together and meeting each other despite the physical distance between each other.

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# INNOVATIONS IN MARITIME RESEARCH THROUGH CO-OPERATION BETWEEN UNIVERSITY AND EMPLOYER OF THE STUDENT WRITING HIS/HER MASTER THESIS

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**Abstract.** Satakunta University of Applied Sciences started a Master´s programme for bachelor level Master Mariners 2006. The idea of this Master of Maritime Technology program is to produce leaders, experts and researchers for the maritime industry with a seagoing background of at least three years. The studies consist of 60 credits and half of this is research work partly for the company and partly for the University – Both of which are engaged in the process.

After nine years of experience from this practice there is now a great deal of best practices to be presented. As a result we now know what works in practice and what does not work. The idea of the article is to present best practices of the research methods and guidance methods in practice. The idea is also to present some results of the research conducted by the students.

An investigation among the graduated students has been done on how they were served by the University during the process of research, how they were encouraged or discouraged by their companies or fellow workers etc. But most important is to envisage how the results of the research work benefited the employing shipping companies and the employee. These results concentrate on maritime safety and efficiency as they have been the topics, which have been recently encouraged to be researched by the shipping companies.

The roles of companies and University in promoting the students research are analyzed. The first results show clear differences in the attitudes of different shipping sectors and different market areas. The students in this program work in multinational companies but the research show clear differences also in the attitude of different nationalities in research and how efficiently the company uses its opportunity for free research and co-operation with the Universities.

Research results presentation methods are presented and analyzed. Companies and University have experimentally organized seminars to present the research in different stages at the University with a possibility to participate also from the Shipping company´s premises.

**Key words**: research in MET, logistics and management, safety, efficiency, human element

## 1 LEADERS, RESEARCHERS AND EXPERTS FOR THE MARITIME INDUSTRY

The idea of the Master of Maritime Management program is to produce leaders, experts and researchers for the maritime industry with a seagoing background of at least three years. The demand of minimum three years working experience is regulated by legislation relating to the Act on Universities of Applied Sciences in Finland. This regulation is the starting point for the Master studies and how they are combined with the Bachelor studies. Each student in general is allowed to apply to master studies only after three years has passed since the graduation from the Bachelor level. For the maritime management program the working experience from seafaring after bachelor studies is an extra requirement included in this three years.

As the bachelor level degree is regulated by the STCW-convention, the level of the student's abilities after graduation from bachelor level Universities should be equal. The students should at least have the same basic knowledge when they apply to the master program.

The Master studies consist of 60 credits and half of this is studies essential for the persons who want to work in a shipping company or in the maritime administration. Master programs idea is to form "bridge" from ship to shore and give the required information on top of the STCW topics, which have already been taught to the student previously. The idea is that there has to be a main thread in the studies in a way that the master program starts from the assumption that all the STCW topics have already been handled and also held updated. This is essential as there is only 30 credits which must be effectively used to built the expertise needed in land based organization. Therefore all the 30 credits have to be used effectively and they do have to support also the research work that the student will do as half of the studies consists of research work partly for the company and partly for the University – Both of which are engaged in the process.

## 2 RESEARCH AND GUIDANCE METHODS IN PRACTICE

Satakunta University of Applied Sciences (later SAMK) started the program nine years ago and after nine years of experience from this practice there is now a great deal of best practices to be presented. The studies consist of 60 credits and half of this is research work partly for the company and partly for the University. Studies are designed in a way that persons who are working beside their studies can complete them in 2-2,5 years, but studies can also be completed as full time study basis in one year. The system of studies is planned to combine the work of two groups, which start every second year. The best students in previous group present the results and research methods of the previous group to the following group, which is in their first year of studies. This is combined to the alumni activities formed by the previous groups. In the following I will explain the method using the 2014 group as reference.

The study group selected during the autumn 2013 started their studies in January 2014. The first months the students were learning shipping organization methods and in depth shipping economics. The two courses gave them in more updated knowledge of the last developments in law, economics and practice concerning the working environment internationally. In the beginning of the studies the basic research skills were also presented. In May 2014 the previous study groups best research results were presented for the new students and their employers in a one day seminar organized by the Satakunta University of Applied Sciences together with the ministry of transport and communications in Finland, whose employee had also participated in the previous study group.

The core idea of this practice is to bring together the students, which are in the beginning phase of their studies, the graduating students and the alumnis – together with all their employers. The seminar is organized to fulfill several different goals in mind. First of all it is important way to bring the new research works to the knowledge of all employers. Secondly it is organized for the students and alumni´s so that they can network with each other and all the most important employers and possible future employers, which are not just national but also international shipping companies not just from Nordic countries but also from further afield. Thirdly the research work presented is gathered as a publication, which benefits all participants. Fourthly, the students who are now in the beginning of their studies are able to hear concrete stories of how the best students have conducted their research work together with their employers and the University, how they have planned and targeted the research work, what difficulties they have had and how they have won the difficulties, where they have found guidance and how they have finally reached their targets.

This has been essential for them for their own research and helped enormously their own research process, as they have been able to make more concrete planning of the research in an early stage of their studies when they already have a some kind of idea of their research topic. Finally as the seminars have ended by a dinner and cozy evening spent together with the students and the alumni's, they have been able to network and informally discuss the possible research topics and hear more experiences from the alumni´s.

During the next summer the study group developed their research topics and in the first seminar they present each other the research ideas and the research method, which is then discussed together with the Lecturer and fellow students. After this the employer and University sign the contract together with the research plan and the actual research will start. The roles of the student, Lecturer and the employer are prescribed in the contract and the research plan, which also determines the schedule according to which the research will be conducted. The second seminar is organized when the student has collected his research materials and in that seminar he presents the materials to the fellow students and also presents how he is going to apply the chosen research methods to the materials. Also an important part is planning of the research work in general and how it will be combined with the other studies during this phrase of research in order to create a symbiosis in which they support each other. Roles of the persons guiding the student from University and the employers are also in this phrase more closely determined.

## 3 EMPLOYER ROLES IN RESEARCH

The roles of companies and University in promoting the students research are is crucial. They need to understand their role clearly since the beginning of the process. The results of the analysis show clear differences in the attitudes of different shipping sectors and different market areas. Many of the students in the study program work in multinational companies but the research show clear differences also in the attitude of different nationalities in research and how efficiently the company uses its opportunity for free research and co-operation with the Universities.

The Cruise shipping sector has been this far the model student in understanding the how to benefit from the students and University´s efforts to create new knowledge through research. The example from Germany concerning creation of Cybernetic model of the bridge environment of a cruise vessel is the best example of how the company can respond to the needs of the industry by participating to the process in a way that benefits every aspects of the research. This can therefore be used as a model example of the process.

In the beginning of the process the student only had an idea of a serious of topics in mind when he approached the employer. His idea was to increase safety by combined with the workload at the bridge. After contacting the employer he received some topics, which the employer represented. In the same occasion the employer also presented how he would make the time available for the student if one of the topics would be chosen. After the topic was chosen the employer presented a person in the company responsible for the guidance from the employers side and arranged a starting meeting between the employers representative and the student. In this meeting the employers representative gave the student a list of materials which could be used in the research and also some basic knowledge material as a starting package. The University´s appointed lecturer then supplemented the list. After the student was well aware of the theoretical knowledge he was offered first one and then several vessels bridges for his the experiments of how the model would increase safety in practice. The analysis from this phrase was then taken to the study and the results were fully implemented in shipping company practices afterwards.

Another model example – actually two - from a same stevedoring company can be named in the same occasion. Finnish stevedoring company Finnsteve Ltd. Also understood in the very beginning that the employees participating the study program could really make a valuable effort. The first one was a study on reorganization of working time in the biggest Finnish container port, which had suffered of inefficient practices for decades. Mainly as a result of the study the practices were renewed and as a result the "lock" creating by the unions in the 1970´s were abolished.

The other example from the same company was a preliminary study for a new terminal management and container load planning system in Finnsteve Helsinki Vuosaari terminal. The result was also usable product for several different ports used by the shipping company in different countries and created work for tens of people in planning.

The essential feature in both these two researches were that they were closely negotiated with the University representative and the company together with the student in the beginning of the process and which was carefully planned starting from the outcome.

Two more examples can be taken from the Maritime administration. An excellent research was conducted on Safety of a vessel during sea trials. This research revealed that the process of sea trials lacked the legal framework totally which led to serious problems in variety of practices. The starting point was however different. The whole research idea was already based on the findings of the student in his own profession. The whole studies were used to collect different applications on different side effects of lacking ship safety and collected to the theoretical part of the study. During the empirical part of the study the student was present in the whole process of three different kinds of vessels sea trials and gathered the problems and deficiencies.

The resolution was that there should be common legislation for the industry for the European level to solve all the problems without giving the competitive advantage for the other countries shipbuilding industry.

The other research from the student working in maritime administration revealed the problems for the industry in facing the new Marpol air pollution requirements. An excellent example of combining the cooperation in research by the industry representatives and the administration by a person who had been previously employed by the shipping industry organisation and thereafter ministry transport and communication and now after graduation a permanent representative of Finland in IMO.

## 4 CONCLUSIONS

To summarize, the study program, which consists of studies combined to research has roved useful for both the students, companies, administration and the University of applied Sciences. It has fulfilled every participants need in a coherent manner and found its place to support the industry. It creates leaders experts and researchers a planned originally since 2003. All the model examples mentioned have moved upwards in their careers soon after graduation. They have either moved upwards in the same organization or to new organizations – but all have received more demanding posts as in the management. A research conducted among the alumnies in the beginning of this year gave significant feedback – All the students had experienced the studies useful and answered that they had been able to use their new expertise in their new positions. The first student was accepted to take the doctoral degree in WMU in Malmö last year without any supplementary studies – As result, which can be considered appraisal for the methodological skills served by the University of applied sciences in the masters program.

However, the most important result is that the research conducted by the students is constantly used to enhance maritime safety and efficiency of the industry when the result are implemented to the work in shipping companies and maritime administration.

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# ENHANCING PRODUCTIVITY IN MET BY MEASURING LEVEL OF KNOWLEDGE ON STCW 2010 MANILA AMENDMENTS AMONG ACADEMICIANS IN A MARITIME UNIVERSITY, PHILIPPINES

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**Abstract.** This study delved into the level of knowledge on STCW 2010 Manila Amendments as a way to enhance productivity in maritime education and training (MET) among academicians specifically Master Mariners and Chief Mates of John B. Lacson Foundation Maritime University-Arevalo, Iloilo City, Philippines during the first semester for school-year: 2014-2015. The instrument was adopted from Solas et al. (2013), revised, and underwent content validity. Results showed that generally, Master and Chief Mates had very high level of knowledge on STCW 2010 Manila Amendments. Furthermore, there was no significant difference in the level of knowledge on STCW 2010 Manila Amendments among Master and Chief Mates. Since these academicians have high level of knowledge on STCW 2010 Manila Amendments, this can be a first step to enhance productivity in teaching maritime education and training (MET) such as high board exam performance and skillful seafarers. Furthermore, these academicians must always update themselves since they are vectors of information and they are at the front line in producing competent seafarers.

## 1 INTRODUCTION

Seafarers play an important role in maritime industry. The International Maritime Organization (2010) divided them into three levels, namely, management level, operational level, and support level.

As we all know, seafaring is a profession where accidents are inevitable. That is why, the competence of seafarers is the most crucial factor to consider for safety of the crew, ship operation, and environment (ISF and ICS, 2011). The standards of competence among seafarers are highly stipulated in the IMO Convention on Standards on Training, Certification and Watchkeeping (STCW) for Seafarers. However, in 2010 during a diplomatic conference, the Manila 2010 Amendments were adopted to ensure that the STCW Convention and Code are applicable to seafarers in enhancing their seafaring skills through adequate trainings (IMO, 2010; ISF and ICS, 2011). In the Manila 2010 Amendments, the nine key new trainings requirements based from ISF and ICF (2011) are: changes to competence tables, leadership and teamwork, training record books, mandatory security training, refresher training, tanker training, new seafarer grades and certification, medical standards, and prevention of unsafe alcohol use (.05% blood alcohol level or .25 mg/L alcohol in the breath).

The other amendments include the number of rest hours from 70 to 77 hours and 10 resting hours in 24 hours period (ISF and ICS, 2011), marine environmental awareness training, training to cope with pirate attacks, training on polar waters, and training for operating Dynamic Positioning System (STCW Online, 2011).

Chae (2014) discussed the challenges of STCW Manila Amendments to the Far East and suggested solutions such as joint on-board training center, joint Asia maritime e-learning systems, methods to reduce workload, ship inspection burdens and determine mandatory minimum safety manning standards in a safe way, technical cooperation fund to installation of training equipment, and clarify vague terminology of STCW Manila Amendments.

This study aimed to determine the level of awareness of academicians specifically Masters and Chief Mates of JBLFMU-Arevalo on STCW 2010 Manila Amendments and to find out if there is a significant difference in the level of awareness on STCW 2010 Manila Amendments between Masters and Chief Mates of JBLFMU-Arevalo during the first semester for schoolyear 2014-2015.

## 2 METHOD

### 2.1 Purpose of the Study and Research Design

This survey aimed to determine the level of awareness on STCW 2010 Manila Amendments among academicians specifically Master and Chief Mates at JBLFMU-Arevalo during the first semester of schoolyear 2014-2015.

### 2.2 Respondents

The respondents of this study were the academicians specifically the Master and Chief Mates of John B. Lacson Foundation Maritime University-Arevalo. Complete enumeration was used to collect data from the respondents.

### 2.3 Instrument

The instrument was adopted from Solas, Erdao, Pangulong, Valdez, and Villanueva (2013) on STCW 2010 Manila Amendments. This was revised and underwent content validity from experts. The responses were "Highly Aware," "Fairly Aware," "Moderately Aware," and "Unaware."

### 2.4 Data Collection

Once the questionnaires were answered by the Master and Chief Mates, data were recorded or tallied for descriptive and inferential analyses.

### 2.5 Data Analysis

The following descriptive and inferential tests were used:

1. Mean was used to determine the level of awareness on STCW 2010 Manila amendments:

| *Mean Scale* | *Description* |
|---|---|
| 3.44 to 4.0 | Very high (Amendments are fully mastered) |
| 2.83 to 3.43 | High (Amendments are very satisfactorily mastered) |
| 2.22 to 2.82 | Moderate (Amendments are satisfactorily mastered) |
| 1.61 to 2.21 | Low (Amendments are fairly mastered) |
| 1.0 to 1.60 | Very low (Amendments are poorly mastered) |

2. Standard deviation was used to get the homogeneity of the responses.

3. Mann-Whitney U test was used to test for the significant difference of the level of awareness on STCW 2010 Manila Amendments when respondents were classified according to Masters and Chief Mates set at .05 level of significance.

## 3 RESULTS AND DISCUSSION

The level of awareness of Masters on STCW 2010 Manila Amendments is "very high" which means that they had fully mastered the Amendments.

On the other hand, Chief Mates exhibit "very high" awareness except for the statement, "Each tanker man category will have two levels: Basic (currently called assistant) and Advanced (currently called person-in-charge)" which is "high" which means that they had a very satisfactory mastery of the Amendments.

However, when taken as a whole group, academicians exhibited "very high" awareness except for "Electro-Technical Officer and Electro-Technical Rating were established, particularly in the passenger ship industry, in contribution for career development and improve the flexibility of roles on-board" which is "high". Table 1 show the results.

**Table 1** Level of Awareness on STCW Manila 2010 Amendments Among Master, Chief Mates, and When Taken as a Whole Group

| Statements | Master Mariner | | | Chief Mates | | | As a Whole Group | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | Description | SD | Mean | Description | SD | Mean | Description | SD |
| 1. The STCW 2010 Manila Amendments are applicable to all seafarers starting January 1, 2012. | 3.67 | Very High | .71 | 3.86 | Very High | .38 | 3.75 | Very High | .58 |
| 2. There is a need for deck officers to be competent in the use of Electronic Chart Display and Information System (ECDIS) and for engine officers to be able to operate pollution prevention equipment. | 4.0 | Very High | .00 | 4.0 | Very High | .00 | 4.0 | Very High | .00 |
| 3. In order to increase substantial competence of deck and engine officers, requirements related to leadership, teamwork, assertiveness training and managerial skills must be taken. | 3.67 | Very High | .50 | 4.0 | Very High | .00 | 3.81 | Very High | .40 |
| 4. It will be mandatory for all deck and engine rating trainees to demonstrate competence through the use of on-board training record books with completion to be supervised by officers responsible for the on-board training. | 3.78 | Very High | .44 | 4.0 | Very High | .00 | 3.88 | Very High | .34 |
| 5. All seafarers are required to provide evidence of appropriate level of competence in basic safety training (survival, fire fighting, first aid and personal safety) every five years to maintain their standards of competence throughout their careers. | 4.0 | Very High | .00 | 4.0 | Very High | .00 | 4.0 | Very High | .00 |
| 6. Seafarers who hold certificates of proficiency in survival craft, rescue boats and fast rescue boats, and advance fire fighting will have to maintain their level of competence every five years. | 3.89 | Very High | .33 | 4.0 | Very High | .00 | 3.94 | Very High | .25 |
| 7. The following subjects will be added to Personal Safety and Social Responsibilities (PSSR): communication, control of fatigue, and teamwork. | 3.56 | Very High | .53 | 3.57 | Very High | .79 | 3.56 | Very High | .63 |
| 8. There are comprehensive trainings in oil, chemical and gas tanker operations at both basic and advanced levels. | 3.56 | Very High | .76 | 3.57 | Very High | .79 | 3.56 | Very High | .73 |
| 9. Each tanker man category will have two levels: Basic (currently called assistant) and Advanced (currently called person-in-charge). | 3.67 | Very High | .71 | 3.43 | High | .98 | 3.56 | Very High | .81 |

| Statements | Master Mariner | | | Chief Mates | | | As a Whole Group | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | Description | SD | Mean | Description | SD | Mean | Description | SD |
| 10. Extensive trainings and certifications for the new grades of Able Seafarer Deck and Able Seafarer Engine are unfolded to enhance navigational and engine watch rating requirements. | 3.78 | Very High | .44 | 3.86 | Very High | .38 | 3.81 | Very High | .40 |
| 11. Electro-Technical Officer and Electro-Technical Rating were established, particularly in the passenger ship industry, in contribution for career development and improve the flexibility of roles on-board. | 3.56 | Very High | .53 | 2.0 | Low | 1.15 | 2.88 | High | 1.15 |
| 12. Medical fitness standards and requirements for certification are developed to aid seafarers on health concerns. | 3.89 | Very High | .33 | 3.86 | Very High | .38 | 3.88 | Very High | .34 |
| 13. For prevention of unsafe alcohol use, there is a specific limit for seafarers drinking liquor of 0.05% blood alcohol level or 0.25 mg/L alcohol in the breath. | 3.67 | Very High | .50 | 4.0 | Very High | .00 | 3.81 | Very High | .40 |
| 14. Seafarer's minimum rest period in any seven-day period is increased to 77 hours from 70 hours. | 3.44 | Very High | .73 | 3.57 | Very High | .53 | 3.50 | Very High | .63 |
| 15. Seafarers must now have at least 10 hours rest in any 24 hour period. | 3.77 | Very High | .44 | 4.0 | Very High | .00 | 3.88 | Very High | .34 |
| 16. It is mandatory to maintain records of each individual seafarer's rest hours which will be checked during Port State Control inspections. | 3.56 | Very High | .53 | 3.71 | Very High | .76 | 3.63 | Very High | .62 |
| 17. Seafarers holding STCW certificates issued prior to January 1, 2012 will have to meet the new requirements, including refresher trainings, in order for their certificates to be revalidated beyond January 1, 2017. | 3.56 | Very High | .53 | 4.0 | Very High | .00 | 3.75 | Very High | .45 |
| 18. By January 1, 2014, all seafarers will have to be trained and certified with security-related matters which include anti-piracy elements and to know the operations during security-related emergencies and contingency procedures. | 4.0 | Very High | .00 | 3.86 | Very High | .38 | 3.94 | Very High | .25 |
| 19. The training that will need to be refreshed by an approved method are: Proficiency in Survival Craft and Rescue Boats, Advanced Fire Fighting, Basic Safety Training, Fast Rescue Boat, and Medical Training. | 3.67 | Very High | .50 | 3.86 | Very High | .38 | 3.75 | Very High | .45 |
| 20. The included three levels of security training in the amendments are: Level 1 – Security Awareness, Level 2 – Person with Security Duty, and Level 3 – Ship Security Officer. | 3.66 | Very High | .50 | 3.43 | Very High | .53 | 3.56 | Very High | .51 |
| **Grand Mean and Standard Deviation** | **3. 72** | **Very High** | **.45** | **3.73** | **Very High** | **.37** | **3.72** | **Very High** | **.46** |

**Note:** Means, descriptions, and standard deviations are interpreted horizontally. Legend: Very high – 3.44 to 4.0; High – 2.83 to 3.43; Moderate – 2.22 to 2.82; Low – 1.61 to 2.21; and Very low – 1.0 to 1.60.

## 4 CONCLUSIONS

This study concludes that academicians specifically Masters and Chief Mates generally had very high awareness on STCW 2010 Manila Amendments. This could be a link in enhancing productivity in maritime education and training (MET) such as high board exam performance and skillful seafarers.

Furthermore, there was no significant difference in the level of awareness on STCW 2010 Manila Amendments among Master and Chief Mates.

It is recommended that professional instructors must update themselves of the STCW 2010 Manila Amendments since this is the guide of seafarers in attaining competency in seafaring profession.

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# THE DYNAMICS OF PROPULSION TECHNOLOGY ADOPTION IN THE MARITIME INDUSTRY: A SYSTEMS DYNAMICS MODEL OF TECHNOLOGY TRANSITION

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**Abstract.** As academics we seek to develop or refine enhancements to propulsion technologies, we look for energy efficiencies, but once found will those new efficient energy methods be used immediately? History traces maritime propulsion technology adoptions over decades and centuries. When new energy saving technologies are available, ship-owners are seemingly reluctant to adopt the new technology or embrace the new technology withskepticism, regarding available infrastructure and concern about investment in medium term developments. The reluctance may be completely rational as ship-owners will invest millions for a propulsion plant that will be in use for decades. Owners will look at the tradeoff between the benefits versus risk of the new propulsion technology – both have considerable uncertainties associated with them before adoption. Through causal loop and dynamic modeling the intent is to gain qualitative insight into the factors affecting of the adoption of a marine propulsion system in the merchant marine industry.

What is the tipping point that must be achieved before energy efficient technological changes will be adopted – overcoming the inertia of the international maritime community? A properly constructed model ofthe maritime propulsion industry will allow us to ascertain the adoption of an energy efficient system over time and varying external conditions. A systems dynamic model will allow for exploration of the interactions of the industry and allow for varying conditions to be reflected and the resulting behavior illustrated.

The maritime industry is complex and consists of a myriad of stakeholders all set in and impacting a global theater. The maritime industry faces accelerating economic, technological, social, and environmental challenges with respect to propulsion mode and energy efficiency. How will the industry and specifically the ship-owner react to these dynamic changes? The proposed research will serve to model this propulsion question.

**Key words:** maritime, marine propulsion, new technology adoption, dynamic modeling, prospect theory

## 1 INTRODUCTION FROM OARS TO LNG

The maritime transportation industry is century's old and truly global in nature. Marine propulsion is the system used to generate the thrust necessary to move the ship or vessel across the water. Propulsion modes developed from non-mechanized to mechanize over centuries in some cases and several decades in other cases.

The time line of adoptions from the 8th century to present, represent years of historical development that helped shaped the maritime enterprise. As propulsion technology developed, often it was not until significant factors, in many cases external to the technology itself, were achieved that industry fully embraced the propulsion concept and technological acceptance gained speed. What are the factors that affected the 8th century Gallery and the transition to sail vessels in the 16th Century? Are those the same factors that affected the sail ship transition to steam and similarly replaced steam ships with diesel propulsion?

## 2 EXTERNAL FACTORS AFFECTING PROPULSION MODE ADOPTION

Logic would follow, in an effort to run profitably, a ship operator would like to use the most efficient method of propulsion, the least expensive fuels suitable for that mode of propulsion and geographic operating area. Does data, with respect to adoption of new propulsion mode, support this statement or are there external factors not yet revealed?

The N.S. Savannah is an interesting case study challenging that question. The nuclear merchant vessel Savannah (N.S. Savannah) was constructed and operated commercially for 10 years. The Savannah was the first and only nuclear powered merchant ship developed. (Conner 2012) While operating, the N.S. Savannah ran safely for over 3 years without refueling. Understanding the high cost of fuel to operate merchant vessels, why did this mode of transportation fail despite its ability to run years without refueling? The US Navy currently operates several surface and submarine vessel utilizing nuclear propulsion. Why does this propulsion technology suit the Navy and not the US merchant industry? Currently LNG fueled diesel vessels are being adopted (Woessner 2013), while hydrogen fueled vessels are met with only cautious interest despite the economics of the fuel. (Armani 2011) Does the decision making for a propulsion mode starts and ends with economics? If the propulsion mode maximizes economics is the decision already completed? Or is this an over simplification of the decision making process?

## 3 START WITH ECONOMICS

The long life of the ship owner's principal asset – the ship – requires that that the propulsion plants have an equally long life. A typical ship will last 25 years (approximately) and the engine will need to be useful for the entire life of that vessel. Generally, vessel propulsion equipment is not replaced during its life due to prohibitive costs associated with such an endeavor. When a ship owner chooses a propulsion plan he/she

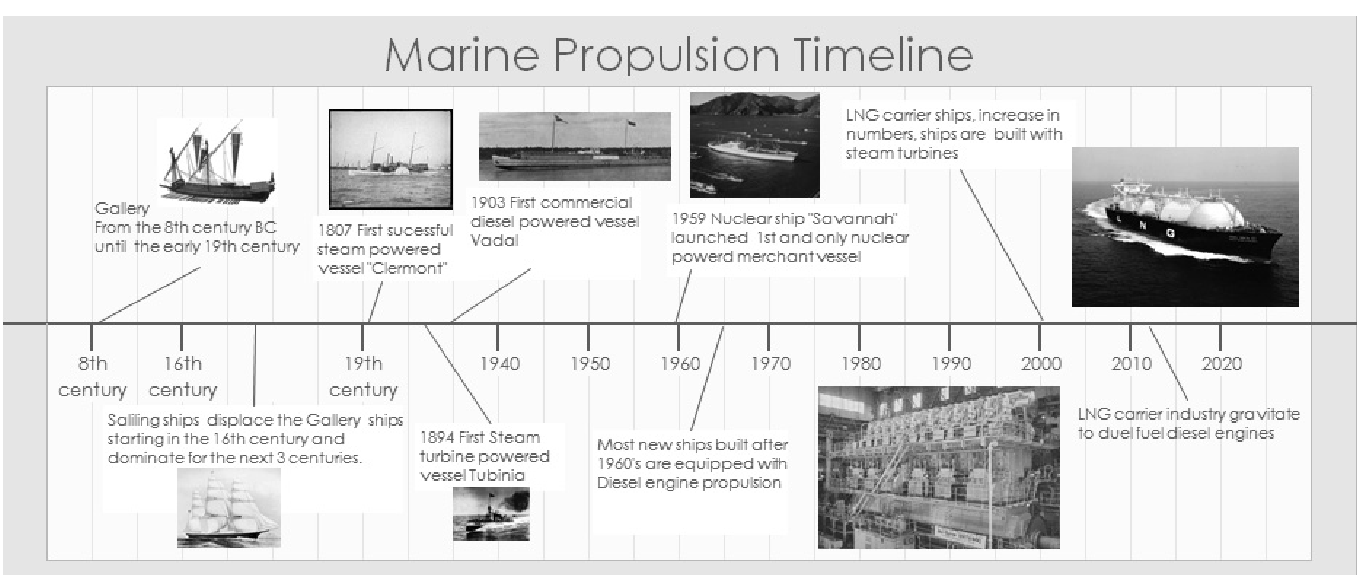


**Figure 1** Historical timeline for Marine Propulsion technology transitions.

| S65ME-C8 fuel consumption calculation |
|---|
| 164 g/kWh = .2696 lb/hp·hr |
| .2696 lb/hp·hr = 0.0001223 metric tons / hp·hr |
| 0.0001223 metric tons / hp·hr x 23,113 hp = 2.84 tons/hr |
| 2.84 tons/hr x 24 hr /day = 67.68 tons/day |
| 68.16 tons/day x 250 days per year = 17,040 tons per year |
| 17,040 tons per year x $282.00 per ton IFO 380 |
| Yearly cost for fuel is $4,805280 |

**Figure 2** Sample fuel oil consumption

does so with a 25 year planning horizon. Even if the ship owner is using the vessel as an asset play (buy ship low – sell high), the rational ship owner will maximize the value of the ship on the secondary market with a propulsion plant that is reliable, efficient & technically sound.

The operating costs of a vessel are comprised of fuel costs, crew costs and a host of vessel-specific overhead costs. It should be noted that fuel costs alone can represent up to 60% of the operating costs for a vessel. Therefore, the fuel efficiency of the propulsion plant is a critical factor in the operating costs of an engine. If the engine economy and fuel efficiency of the vessel are poor, then the cost for the ship's operation will be greater than for a more efficient comparable engine. Reduced profits for the ship owner result from inefficiencies of propulsion operation. Companies will often look keenly at the operation parameters to see where improvements can be made. Such evaluation often results in plans for alternative operations, such as change in speed (slower to reduce fuel consumption) or acquisition of better equipment to improve efficiency.

To this end propulsion costs are calculated to include specific fuel consumption calculations. These calculations involve lengthy formula to reflect costs for engine operation under way. The actual calculations are in figure 2 right.

The economics of the planning horizon can be modeled dynamically for most key aspects of ship operation. However, this is just a snapshot of the economics. To fully capture the long service life economics it would be necessary to incorporate, time value of money, interest on mortgage, mortgage, ship yard periods and end of service life disposal. The conceptual diagram of these aspects is shown in figure 3. Operating days or hours per year are reflected in figure 3 as the

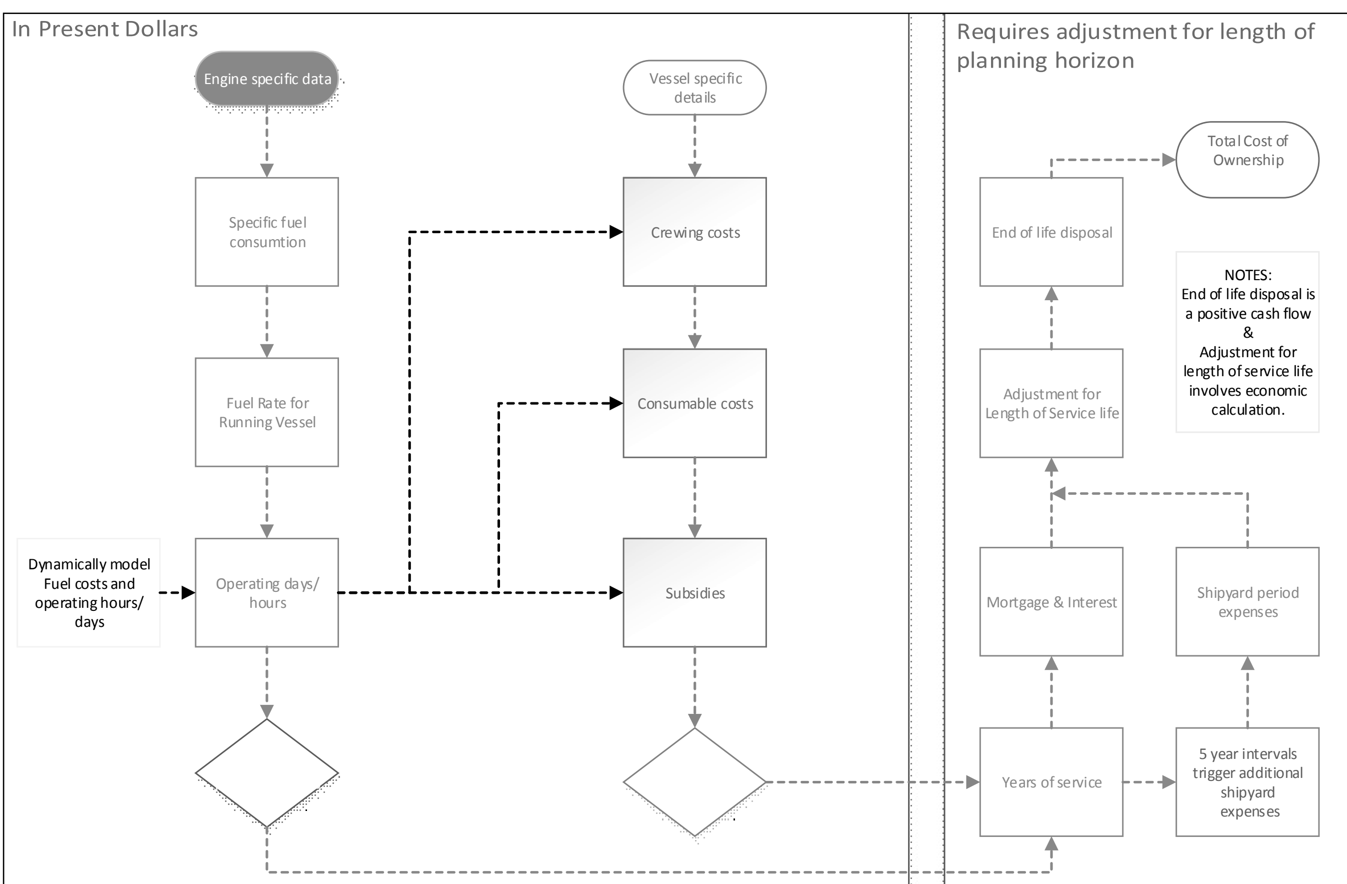


**Figure 3** Economic Aspects of Shipping Industry (Yearly and Extended Service life)

industry standards of 24 hours per day and 250 running days per year. However, these can figures be dynamically modeled to reflect higher rates of operation or lower rates.

Of note is the segregation of the day/monthly or yearly costs reflected on the right side of figure 3 – these costs are in present dollars. Consumable items container spare parts and are adjusted for prolonged operation to reflect wear and replacement. Equations are adjusted to reflect manufacturers specified running/replacement periods and frequency.

Expenses for the extended planning horizon need to be adjusted through economic values to represent the worth of those dollars in frame of reference. Adjustment is through sequence of economic equations (representing the time value of money) and a specified interest rate.

Figure 3 is a conceptual model that includes the propulsion related costs, running costs, extended life costs, and disposal payment. The left side of figure 3 represents costs associated with the vessel underway or in operation. Inputs to the model can be dynamically simulated to reflect changes in fuel cost or operating days. The middle section of figure 3 illustrates the running costs of the ship (minus subsidies - if any – which is a positive). These running costs (or subsidies) are attached to the ship whether it is propelled or not. The right side of figure 3 depicts the longer term nature of the shipping industry. The years of service will become a multiplier for the propulsion and running costs. Additionally the years of service will trigger expenses associated with mandatory shipyard period every 5 years. The green or right side of the conceptual model will be adjusted for service life using economic equations and interest rate. The conceptual model will result in a total cost of ownership for the ship.

The ship owner wants to maximize the profit from a voyage (low voyage costs < high voyage revenues) but typically profit margins are low and open trade. Voyage costs for a vessel consist of port costs and operating costs. Port costs are specific to the area where the vessel trades and are not controlled by the ship owner. Therefore, the ship owner will evaluate the operational cost from the vessel as it is under his/her control.

The conceptual model is deliberately segregated in yearly and longer term costs because it is necessary to evaluate the operation of the actual vessel in both long term cost of ownership and short term operation profitability. The daily/weekly/yearly expenses are monitored for areas where improvement can be made technically that add to a better performance or efficiency. On the other hand it is in this daily/weekly/

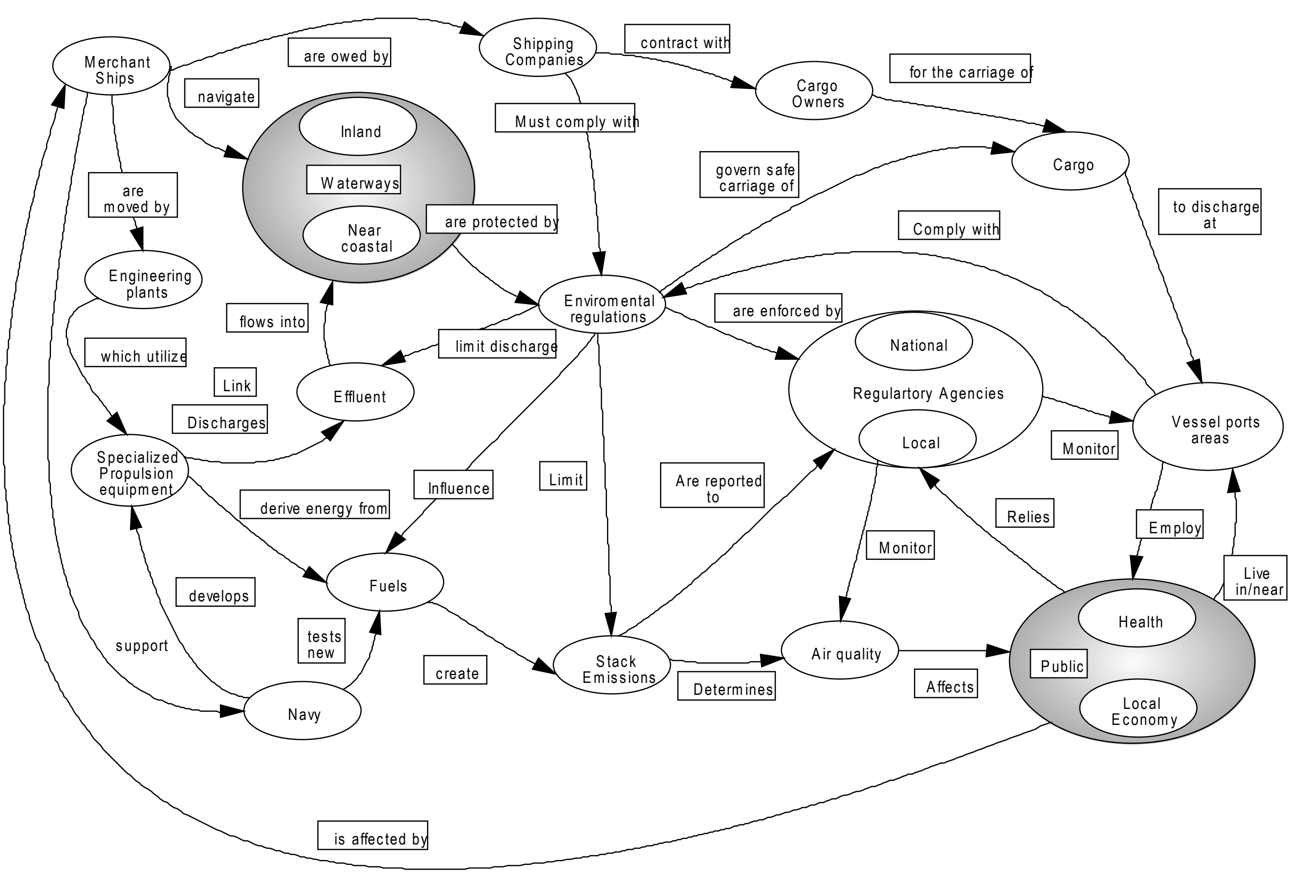


**Figure 4** The Systemigram of the Merchant Ship and industry in a day to day setting.

year expense area that operators seek reduced to lower costs. The ship owner often straddles the line between efficient and substandard operations.

The conceptual model reflects how the multi-level economics model will fit into the decision making for a new propulsion mode. The challenge is to develop a system model of the maritime industry; marrying the economics to the complex system itself. Then relate that structure to the dynamics of maritime propulsion. This will provide for an overview of the industry an illuminate exogenous factors that may influence technology beyond pure economics.

## 4 MARITIME PROPULSION WITHIN THE MARINE INDUSTRY, BEYOND THE ECONOMICS

While much of the costs for the ship operator stem from the fuel for vessel propulsion, pure economic models of the maritime industry fail to account for much of the underlying forces of the merchant maritime industry. Figure 4 is a Systemigram of the ship-owner within the maritime theater based upon the current merchant mariner industry (present day) and normal day to day operations. The Systemigram is an amalgam of a system description conveyed in a diagram. The pictorial representation of the maritime industry via the systemigram is helpful to visualize the relationships within the sector, but static in nature.

The Systemigram is read from top left to bottom right. The systemigram will illustration via nodes, links and words the purpose of the system. In general the Systemigram illustrates how the merchant ship-owner is linked to other nodes and what is the relationship between the merchant ship owner and the nodes.

What can be seen in this Systemigram is that merchant vessel carry cargo to discharge at ports. Commerce, from the carriage of goods by the vessel to the port, affects the local community. Further, those merchant vessels utilize engineering plants using fuels for propulsions. Those propulsion plants are monitored for discharge to the environment via the air and water. International, national and local regulatory agencies are monitoring stack gas emissions from the propulsion process, the emissions affects the air quality and the public in port areas. The communities are affected by the air quality arising from vessel emissions but are also affected by the goods brought into the local area for transport and sale.

As indicated, the Systemigram is read from top left to bottom right, however the center of the page holds a node that is highly linked to the others; namely environmental regulations. Many nodes are linked to environmental regulations and the output links from this node are declarative and forceful. It becomes apparent that in today's maritime industry the impact on the environment is significant. Other significant nodes affecting propulsion equipment adoption can be through the relationship between the merchant vessel and the Navy. The merchant vessel supports the Navy with logistics. The Navy develops specialized propulsion equipment and new fuels. What cannot be seen from the systemigram is the strength of each of the links or direction (reinforcing or opposing).

Why did the change from sail to steam engine and from steam to diesel take so many years given the obvious economic advantages of the competing alternatives? The answer is not simple, but the systemigram is a start. With the complex maritime theater mapped, we have better insight to who the stakeholders are and what are the links or relationship among parties that might affect the adoption for new propulsion technology. We will use system dynamics to model the interactions among the actors.

## 5 MARITIME PROPULSION AND SYSTEM DYNAMICS

To model the propulsion adoption process including the effects of the system and actors we will use a system dynamics model. Stocks, and flows along with feedback are the two central concepts of dynamic systems theory. Stocks are accumulations. These are the state of the system, for example the number of commercial merchant vessels. These are represented in a diagram by a rectangle. Flows are characterized by rate of increase or decrease to the stock, for example the rate of ship building or retirement. The flows are characterized in a diagram by a valve indicating a rate of change of the stock. Inputs and outputs to a stock are represented in systems dynamics as pipes with arrows indicating an outflow or inflow. Feed backs are an illustration of the interaction of the system players or actors. The actions of the players cause a change. The change triggers other actions or others to act. Thus a new situation is present which then feeds back to the system influencing our next decision. The feedback can be positive (+) or negative (-). The dynamics of the systems result from the feedbacks. Delays are also a part of the dynamic modeling and create instability in systems. The delay feature simulates the time delay between the initiation of a control action and its effects on the state of the system.

The spread of rumors and new ideas, the adoption of new technologies, and the growth of new products can all be viewed as epidemics in which the innovation spreads by positive feedback as those who have adopted it 'infect' those who have not. The concept of positive feedback as a driver of adoption and diffusion is

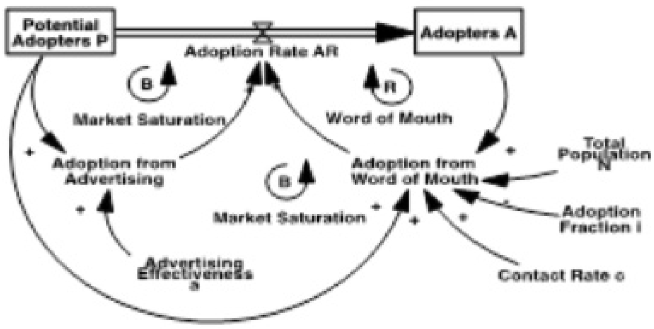


**Figure 5** The Bass Diffusion Model

very general, and can be applied to many domains of social contagion.

In 1969, Frank Bass developed a model for the diffusion of innovations; this has become one of the most popular models for new product growth and is widely used in marketing, strategy, management of technology and other fields. The Bass Diffusion Model is a system dynamic model using stocks, flows and feedback. Figure 5 (above) is the Bass Diffusion Model.

However, this model in its current form cannot respond in modeling the maritime case of adoption of new propulsion technologies; since the numbers of potential adopters are small relative to other types of technology adopters, very different dynamics, different set of variables, and different balancing and reinforcing loops.

Therefore, we use concepts of a diffusion model (like Bass) and modify the model to reflect specific variables of the maritime industry detailed in the systemigram. The Maritime propulsion adoption model is an adaptation of the Bass Diffusion Model.

The power of the systems dynamic model is that underlying the causal relationships are mathematical relationships. In the model figure 6, the population of ships is $N$. We also have the fraction of ships that have adopted $f$. As the fraction of adopters $f$ get larger it limits the number of potential adopters $P$ from the total population $N$ of ships.

The variables and equations for the underlying mathematical relations ships are as follows:

Figure 6 System dynamics model variables are defined as follows:

| | |
|---|---|
| $P$ = Pool of Potential Adopters | $f$ = Fraction of adopters |
| $A$ = Adopters | *n = Rate of Military interactions* |
| $N$ = Total population of ships | *r = regulatory compliance policy* |
| $AR$ = Adoption Rate | *c = Rate of port/commerce interactions* |
| $Ar$ = Adoption from regulation | *s = social pressure/policy* |
| $Aw$ = Adoption from waterfront word of mouth | $Av$ = Adoption from value |

$v$ = Value is an output from the prospect theory calculation of cost differential between the proposed propulsion mode and the existing or alternative modes and risk.

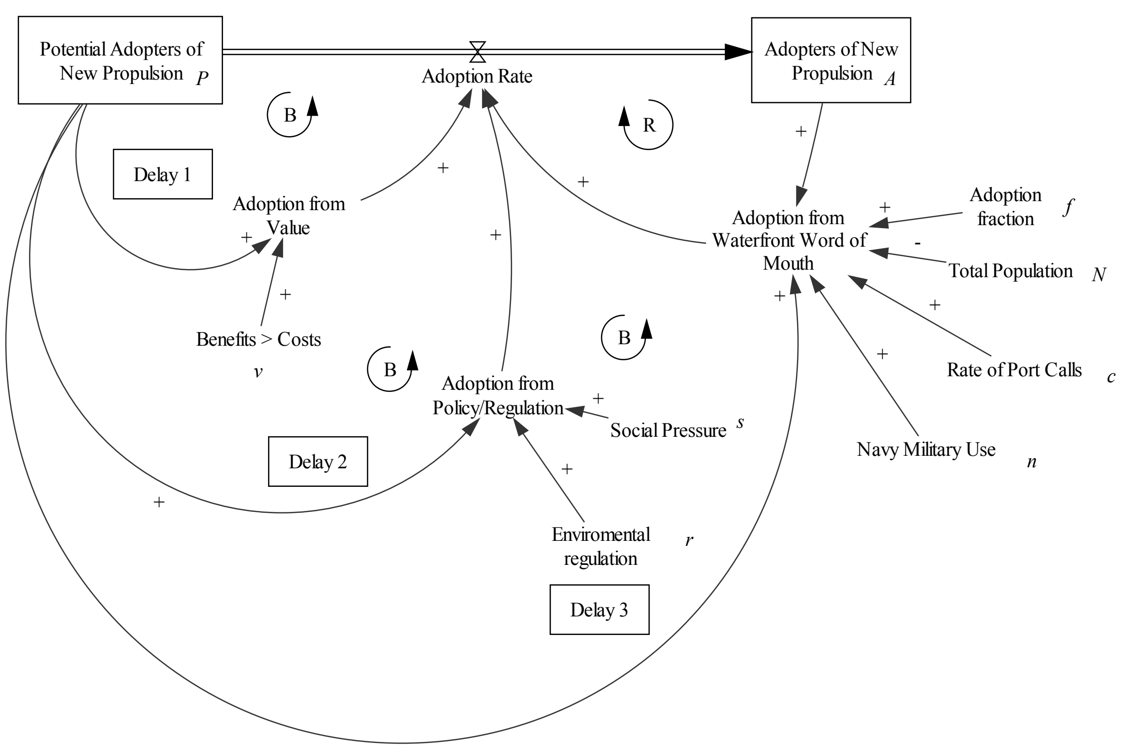


**Figure 6** Maritime Propulsion Adoption Model

Figure 6 System dynamics model equations are defined as follows:

$N = P + A$ where $N$ is constant, $P$ is the pool of potential adopters and $A$ is the adopters.

$A = INTERGRAL\ (AR, A_0)$ where $AR$ is adoption rate and $A_0$ is the initial installed base.

$P = INTERGRAL\ (-AR, N - A_0)$ where $AR$ is adoption rate, $N$ is the population of ships minus the installed base)

*AR = Adoption from Value + Adoption from Policy/ Regulation + Adoption from Word of Mouth*.

$Aw = c \times f \times n \times P(A/N)$ where $c$ is the contact in port or commerce interactions, $f$ is the adoption fraction, $n$ is interaction/commerce with military or Navy, $P$ is the pool of potential adopters, $A$ is adopters and $N$ is the population of ships.

$Av = v \times P$ where $v$ is perceive value (benefits/costs) and $P$ is the pool of potential adopters.

$Ar = r \times s \times P$ where $r$ is required compliance, s is social pressure and $P$ is the pool of potential adopters.

## 6 INTERPRETING THE MARITIME PROPULSION SYSTEM DYNAMIC MODEL FIGURE 6

The stock of potential adopters would represent ship-owners evaluating new engine technologies. The adoption rate of new propulsion technologies is represented by a flow and would be as a result of inputs from the adoption from value, policy/regulatory requirements, as well as waterfront word of mouth variables. The eventual stock of Adopters represents ship owners that have chosen to utilize the new propulsion mode.

Starting with the adoption of propulsion mode due to value; simply stated this balancing loop illustrates how the potential adopter exercises their option to delay or wait until some of the uncertainties and benefits are more fully realized. Often this means a delay until the benefit is greater than cost.

In the case of Maritime Propulsion, the initial investment in the propulsion mode is costly. However, significant costs such as the training of employees on the new technology as well as any costs associated with changes to infrastructure to accommodate that new technology must also be considered. The auxiliary variable 'Adoption from Value' can be explained by a financial investing term "deep in the money"[1]. When the potential adopter is assured of value for investment (benefits > then costs with low/lower risk) this increases the Adoption Rate (AR).

The second balancing loop is a result of forced adoption from policy or regulation. Often regulatory agencies will pass policies limiting discharges into the environment for the greater good. The policies are authored; often there is a delay to the policy making due to politics and bureaucracy and eventually forced compliance is required. The second balancing loop is affected two auxiliary variables policy (regulation) as well as social pressure.

An example of this forced compliance is in emission regulations in the State of California. It is unlikely that a ship owner would voluntarily spend 30% more on fuel than necessary. However, policy and social pressure in the State of California required compliance with the policy or be banned from trade in that port. When the potential adopter is forced to adopt a new technology (or face economic consequences) this increases the Adoption Rate (AR).

The third balancing loop and only reinforcing loop is as a result of waterfront word of mouth. There is a saying in the Marine community, "It is not a small world – it is a small waterfront". This explains the third balancing loop. Ships come in contact with other ships in ports or during commerce, "exposing" themselves as in the epidemic example to other operators. The more frequent the contact, the more exposure. Exposure to adopters of the technology, either military or non-military will lead to word of mouth experience.

The third balancing loop is affected a delay and four auxiliary variables of port call frequency (contact), military use (adopted user outside of population), the number of adopters, as well as ships without the technology. The number of ships without the technology comprises a much larger pool than potential adopters. As the life of a vessel is typically 25 years, this ship will likely never join the pool of adopters but participate in the Waterfront Word of Mouth adoption. The adoption from word of mouth increases the Adoption Rate (AR).

As the pool of adopter grows, there is a reinforcing loop as part of the Word of Mouth adoption loop. This reinforcing loop results from Adopters actively participating in in a word of mouth exposure which is governed by the auxiliary variables increasing the adoption rate. Please note, the term word of mouth is used, but this exposure and contact could be from email, fax and casual observation. This does not necessarily have to be by direct contact.

When the propulsion mode is initially adopted, the adopter population is zero; the only source of adoption is from Value and to a lesser degree any word of mouth from military applications. The initial growth will be as a result of adopters perceiving a Value in terms of benefit and cost.

[1] DEFINITION of 'Deep In The Money' An option with an exercise price, or strike price, significantly below (for a call option) or above (for a put option) the market price of the underlying asset. http://www.investopedia.com/terms/d/deepinthemoney.asp#ixzz3ZEgfjBq9

The adoption resulting from 'Value' has several underlying variables that form part of a positive feedback. These positive feedbacks can the initial growth for a propulsion product. In the initial phase there is little 'Word of Mouth' awareness with the exception of Military use – which may be of some value but not a direct feedback. The initial growth of a new propulsion technology will be as a result of adopters seeking 'value' (Value loop) as well as regulatory requirements (regulatory loop). As indicated above 'value' indicates that benefits > costs with lower risk.

Initial growth will be in sectors where the existing network or infrastructure can be utilized. This lowers the costs to adopt the new technology and allows for the adopter to arrive at the benefits > costs more quickly than other potential adopters.

For example, ships carrying Liquefied Natural Gas (LNG) as a fuel are among the early adopters of new slow speed diesel engines using LNG as fuel source. This also illustrates a concept of complementary goods. The ships are loading LNG as a cargo, they are already at the port facility and the infrastructure is in place to load the LNG as a fuel. A benefit is achieved by utilizing existing networks (a new fuel terminal does not need to be constructed) as well as no deviation to a specialized fueling facility. The facility is built already and the capabilities present.

If there is a benefit to the LNG fuel in the new engine it will be gained by the vessel at lower costs (little or no infrastructure costs and compatibility with existing equipment) allowing for value to be realized more quickly. With value achieved at a lower threshold, the vessel may adopt the technology and become part of the reinforcing loop of adopted users.

The positive feedback associated with regulatory compliance will also help to spur initial growth. Ship owners seek to comply with regulations, non-compliance will likely adversely affect economics or result in punitive measures. If a product is compliant with new requirements it will be attractive or favored over other modes of propulsion that are not fully compliant. Once installed, the new technology adopter becomes part of the adopted pool and provides the benefits of Waterfront word of mouth reinforcement.

A negative feedback loop is self-limiting rather than self-reinforcing. In most cases the potential adopters are from new ship building, economics often prohibit the replacement of an engine. With the ship population essentially fixed. Ship retirements equal the number of new ships or very early so over a 25 year period 1990 -2015 for container ships. Therefore, as adoption occurs it increases the fraction of engine adopters in the population. This in turn, reduces the number of potential adopters from the population. The increase in the fraction of adopters will at a point retard growth since the population is nearly constant.

## 7 HOW DO WE MODEL THE SHIP OWNERS DECISION MAKING

The system dynamics model above has several auxiliary variables that represent key phenomena. These variables are critical to the function of the dynamic model and require additional modelling to capture the behavior and essence. Perhaps the most important of these variables is the notion of value. Value will be used as benchmark for how the potential adopter will make technical and economic decisions under risk.

Utility theory is the canonical approach to incorporating risk aversion into an economic decision model. In conventional utility theory, people are expected to make rational decisions that maximize their wealth or income (utility). Gains and losses are equally weighted for the rational decision maker.

People tend to be loss adverse. The ship owner is highly risk adverse as there is long term implications to a decision made involving propulsion choice. He/she cannot afford to be wrong and 'live' with a bad decision for the life of the vessel. The risk adverse ship owner may well reject opportunities that could increase their net income (gains) if possible losses (risk) are involved. A new/unproven technology would be such an example. If a new propulsion technology were developed the gains would have to be large enough to overwhelm the pain from suffering losses.

In prospect theory, people do not value losses and gains equally. Prospect theory puts greater weight on losses than it does gains (a dollar lost has greater value than a dollar gained). Prospect theory is appropriate for modeling the nature of the risk aversion of the maritime propulsion industry in that it seeks to maximize **value** not wealth. In maximizing value the people are willing to sacrifice possible increases in future income for less risky or safer economic prospects.

Utility theory is based upon decisions seeking to maximize utility. The ship owner instead displays characteristics of behavioral economics reflected in prospect theory. The maritime propulsion community is risk adverse. The ship owner would rather forego some efficiency (savings) related to the engine for the value choice with less risk. The use of Prospect Theory will capture overall risk as it better reflects the importance of risk aversion to technology adoption and the economic implications.

The key to modeling technical and economic risk with prospect theory will center on the concept of value. Value can be expressed as a positive and negative outcome. Prospect Theory will be used for this purpose as it expresses the ship owners tendency to reject opportunities that increase their income if possible losses are involved.

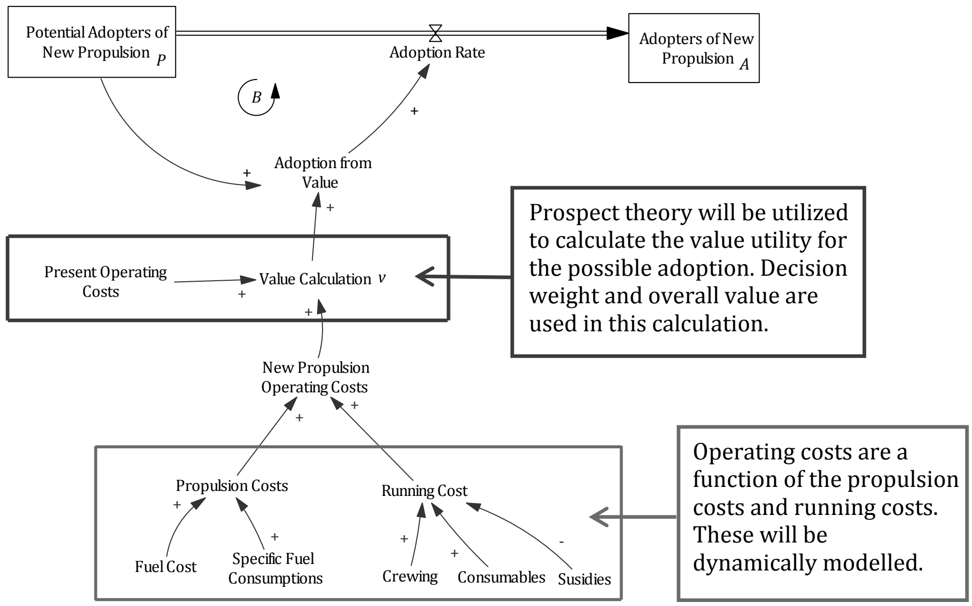


**Figure 7** Maritime Propulsion Adoption Model – question 6 modeling economic and technical risk

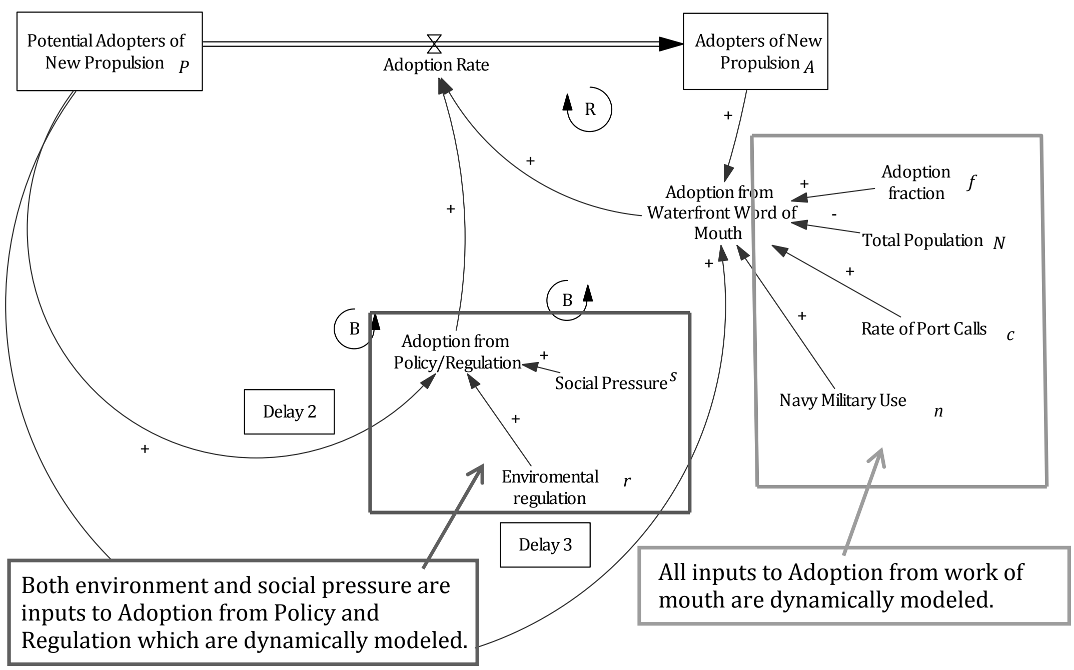


**Figure 8** details additional auxiliary variables that will affect new propulsion mode

Figure 7 shows part of the Maritime Propulsion Adoption model. For ease of illustration I have shown the conceptual model in pieces from the dynamic model built in a modeling software program called Vensim. This partial figure of the model shows the 'Adoption of Propulsion Mode Due to Value'. The operating costs are dynamically modeled so that specific fuel consumption, fuel costs, crewing, consumables and subsidies (if applicable) can be varied and simulated. The new propulsion mode costs are calculated. The potential adopter chooses between the options available to them ($new mode of propulsion or $traditional mode). This choice is based on two dimensions, the apparent value of each attribute or option, and the weight assigned to those values or options. These two features—overall value & weight—are then combined by the decision maker and the option with the highest combined value is chosen by the decision maker.

The output of the value loop will either be sufficient to convince the ship owner to adopt the technology or delay/ wait until some of the uncertainties and benefits are more fully realized producing a higher 'Value'.

In the case of Maritime Propulsion, the initial investment in the propulsion mode is costly. Added to this are costs of training employees on the new technology. Lastly, infrastructure costs (if any) to accommodate the new technology in port areas. The propulsion investment has a long planning horizon of more than 20 years. When the potential adopter is assured of value for investment (benefits > then costs with decision weighted risk) this increases the Adoption Rate (AR).

Technological risks are also reflected in the figure 7 model by 'Consumables'. Under the running costs there is a variable 'Consumables' – this figure represents maintenance required by engines for upkeep. Consumables can be dynamically modeled in Vensim and are represent parts for replacement and reflective of reliability. If new technologies parts are more less/expensive or require more/less frequent replacement it will be shown as increase/decrease cost respectively in this category.

Additional adoption factors such as the implementation of environmental factors, social pressure, rate of port calls and contact with military adopter will be modeled dynamically within the model. Figure 8 shows of forced adoption through regulation and social pressures. Figure 8 also included the loop noting the spread of the 'contagion of adoption' through word of mouth and other social interactions of the technology. The values will be variable so that effect of the variable can be noted. A built in slide bar is available in Vensim to vary the output of the variables and note the effect of those changes.

## 8 EARLY RESULTS AND FUTURE WORK

Using prospect theory, multi-level economic modeling and the dynamic model from figure 6 the early results confirm the intuitive thoughts on propulsion mode adoption. The model is still being evaluated using data from the steam to diesel technology adoption timeframe. Data collection is time consuming but early graphical results confirm the adoption curve for this technology transition. Several technological adoptions or failed adoptions must be examined before the model is fully vetted. Work is in progress to fully collect data, execute and interpret the output of the model with various propulsion technology modes both past and present.

## 9 CONCLUSION

The current system dynamics model is a work in progress. The relationships between the maritime propulsion communities are fully developed and modeled. Further work is needed to fully validate the model, and confirm that no significant factors have been overlooked.

Early results indicate that the use of behavioral economics in prospect theory appears to provide better insight into the behavior of the ship owner versus traditional utility theory. The length of time that the ship owner will use a propulsion engine as well as the impact to the operating costs of the vessel of the engine choice makes the ship owner risk averse. It appears that prospect theory in conjunction with system dynamic modeling could paint a more accurate picture of the average ship owners decision making behavior than conventional utility and economic theories.

Within the abstract for this paper I posed three questions regarding the adoption of a new efficient energy mode of transportation specifically would it be adopted immediately, what are the tipping points for the decision to adopt and how does the industry react dynamically to changes. The present system model is a significant step towards answering these questions. There is more work to be done to validate and fully support the initial results from this model.

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# ARE WE READY FOR THE MILLENIALS?: THE STATE OF READINESS OF THE MARINE EDUCATION AND TRAINING COMMUNITY: A PILOT STUDY

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**Abstract**. The need to transform and accelerate employee learning is a top three global human capital trend according to a large longitudinal survey of thousands of human resource and talent management professionals across a wide range of industries [1]. The percentage of companies rating employee learning as very important tripled since last year, now more than eight in 10 indicate that learning and development is important. The reason for this rise in the importance of employee learning and development is in response to the "skills gap" [2] (where skilled trade workers are the toughest jobs employers are having difficulty filling [3]). In regards to seafarers, the maritime sector is not immune to this "skills gap" [4]. However, despite this increased recognition of its critical importance of employee learning and development, there is a significant readiness gap (i.e., fewer than 40 percent of respondents indicated that their organizations are ready for learning and development in 2015 [1]). This readiness gap is reflected in the fact the currently *Millenials* make up more than one-third of the workforce (and by 2020, *Millenials* will make roughly half of the workforce [5]). *Millenials* seek personalized, digital, on-demand, fast-to-absorb learning solutions that is available on mobile devices. Many companies are stuck with decades-old learning management systems with only 25 percent indicating comfort with today's digital learning environment [1]. There are many strategies for closing skills gap by closing the capability gap (e.g., [6]). By surveying the MET community, this pilot study examines a small subset of the maritime sector and its current state of readiness to determine if similar capabilities gaps may exist. While the results of this pilot study are indicative of the readiness of the maritime sector, they are by no means conclusive. Based on the results of this pilot study, a much broader survey should be completed and such results many also identify several solutions for addressing the capabilities gap, including potential suggested modifications to the existing IMO model courses paradigm.

**Key words**: maritime education and training (MET), learning and development, skills gap, capability gap, state of readiness

# 1 INTRODUCTION

The need to transform and accelerate employee learning is a top three global human capital trend according to a large longitudinal survey of thousands of human resource (HR) and talent management (TM) professionals across a wide range of industries [1]. The percentage of companies rating employee learning as very important tripled since last year, now more than eight in 10 indicate that learning and development is important. The reason for this rise in the importance of employee learning and development is in response to the “skills gap” [2] (where skilled trade workers are the toughest jobs employers are having difficulty filling [3]). In regards to seafarers, the maritime sector is not immune to this “skills gap” [4]. However, despite this increased recognition of its critical importance of employee learning and development, there is a significant readiness gap (i.e., fewer than 40 percent of respondents indicated that their organizations are ready for learning and development [1]).

This readiness gap is exacerbated by the fact that most of the learning and development programs are being directed and coordinated by *Baby Boomers* (born between 1946 and 1964) and *Gen Xers* (born between 1965 and 1980) and currently *Millenials* (born between 1981 and 1997) make up more than one-third of the workforce (and by 2020, *Millenials* will make roughly half of the workforce [5]). *Millenials* are digital natives [7] and grew up immersed in digital technologies (e.g., using personal computers, mobile devices, video games, social media, and the Internet) and are considered technologically adept/interested and digitally literate [8]. *Millenials* seek personalized, digital, on-demand, fast-to-absorb learning solutions that is available on mobile devices. On the contrary, *Baby Boomers* and *Gen Xers* are digital immigrants [9] since they largely grew up in an analog world and have had to adapt their ways to the growth of these digital technologies which were introduced during their lifetimes. Thus, this divide between digital immigrants (who oversee learning and development) and digital natives (who will become the majority consumer of learning and development in the near future) only make the readiness gap even starker. In fact, many companies are stuck with decades-old learning management systems with only 25 percent indicating comfort with today’s digital learning environment [1].

This pilot study sets out to examine if the readiness gap and the digital divide in the maritime industry is the same, better, or worse than that described by the Deloitte Global Human Capital Trends survey.

# 2 METHOD

To better understand maritime learning and development, a global study of maritime professionals was conducted. A descriptive survey was selected as an effective means to gather information that is not easily observed [10].

## 2.1 Measurement

A survey was developed to replicate the information elicited in Deloitte’s Global Human Capital Trends survey. See the appendix for a complete listing of the instrument. The survey was designed to key information about human resource (HR) practices in the maritime industry:

1. Identify the most significant HR challenges,
2. Determine level of HR readiness, and
3. Elicit best or effective HR practices.

In order to achieve those objectives, four categories of questions were developed. The first group of questions gathered information about HR priorities and readiness. The second group of questions gathered information about HR capabilities. The third group of questions asked about HR trends and practices within the organization. Finally, the last group of questions gained demographic information about the maritime organization in which the respondent worked.

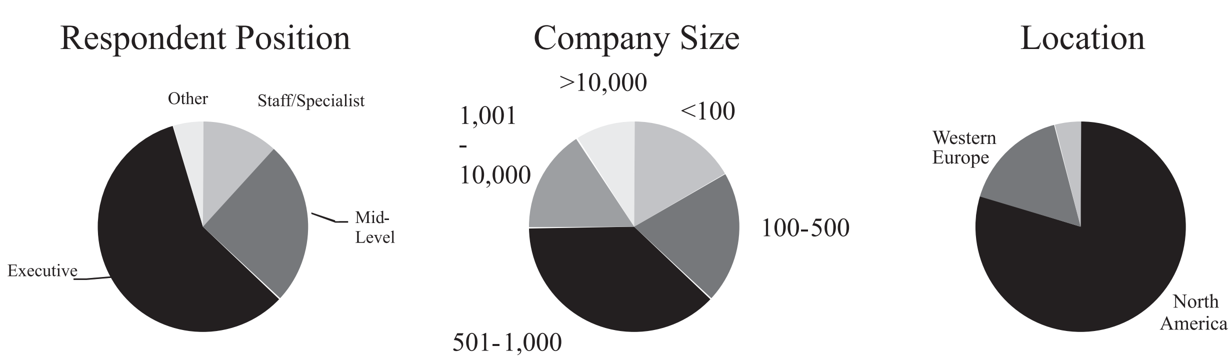


**Figure 1** Demographics of Survey Respondents

### 2.2 Data and Sample

An online survey was administered during the second quarter of 2015. Since survey participation is declining in general [11], it was sent directly to 142 maritime industry leaders (e.g., Chairmen, Presidents, VPs, CEO's, COO's, Executive Directors, etc.) of global companies, predominantly based in North America and the U.K. with a personal invitation to participate. This direct appeal using a modified Dillman technique [12] yielded 28 responses (for a response rate of 19.7%) to the survey, of which 20 were complete (for a completion rate of 71.4%). The following figure set provides a summary of the demographic data of the respondents.

The following describes the results of this survey of maritime readiness for a selected list of five HR trends/challenges.

## 3 RESULTS

Using a Borda count to combine the respondents' ranking of the five HR trends posed (see question 1 in Appendix), the following is the order of maritime HR trends:

1. Culture and Engagement of workforce
2. Workforce capability
3. Learning and Development of workforce
4. Leadership
5. Performance Management of workforce

This is similar to the global results found in the Deloitte study of all industries, with the exception that leadership and workforce capability are inverted. Thus, workforce capability (leadership) is more (less) important in maritime than in industry at large.

Using the methodology of the Deloitte study, respondents were asked to rate the importance of each of the five HR challenges using a four-point scale (very important, important, somewhat important, not important) (see question 2 in Appendix). They were also asked to rank their readiness for dealing with each of the five HR challenges again using a four-point scale (not ready, somewhat ready, ready, very ready) (see question 3 in Appendix).

These ratings were then indexed on a 0–100 scale in which 0 represents the lowest possible degree of importance/readiness ("not important/ready"), and 100 represents the highest possible degree of importance/readiness ("very important/ready"). An overall index score was calculated for each trend using the respondents' ratings of "importance" and "readiness." The index scores were also used to calculate the "capability gap" described in the following endnote. The Deloitte Human Capital Capability Gap is a research-based score that shows HR's relative capability gap by looking at the difference between the "readiness" and "importance" index scores for each trend. It is computed by taking the "readiness" index score and subtracting the "importance" index score based on the 0–100 scale described in the previous endnote. For example, a trend with a readiness index score of 50 and an impor-

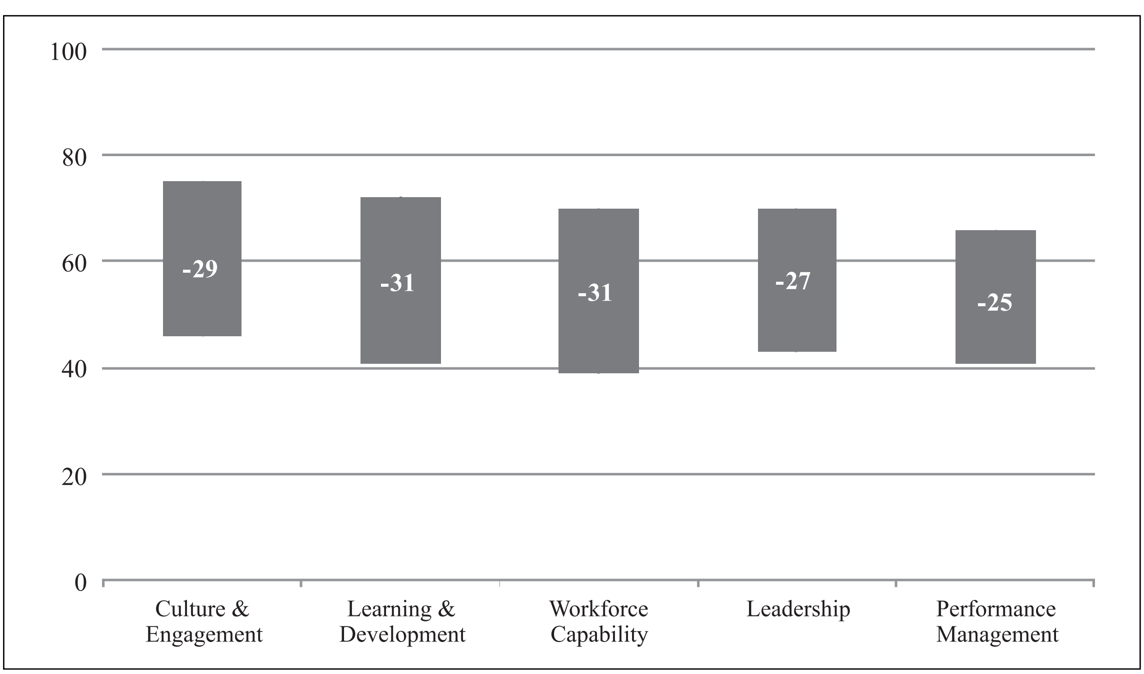


**Figure 2** Maritime Capability Gaps

tance index score of 80 would produce a capability gap of -30. Negative values suggest a shortfall in capability, while positive values suggest a capability surplus. [1]

The following is a summary of the capabilities gaps.

In comparison to industry at large, maritime has smaller capability gaps for the HR challenges of culture and engagement, leadership, and performance management. On the other hand, the maritime capabilities gaps for learning and development, and workforce capability are larger than that of industry at larger.

Respondents were also asked to assess specific capabilities of their organization associated with each of the five selected HR trends. The following are the summary results:

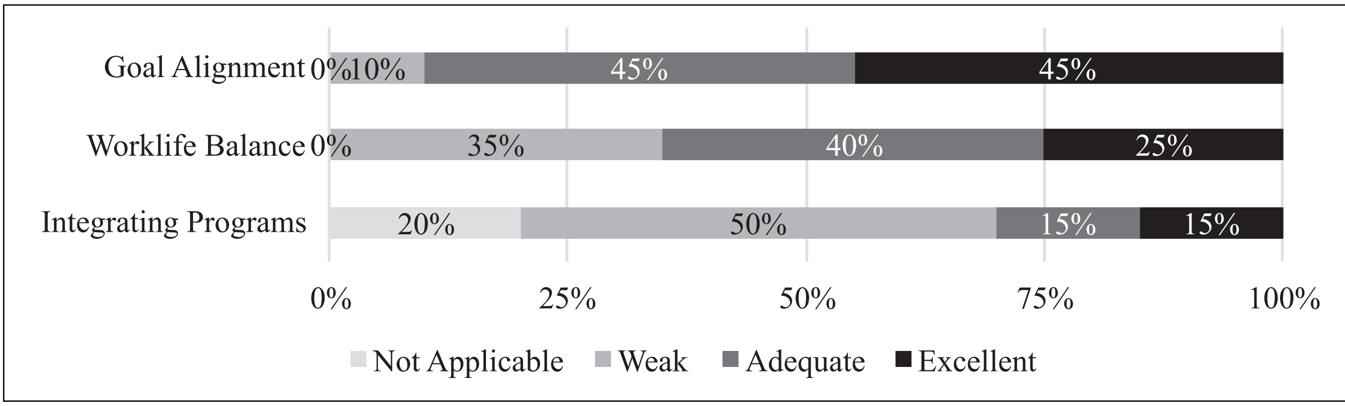


**Figure 3** Culture & Engagement Capabilities

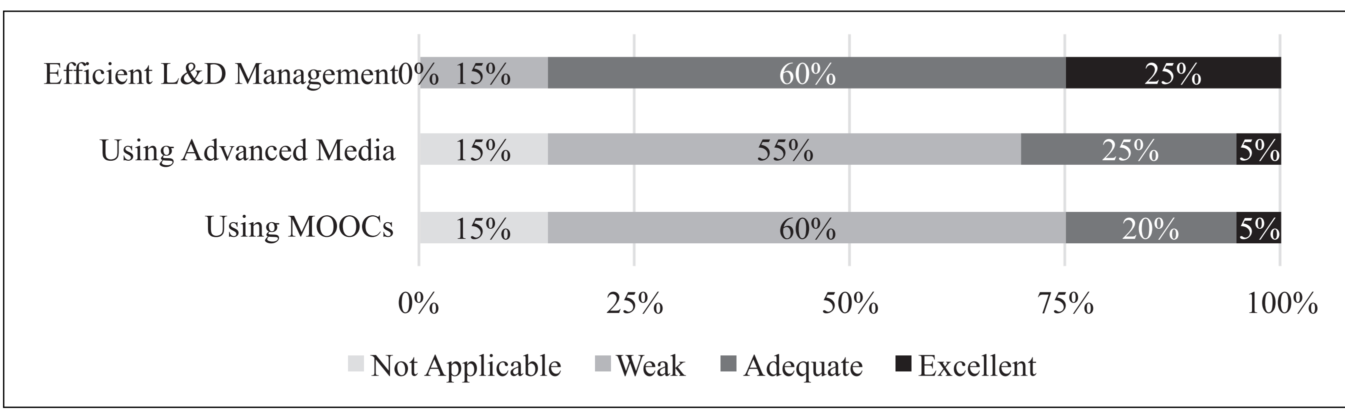


**Figure 4** Learning & Development Capabilities

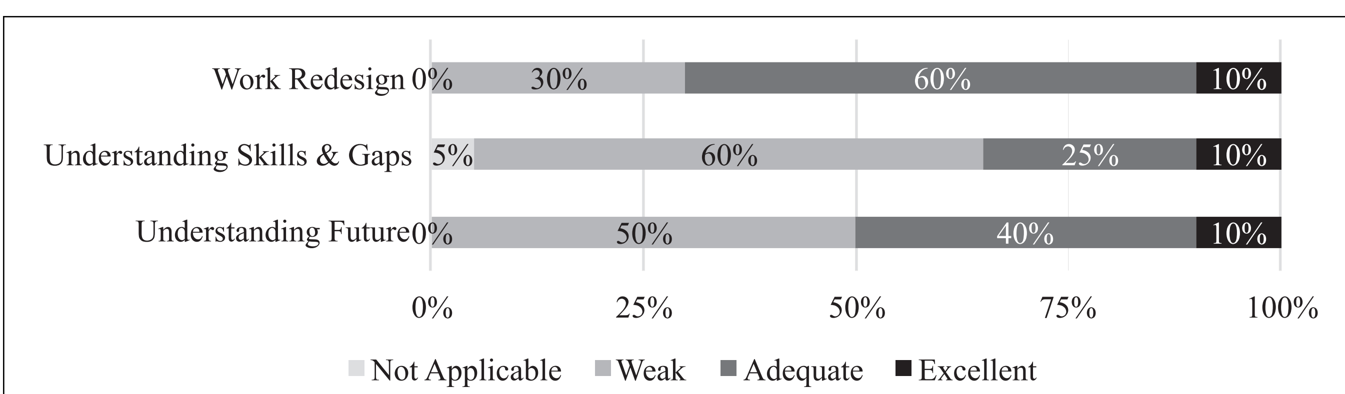


**Figure 5** Workforce Capability Capabilities

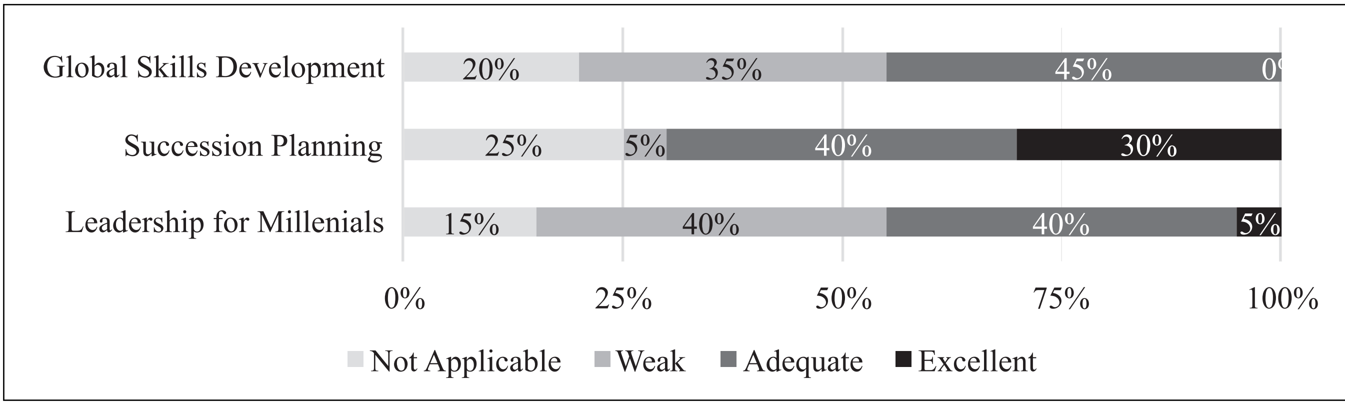


**Figure 6** Leadership Capabilities

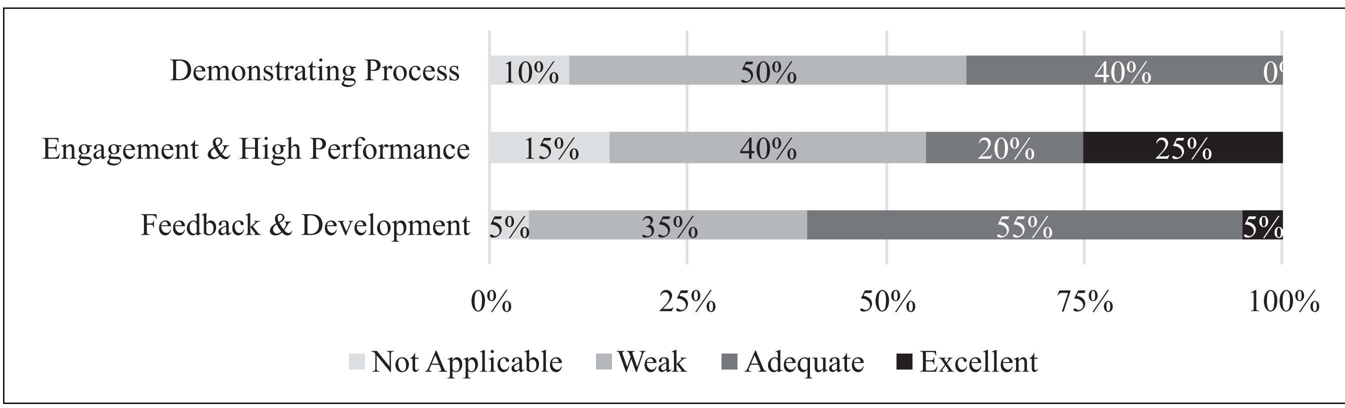


**Figure 7** Performance Management Capabilities

In general, the self-assessed maritime capabilities are similarly distributed to those of industry at large, but culture and engagement, and workforce capabilities are considerably lower (for this small sample).

Respondents were also asked to rate their state of their organization's HR capabilities beyond the current year (see question 9 of Appendix). The following are the responses:

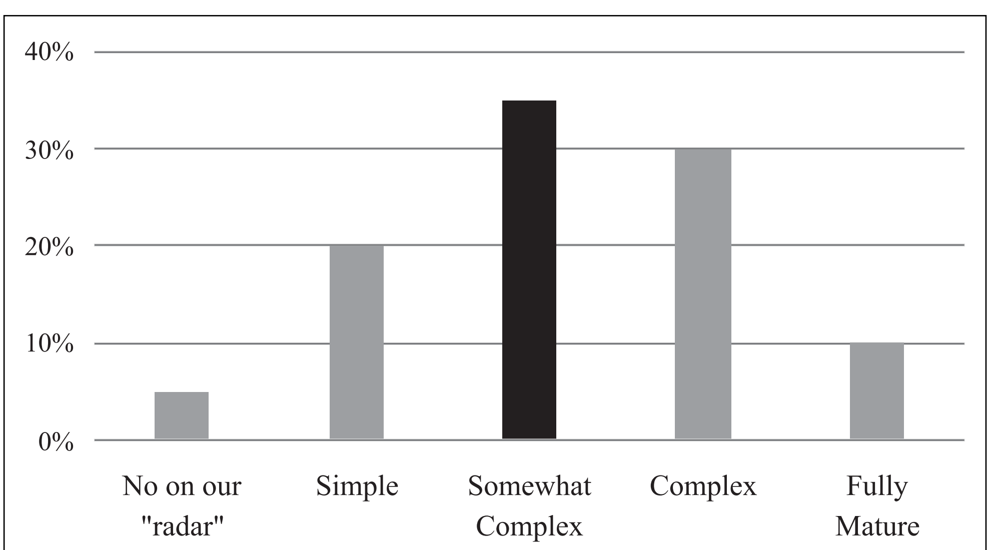


**Figure 8** Maturity of HR Capabilities

For this small sample, most respondents (35%) viewed their organization as having a somewhat complex set of capabilities for the future, while only 40% viewed their future capabilities as complex or fully mature and another 25% as simple or not yet considered.

## 4 DISCUSSION

In general (and based upon an extremely small sample), the HR trends for maritime industries are similar to those of other industries. However, it is unclear if the small sample can be considered representative of maritime industries at large and additional survey responses will be necessary to validate this statement. Maritime rated workforce capabilities relatively higher and leadership as relatively lower. Likewise, the readiness gap (difference between perceived importance and perceived capabilities) for workforce capabilities and learning and development are considerably more significant than that describes by the Deloitte survey for all industries. Even as a pilot study, attention should be paid to these two significant gaps – the first of which uncovers the skills gap and steps taken to address that gap. There are many strategies for closing skills gap by closing the capability gap (e.g., [6]). Again, even with a small sample size, the second gap reveals potential MET deficiencies. Perhaps the largest issue here may be the long delay in updating the MET regime – perhaps including the existing IMO model course paradigm. Given the demands of *Millenials* for an on-demand training environment and the fact that they will soon become a majority element of the workforce, the notion of a prescriptive hours-on-task style of training is outdated and needs to be modernized to a performance-based, on-demand, interactive, multi-modality form of MET. Additional study in this area is required to confirm these gaps and to recommend future improvements to MET.

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APPENDIX

**Global Survey of Maritime HR Trends**

A report by Deloitte published the global human capital trends for 2015. Based on surveys and interviews of more than 3,300 business and HR leaders from 106 countries, it is one of the largest longitudinal studies of talent, leadership, and HR challenges and readiness around the world. We are interested in learning if these global trends apply to the maritime industries or if there are unique trends within our industry.

1. Which human resource challenges are most important to your organization?

Please rank the following five human resource challenges.

- ○ Leadership
- ○ Culture & Engagement of the workforce
- ○ Learning & Development of the workforce
- ○ Workforce Capability
- ○ Performance Management of the workforce

2. How important are the human resource challenges to your organization?

Please rate you're the importance of each of the HR challenges to your organization.

| | Not Ready | Somewhat Ready | Ready | Very Ready |
|---|---|---|---|---|
| Leadership | ○ | ○ | ○ | ○ |
| Culture & Engagement of the workforce | ○ | ○ | ○ | ○ |
| Learning & Development of the workforce | ○ | ○ | ○ | ○ |
| Workforce Capability | ○ | ○ | ○ | ○ |
| Performance Management of the workforce | ○ | ○ | ○ | ○ |

3. What is your organization's readiness to deal with the human resource challenges?

Please rate your organization's readiness to deal with each of the HR challenges.

| | Not Ready | Somewhat Ready | Ready | Very Ready |
|---|---|---|---|---|
| Leadership | ○ | ○ | ○ | ○ |
| Culture & Engagement of the workforce | ○ | ○ | ○ | ○ |
| Learning & Development of the workforce | ○ | ○ | ○ | ○ |
| Workforce Capability | ○ | ○ | ○ | ○ |
| Performance Management of the workforce | ○ | ○ | ○ | ○ |

4. What are your organization's capabilities associated with leadership?

| | Not Applicable | Weak | Adequate | Excellent |
|---|---|---|---|---|
| Including global skills and experiences in leadership program | ○ | ○ | ○ | ○ |
| Maintaining clear and current succession plans and programs | ○ | ○ | ○ | ○ |
| Providing focused leadership programs for Millennials | ○ | ○ | ○ | ○ |

5. What are your organization's capabilities associated with culture and engagement?

| | Not Applicable | Weak | Adequate | Excellent |
|---|---|---|---|---|
| Aligning our employees; personal goals with corporate goals | ○ | ○ | ○ | ○ |
| Helping employees balance personal and professional life/work demands | ○ | ○ | ○ | ○ |
| Integrating social, community, and corporate programs | ○ | ○ | ○ | ○ |

6. What are your organization's capabilities associated with learning and development?

| | Not Applicable | Weak | Adequate | Excellent |
|---|---|---|---|---|
| Effectively managing L&D operations | ○ | ○ | ○ | ○ |
| Using advanced media (gaming, video, simulation) | ○ | ○ | ○ | ○ |
| Using on-demand formats | ○ | ○ | ○ | ○ |

7. What are your organization's capabilities associated with workforce capability?

| | Not Applicable | Weak | Adequate | Excellent |
|---|---|---|---|---|
| Redesigning work to assess skills in different places | ○ | ○ | ○ | ○ |
| Understanding current skills and capabilities gaps | ○ | ○ | ○ | ○ |
| Understanding future skills requirements | ○ | ○ | ○ | ○ |

8. What are your organization's capabilities associated with performance management?

| | Not Applicable | Weak | Adequate | Excellent |
|---|---|---|---|---|
| Demonstrating performance process as an effective use of time | ○ | ○ | ○ | ○ |
| Driving engagement and high performance through performance process | ○ | ○ | ○ | ○ |
| Driving feedback and development through performance process | ○ | ○ | ○ | ○ |

9. What is the current state of your organization's HR capabilities for 2016 and beyond?

○ Not on our "radar"
○ Simple
○ Somewhat Complex
○ Complex
○ Fully Mature

10. How much will your organization invest in learning and development in the 12-18 months?

11. How do you measure the return on your organizational investment for learning and development?

12. What do you see as the biggest HR trends for the maritime industries?

13. What is the size of your organization?

○ Small (<100 employees)
○ Small/Medium (100-500 employees)
○ Medium (501-1,000 employees)
○ Medium/Large (1,001-10,000 employees)
○ Large (>10,000 employees)

14. What is your level within the organization?

○ Staff/specialist
○ Mid-level
○ Executive-level
○ Other

15. Where are you located?

○ Central/Eastern Europe
○ Western Europe
○ Africa/Middle East
○ Latin and South America
○ North America
○ Asia/Oceana

P r o c e e d i n g s
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# MARITIME TRAINING THROUGH THE USE OF SIMULATORS

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**Abstract.** The purpose of this paper is to call to mind the importance of adequate training for mariners due to the high level of social, economic, and environmental impacts that are possible in the event of a miscalculation on the part of the mariner. However, determining what defines the most effective training method which would ensure maximum information retention and ability is essential. This paper discusses the reasons why simulation in combination with real world cadet shipping experience is the most effective means for training. Current theories on how the mind works, several educational and learning theories which exist, along with how the mind interprets information and then stores it, are critical to developing training strategies. The Theory of Situated Cognition, the Information Processing Theory and the Cognitive Apprenticeship Method along with how they align with both Cadet Shipping and Simulator based training, solidifies both training platforms as beneficial tools for maritime based training. Although extremely beneficial, the Simulator and Cadet Shipping have several disadvantages as well. This paper will draw upon all of the previously mentioned aspects, and explain why the combination of experience as a cadet onboard a ship alongside experience in a simulator will maximize the learning retention and understanding of the student.

**Key words:** education, navigation, situated cognition, simulator training, cadet training

## STUDIES AND REFERENCES

Several references will be used including a study conducted by Tamera Reul with assistance of several Marine Transportation Professors at SUNY Maritime College, involving a survey of current students who are utilizing a simulator as well as students who have experience as a cadet on board operating vessels. Interviews of experts in the field along with several texts, documents, and outside studies from reputable organizations will also be referenced.

Recent catastrophes such as the grounding of the *Costa Concordia* and the sinking of the *MV Sewol*, have reminded the world of the extreme importance of Maritime Safety. The topic of Maritime Safety has always been a critical, yet constantly evolving, issue which has been primarily reactionary. Examples such as the sinking of the *RMS Titanic* which led to regulations being created to improve lifesaving equipment onboard vessels and the grounding of the *Exxon Valdez* which led to the Oil Pollution Act (OPA) of 1990 in the United States, show how tragic events lead to drastic changes in the standards of maritime safety. These recent catastrophes will most likely have similar outcomes, drastically rewriting the pages of both history and regulation books around the world.

Although regulations will eventually be put in place to address many of the more imposing contributing factors of these incidents, there may be another key underlying issue which impacts not only these situations, but is an issue which causes most maritime accidents to occur. In the paper, *The Human Element as a Factor in Marine Accidents*, it states that the SAFECO project (a thorough analysis of 75 separate marine accident cases) indicated "that a central result of this analysis is the paramount importance of the human factor. In fact, in the majority of cases reviewed, the incident was due to one or more of the following: Poor crew competence, lack of communication, lack of proper maintenance, lack of application of safety or other procedures, inadequate training, poor judgment of the situation, and so forth. This general conclusion also means that many of the serious accidents reviewed might have been averted if some of the above deficiencies did not exist" (Psaraftis, page 10). Most authorities in the field will agree that greatest cause of marine accidents is Human Error. Just from the few incidents mentioned earlier, Human Error stands out as a predominant issue. Human Errors led to all of these situations including errors such as departure from the passage plan, delay in the abandon ship announcement, certifying improper loading conditions, not ordering the passengers to their abandon ship stations, and traveling at an unsafe speed in restricted visibility. The unfortunate side of having vessels operated by people is the inherent vice of Human Error. People will make mistakes, however it is also possible to make the number of mistakes made shrink significantly through the use of proper training.

As the understanding of how the mind works, learns, and utilizes information expands, the educational community's understanding of training techniques has grown and evolved significantly. Significant technological advancements, such as the advent of the Simulator, have drastically changed the landscape for maritime training. Almost every task onboard a vessel can now be replicated from how to load and discharge cargo, to how to safely navigate a congested waterway through the use of a Simulator. Many training schemes are now adopting Simulator Training as a way to earn "sea time" onboard vessels for various certificates. Although the Simulator provides countless opportunities to provide experience to the trainee (which would be otherwise impossible onboard an operating vessel), Simulators have significant drawbacks as well. Although the use of the Navigation Simulator as a training technique is extremely beneficial for training purposes, it cannot replace real world experience and must be used in conjunction with time spent onboard vessels in order to create a truly competent mariner.

In order to be an effective instructor, one must truly understand how to effectively transfer one's own knowledge to the student and understanding how the mind processes information can greatly improve the student's retention of information. The Information Processing Theory is one explanation on how the mind accepts, interprets, and stores information. This theory compares the mind to a computer as is explained by Michael Orey in the publication, *Information Processing*, by stating that as a person receives sensory information, they hear or see something, their Sensory Register (Similar to an Input Device ie. CD) is instantaneously registered in the brain for a period of time being only about two to three seconds long, and is then immediately sent to your Short Term Memory (Similar to a CPU) to be processed. Short Term Memory is essentially where consciousness exists; where the received Sensory Input information is registered, analyzed and interpreted, lasting for about 20 seconds long. Once the item has been analyzed within the Short Term Memory, it is then sent to the Long Term Memory (Similar to a Hard Drive) where it is stored. Long Term Memory is where everything that we know or know how to do exists and is broken up into three types of memory including Declarative (facts), Procedural (procedures), and Episodic (Experiences) (Orey, 2001).

As this information is received, analyzed, and then stored as Declarative, Procedural, or Episodic information, it is important for the educator to relay the information in a way so that the information is stored in the correct context. It would be more effective for a mechanic to learn how to repair an engine by going through the steps of repairing an engine then to simply memorize the steps from a manual. This is because the information is being stored as Episodic information after having accomplishing the task rather than Declarative information by memorizing the manual. This concept of learning information in the way the student will need to retrieve it later is known as Situated Cognition. If the student learns a piece of information through memorization, it will most readily be retrieved by the brain when asked a question. If the student learns a piece of information through accomplishing a task, the brain will most readily retrieve the needed information when presented by the same situation. The use of Cognitive Apprenticeship re-enforces the concept of Situated Cognition. As the article, *Situated Cognition and the Culture of Learning* states, "Cognitive Apprenticeship Methods try to enculturate students into authentic practices through activity and social interaction in a way similar to that evident – and evidently successful – in craft apprenticeship" (Brown, page 37). This concept of Cognitive Apprenticeship Methods, attempts to combine the traditional idea of an apprenticeship, allowing the individual to gain experience by watching a professional in the field, and combining it with cognitive training techniques, training through participating in the task. The article continues by pointing out that, "apprenticeship techniques actually reach well beyond the physical skills usually associated with apprenticeship to the kinds of cognitive skills more normally associated with conventional schooling. This extension is not as incompatible with traditional apprenticeship as it may first seem. The physical skills usually associated with apprenticeship embody important cognitive skills" (Brown, page 39). The combination of apprenticeship training with cognitive training techniques is highly effective as it not only allows the individual to gain experience by watching an expert but by also being allowed to participate in the task, makes the Cognitive Apprenticeship Method an extremely effective training technique.

Within the maritime education community, there are two opportunities which are classified as a Cognitive Apprenticeship Method. The first opportunity is Cadet Shipping and the second is Simulator based training courses. Cadet Shipping has been a training method in the maritime industry for an extremely long time and constitutes of a maritime officer candidate being placed onboard an operating vessel under the rate of cadet. As a cadet, the candidate has no true responsibilities except to learn and participate in as many operations as possible onboard the vessel. They usually work alongside one of the officers, slowly gaining experience in a real world training environment. When the cadet first joins the ship, they are usually instructed to watch all operations and are not allowed to partake in much of the operation; however, over time the cadet will improve and will slowly partake in a larger percentage of the operation, possibly taking part in the full responsibilities of a maritime officer onboard the vessel. In addition to the apprenticeship nature of Cadet Shipping, it involves a substantial amount of Situated Cognition training due to most training institutions involving some form of an academic project which the student is required to accomplish while onboard the vessel. These academic projects tend to have a substantial number of questions and assignments related several topics which the student will need to know as a maritime officer. This academic project is intended to guide the student's learning, ensuring they cover the key learning points required of the experience. Chief Mate Andrew Colleran, explained in a personal interview some of the benefits of Cadet Shipping by stating, "Positively, absolutely, and unequivocally a great positive in cadet training is having the experience onboard a commercial vessel. Pro's - the Cadet is exposed first hand to life onboard a vessel, the Cadet has to learn how to keep a work schedule, the Cadet begins to grasp responsibility of the job at hand, and the Cadet learns critical work and communication skills. They are able to work with bridge, deck, cargo and mooring equipment under supervision of ships officers" (Colleran, 2015). The combination of real world training and the academic project makes Cadet Shipping an outstanding example of a Cognitive Apprenticeship Method.

Cadet Shipping has been the only true Cognitive Apprenticeship Method available to the maritime education community until recent technological advancements brought about the development of the Training Simulator. This new piece of technology allows the instructor to be able to place the student in almost any situation that a maritime officer might experience in the field. This allows the student to gain experience with situations that they would most likely never experience with Cadet Shipping. It also completely removes the factor of extreme consequences if the student makes a mistake, allowing the student to accomplish which would have been impossible onboard an operating vessel. As Chief Mate Elspeth Hannaford stated in an interview, "the importance of repetition must be stressed… there is peace of mind in knowing that after it has been pressed x number of times, it never has to be pressed again, because the cadet being evaluated is now familiar enough with a procedure that they do not need to be reset" (Hannaford, 2015). The student is allowed to make the critical mistakes and learn from them. If the student ever experiences a similar situation in the field, this previous experience will be quickly registered, allowing the individual to make the best decision since this training experience has been stored as an Episodic Memory. When combining this Situated Cognition training technique with a structured lesson plan, the Simulator can also present itself as being the perfect platform for utilizing the Cognitive Apprenticeship Method as Captain Keith Wagner, mentioned in an interview, “Simulator training is a great tool for learning, improving, and evaluating. It’s a safe environment where individuals can test their abilities without consequences” (Wagner, 2015). The Simulator allows the student to focus on the training aspect of the lesson rather than on the consequences of what might happen if the student were to make a mistake. The student can also have as many practice attempts as is needed until the student has fully mastered whatever task is necessary.

Although both the Cadet Shipping and Simulator training opportunities both constitute as excellent examples of Cognitive Apprenticeship Methods, there are several underlying issues, or gaps in training, which both platforms present. For the Cadet Shipping training opportunity, the institution which is responsible for the overall training of the student, such as a maritime academy, has extremely little control of the level or type of experiences the student may obtain. As Professor Anthony Palmiotti stated in an interview, “Cadets onboard commercial vessels get to see the real world in action, both the good and the bad. If treated correctly onboard they can learn to put theory into practice at many levels. However, poor Mates/Master can create a negative experience” (Palmiotti, 2015). Most students who partake in Cadet Shipping return with good experience, stating that they learned a great deal and that the experience was critical to their learning experience. Unfortunately, there are also a large number of students who return stating that they did not learn very much and were treated extremely poorly by the crew. As Chief Mate Drew Colleran stated in an interview, “The student is away from family in a dangerous environment as someone with very limited skills and knowledge. In some cases they might not be treated as ‘crew’ and are neglected in terms of training. Without proper supervision and leadership, cadet training can take a backseat to vessel operations, there by the cadet loses out” (Colleran, 2015). As most Officers onboard vessels are not primarily instructors and the operations and safety of the vessel comes before training, a student may find that they are neglected training wise during their time onboard a vessel. In addition to the possibility of not having Officers onboard who offer a good training experience, there is also the possibility that the vessel does not conduct all of the operations which the training institution wishes the student to experience. Chief Mate Elspeth Hannaford explained some of these issues in an interview by stating that, “finding appropriate billets such as a cadet that wants to sail deep sea could end up on an inland tug. Getting placed on a vessel that is in dry dock for extended periods of time can also create significant training issues” (Hannaford, 2015). There are a limited number of vessels which are willing to take on students as cadets and it is difficult placing a large number onboard the correct vessels which will provide the appropriate opportunities for the student.

Although the Simulator has much more control over the training opportunities available for the student, it also has significant drawbacks as a training platform as well. The most significant of these drawbacks includes the fact that it is a simulator; it is not an actual vessel and a sense of realism and fear of consequences is a critical lesson in itself. As Chief Mate James Rogin pointed out in an interview, “There are negatives with simulator training as well such as over reliance on electronics, and a lack of real life consequences, ie. ‘I ran aground in the simulator and nothing happened’” (Rogin, 2015). The students become accustomed to pressing the reset button and lose the critical fear factor which is associated with difficult operations. If the student has never had the opportunity to attempt a task in a high pressure situation, then their Episodic Memory will have a more difficult time recalling the important information because of the differences between the circumstances.

Both Cadet Shipping and Simulator based training have excellent benefits for training purposes as they both present an exceptional platform for Cognitive Apprenticeship Method training. However, they both provide significant gaps in their training abilities as well. Fortunately, the portions which are lacking in Cadet Shipping can be obtained through use of the Simulator or vice-versa. Because of this, utilizing both opportunities presents the most efficient training for maritime education purposes. Captain Keith Wagner explained in an interview, “There must be a balance of lecture, simulation, and life experience (e.g. cadet shipping). This mix provides the cadet with knowledge, a chance to put this knowledge into practice with no consequences, and finally the opportunity to bring the skills and experience gained into the workforce” (Wagner, 2015). In order to test this concept, Chief Mate Tamera Reul with the assistance of several other professors conducted a study involving students in Simulator based courses at the State University of New York Maritime College. The study consisted of students filling out a one page survey, indicating how much they had learned during the course and what aspect of the course they felt was the most effective aspect towards their learning. The students surveyed were either in their third (Junior) or fourth year (Senior) at the college and were partaking in either the

Bridge Resource Management course or the Electronic Navigation and Voyage Planning course. Both courses utilize the Simulator to practice the use of the navigation equipment and making navigational decisions from the navigation equipment onboard a vessel. At the State University of New York Maritime College, students either spend all three summers completing their cadet training experience on the school's training vessel or they may participate in Cadet Shipping on their second summer with the first and third summer onboard the school training vessel. The training vessel training program does not allow many opportunities for the students to utilize the navigational equipment until their third summer training cruise. Students who participate in the Cadet Shipping training program tend to have a high use of the navigation equipment during their Cadet Shipping experience. The students surveyed had not participated in their third summer training cruise meaning that those who participated in training vessel only cadet experience had no navigation equipment training from a Cadet Shipping experience and those who had participated in the Cadet Shipping training program had a high level of Cadet Shipping experience with the navigation equipment. When the students were asked what contributed the most to their knowledge and understanding of the navigation equipment (lecture, simulation exercises, cadet shipping experience, or other previous knowledge) the majority of students selected the simulation exercises. However, when the student's answers were divided between those who had participated in a Cadet Shipping experience from those who only participated in the school training vessel cruises a distinct difference in the answers arose. Those who had only Training Vessel experience indicated an overwhelming 81% which believed that the simulation exercises contributed the most to their understanding and knowledge. On the other hand, those who had participated in a Cadet Shipping experience indicated 52% which believed that Cadet Shipping experience contributed the most and 37% which believed that the simulation exercises contributed the most. The most likely reason for this difference is that those who had participated in the school training vessel only, did not have Cadet Shipping experience to compare their growth of knowledge with the simulator towards, making simulator training the most significant contributor to their understanding. The students who had Cadet Shipping experience tended to value the experience they had gained onboard the vessels greatly but they also valued the training opportunities which the simulator had presented to them as well. Although there was this difference of opinion in what contributed the most, both groups of students indicated significant growth of understanding throughout the span of the Simulator based course and felt well prepared for the responsibilities of a Third Officer onboard a vessel due to all training received.

Combining the traditional training method of Cadet Shipping with the new and sophisticated opportunities presented with Simulator based training, creates the ultimate training platform for maritime education. Both training opportunities utilize the Cognitive Apprenticeship Method effectively which utilizes Situated Cognition to store the critical information the student will need as an Episodic Memory. As most of the information a student will need when working in the maritime industry involves the ability to recall information when accomplishing a task, being able to have the student store this information as an Episodic Memory is critical. Not only experts within the industry, but also students currently within a training program, agree that both Cadet Shipping and Simulator based training provide significant advantages and disadvantages as training platforms. Fortunately, there is enough overlap between the two training methods that all critical items can be obtained through the use of both methods. If we wish for them to succeed and prevent future catastrophes from occurring, we must effectively train students so that they are properly prepared for the important tasks they will undertake in the maritime industry which may be accomplished through the combined use of Cadet Shipping and Simulator based training.

**Acknowledgements**

**Personal Communication and Interviews:**

Colleran, A. Senior Lecturer, Marine Transportation Department, State University of New York Maritime College. (2015, May 26). Interview Type: Email.

Hannaford, E. Assistant Professor, Marine Transportation Department, State University of New York Maritime College. (2015, May 26). Interview Type: Email.

Palmiotti, A. Department Head, Marine Transportation Department, State University of New York Maritime College. (2015, May 26). Interview Type: Email.

Rogin, J. Associate Director, Professional Education and Training Department, State University of New York Maritime College. (2015, May 26). Interview Type: Email.

Wagner, K. CEO, DP Training Solutions, LLC. (2015, May 29). Interview Type: Email.

**Contributing Factors to Understanding Survey: Simulator vs. Cadet Shipping**

Conducted: May 2015

Conducted by: Tamera Reul

Assisted by: Andrew Colleran, Elspeth Hannaford, Richard Fitzgerald, and Jeffery Spillane

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## APPENDIX I: SAMPLE OF SURVEY CONDUCTED

**Simulator Training Survey 2015**

**Instructor ________________** **Course ________________**

**Please circle the appropriate answer**

– **What navigational equipment was utilized in this course?**

RADAR ARPA ECDIS GPS AIS Depth Sounder

– How much time on average was spent each week during this course in the Simulator?

Less than 1 1-2 hours 2-3 hours 3-4 hours 4-5 hours

– **Prior to taking the course, how knowledgeable were you about using the equipment?**

No Knowledge Somewhat Knowledgeable Fairly Knowledgeable Very Knowledgeable

– **After taking the course, how knowledgeable were you about using the equipment?**

No Knowledge Somewhat Knowledgeable Fairly Knowledgeable Very Knowledgeable

– **Have you gone out as a Cadet Observer on commercial vessels?**

Yes / No

– **As a Cadet Observer, how much did you use the electronic equipment?**

**RADAR:** Not at all Occasionally Frequently Constantly

**ECDIS:** Not at all Occasionally Frequently Constantly

**Depth Sounder:** Not at all Occasionally Frequently Constantly

**GPS:** Not at all Occasionally Frequently Constantly

– **Did your experience as a Cadet improve your knowledge and understanding of the equipment?**

Yes / No

Why? ________________________________________

– **In your opinion, what contributed the most to your understanding of the equipment?**

Course Lecture Simulator Use Cadet Experience Other previous knowledge

– **Is there anything specific which you believed was the most helpful to your understanding of the equipment?**

________________________________________

– **Is there anything specific which you believed was the least helpful to your understanding of the equipment?**

________________________________________

– **Do you feel this course made you more prepared to stand watch as a 3rd Mate?**

Yes No Somewhat

– **Do you feel that your experience as a Cadet Observer made you more prepared to stand watch as a 3rd Mate?**

Yes No Somewhat N/A

– **What contributed the most to your understanding of the responsibilities of a 3rd Mate on Watch?**

Course Lecture Simulator Use Cadet Experience Other previous knowledge

– **What do you think would have made you more prepared to stand watch as a 3rd Mate?**

________________________________________

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# ANALYSING BURNOUT LEVEL OF SEAFARERS: AN APPLICATION TO TURKISH YACHT MASTERS

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**Abstract.** There is an increasing demand for tourism worldwide. Tourism in many developing and least developed countries is the most viable and sustainable economic development option, and in some countries, it is considered as the main source of foreign exchange earnings. Tourism is an important industry for Turkey and there is a huge potential for marine tourism in Turkey due to the fact that marine tourism comprises a significant and promising field of tourism and there is an increasing potential for marine tourism in Turkey. Hence, coastal and marine tourism can be a major source of growth and employment in Turkey. The number of marinas in Turkey had doubled during the past decade and yachting also became the main component of marine tourism industry. These developments have played a great role in increasing numbers of sailors employed in the yachts. Ideally, every yacht in operation would have an owner and a captain that continuously work in collaboration with each other. However, some unfavorable issues between these parties may occur including problems with a crew member, unexpected maintenance issues, scheduling of yard time, budgets, and other off duty issues. Since yacht master's workload increases dramatically in high season, wide range of psychosocial stressors on board can arise that may also lead to burnout syndrome.

In the light of these, the purpose of this study is to investigate the burnout level of Turkish yacht masters with the conduction of emotional exhaustion (EE) of the Maslach Burnout Inventory (MBI) to assess the respective risks of job-related burnout level. The statistical analysis was carried out by using multiple methods within SPSS software in the study. It is expected that the results of the study provides certain outcomes and guidelines for related organizations dealing with yachting operations as well as suggestions for effective and efficient coordination among the relevant institutions.

**Key words:** Burnout, yacht masters, Burnout Inventory, marine tourism

## 1 YACHT TOURISM IN TURKEY

Turkey is one of the 10 most important tourist destinations around the world that's why country has more competitive advantages by comparing its competitors. It has different alternatives to attract more tourists and also to get more revenues from world's tourism pie. In the beginning of 21st century, people have begun to tend toward some kinds of special interest tourism (Sariisik et al., 2011: 1015).

Yacht tourism, being a part of maritime sector, tends to play a part in the tourist activities and provides important resources for the economy. Realizing the huge potential, the government and private sector are investing heavily in the yacht tourism. A number of new marinas, both private and state, have either been constructed or are under construction (Incaz and Guler, 2000: 232).

Yachting is an excursive, entertaining, restful and sporting type of tourist activity made by both private and commercial types of usually medium sized boats. Yachting differs from cruise tourism by not having a regular transportation between ports, as normally the cruise takes place between bays, gulfs and sheltered areas, which could not be legally classified as harbors (Ergin, 2009). Yacht tourism is composed of private yachting. Private yachts' owners are both local owners and cruiser owners. Local owners moor their own yachts in nearest marina and sail at weekends. Cruiser owners have more convenient time to sail and cruise. Generally they give months to cruise in foreign seas and leave yachts in a marina so as to park for winter. Other groups of yacht tourists are charterers. They rent a yacht or a cabin for certain time from Yacht Charter (Atlay Işık and Cerit, 2008).

The demand of the services supplied by yachts and marinas is different depending on the season of the year. During the summer period, the traffic of leisure crafts increases resulting in higher demand for stay at marinas and ports. On the contrary, during the winter period the demand for shelter increases in order for vessels to be repaired and maintained (Sariisik et al., 2011: 1015).

Yacht crew face with difficulties such as working in extreme hot or cold weather conditions, job stress, and lack of sleep, poor physical conditions and excessive workload that cause burn out syndrome especially in high season. Yacht masters work/rest periods depend on the workload. In high season yacht masters workload increases dramatically due to increased touristic activity (Angelika et al., 2012: 2). Higher workload and stress can cause insomnia and poor sleep quality that are well established risk factors for burnout. Burnout syndrome may manifest by the presence of headache, sleep disturbances, difficulty in concentration, short temper, upset stomach, job dissatisfaction and low morale (Rengamani and Murugan, 2012: 44). When yacht is on charter or the owner is on board the crew will, in essence, be working 24/7. This is a very common problem in yachting and leads to many great crews leaving the industry before they have reached their goals (Thatcer et al., 2012).

As is characteristically found in various studies, higher levels of stressors (e.g., heavy workload and uncertainty about supervisors' expectations) were associated with physical symptoms, such as headaches, and poor job attitudes (Oldenburg et al., 2013: 408).

## 2 BURNOUT SYNDROME

The burnout concept was first described in the 1970s and it was mainly associated to a reaction on interpersonal stressors on the job (Maslach et al., 2001). Over the past 30 years, there is an increasing interest in burnout both from academics and professionals as its negative impacts on employees have been understood (Halbesleben and Buckley, 2004). Moreover, it has become a growing phenomenon in the workplace context. Burn out concept was basically studied in the context of healthcare, social work, psychotherapy and teaching. According to the most prominent definition of burnout; "it is a syndrome of emotional exhaustion, depersonalization, and reduced personal accomplishment that can occur among individuals who work with people in some capacity" (Maslach et al., 1996: 4).

Burnout has been related with negative workplace behaviors including increases in sick leave, resignation, alcohol abuse, increases in smoking and coffee consumption, social and economic problems, workplace accidents, low morale and frequent job changes (Bakker et al., 2000; Demerouti et al., 2001; Leiter et al., 2007).

Burnout mainly results from the increasing level of stress that exhausts people to the point where their energy related resources are insufficient to survive the pressure of a situation (Galanakis et al., 2009). According to Freudenberger (1975), syndrome is linked to the degree of commitment of the individual and the frustration experienced by the failure to achieve its objectives. The lack of insufficient feedback often encounters employees contribute to the emergence and development of this syndrome.

## 3 MATERIALS AND METHOD

The purpose of this study is to investigate the burnout level of Turkish yacht masters with the conduction of the Maslach Burnout Inventory (MBI) to assess the respective risks of job-related burnout level. The statistical analysis was carried out by using multiple methods within SPSS software in the study. It is expected that the results of the study provides certain outcomes and guidelines for related organizations dealing with yachting operations as well as suggestions for effective and efficient coordination among the relevant institutions.

In this study, transversal descriptive study, by applying the Maslach Burnout Inventory (MBI) is conducted. The sample consists of Turkish yacht masters who currently work in the yacht tourism sector. A total of 42 yacht masters participated in the study.

MBI questionnaire with sociodemographic data sheet was used in the study. The MBI measures the dimensions of emotional exhaustion, depersonalization and personal accomplishment, according to which to define the syndrome. This scale has high internal consistency and reliability of nearly 90%, consists of 22 items in the form of statements about feelings and attitudes of the professional in their work and towards patients and its function is to measure burnout (Jimenez et al., 2014: 45).

The emotional exhaustion subscale consists of 9 items that assess experiences emotionally exhausted by the demands of work. The classification of this scale is to statements 1, 2, 3, 6, 8, 13, 14, 16, 20 (Herzberg et al., 1959). The depersonalization subscale consists of 5 items. These items assess the degree to which each recognizes attitudes of coldness and detachment. The classification of this scale is to statements of 5, 10, 11, 15, and 22. The personal accomplishment subscale consists of 8 items. It evaluates the feelings of self-efficacy and personal accomplishment at work. The classification of this scale is to statements of 4, 7, 9, 12, 17, 18, 19, and 21 (Celik et al., 2010). The data were entered in the database and analyzed using Statistical Package for the Social Sciences (SPSS, version 22.0).

Authors own questionnaire construction for the description of demographic and organizational data such as: gender, age, marital status, work experience, education and position. Respondents answer the question of how often they feel in a particular way on a 1–5 scale, where 1 indicates “never,” and 5 means “every time”.

The response categories and their corresponding values for emotional exhaustion, depersonalization and personal accomplishment on the Maslach Burnout Inventory (Maslach et al., 1996) are presented in Table 1.

The MBI scores assigned to each item were totaled and then divided by the total number of items in the subscale, which resulted in an average per subscale. Based on this average, the subscales were divided into high and low. Thus, values above the subscale’s average were classified as high and below the average were considered to be low. Additionally, the classifications obtained by each individual on the three subscales were associated. Hence, when this association was concomitantly High Emotional Exhaustion, High Depersonalization and Low Professional Realization, the resident was considered to be experiencing Burnout Syndrome. Cronbach’s Alpha Coefficient was used to analyze the instruments’ internal consistency (Guido et al., 2012).

**Table 1** Response Categories for Emotional Exhaustion, Depersonalization and Personal Accomplishment on the Maslach Burnout Inventory

| Dimension | High | Moderate | Low |
|---|---|---|---|
| Emotional Exhaustion | 27+ | 17-26 | 0-16 |
| Depersonalization | 13+ | 7-12 | 0-6 |
| Personal Accomplishment | 0-31 | 32-38 | 39+ |

**Note:** The numerical values for the personal accomplishment subscale are reversed. A score of less than 32 on the personal accomplishment sub-scale indicates a high degree of personal accomplishment.

## 4 RESULTS

The study response rate is of 100%. A total of 42 yacht masters, of which 40 (95,2%) are male and the rest of 2 (4,8%) are female. Yacht masters of age between 26 and 45 comprised the majority of respondents (76,2%) in the study. The respondents who have professional experiences of 11 years or more have the highest rate (69%) of participation among them. In the study most of the yachts (57,1%) fly Turkish flag. The rest of them fly flag from 4 different countries. The distribution of graduates according to respondent’s sociodemographic characteristics is presented in Table 2.

Results are calculated for each of the subscales separately, according to the key. This questionnaire has been validated in Turkish language and achieved the following alpha values for the scales as shown in Table 3.

The internal consistency analysis of the items composing the MBI subscales presented a Cronbach's alpha of 0.787 for Emotional Exhaustion and 0.572 for Depersonalization and 0.725 for Personal Accomplishment. It is clear that internal consistency values of subscales of this study is satisfactory for the social sciences. On the basis of the reference levels included in the manual for the MBI questionnaire, it may be assumed that, in the group of yacht masters, emotional exhaustion and depersonalization reached their low level but personal accomplishment reached to the high level using

**Table 2** Baseline characteristics of the study population

| Characteristic | | F | % |
|---|---|---|---|
| Gender | Male | 40 | 95,2 |
| | Female | 2 | 4,8 |
| Age | 18-25 years | 1 | 2,4 |
| | 26-35 years | 16 | 38,1 |
| | 36-45 years | 16 | 38,1 |
| | 46 years or more | 9 | 21,4 |
| Marital Status | Married | 27 | 64,3 |
| | Single | 12 | 28,6 |
| | Divorced | 3 | 7,1 |
| Educational Status | Elementary | 12 | 28,6 |
| | Secondary | 4 | 9,5 |
| | High School | 15 | 35,7 |
| | University | 10 | 23,8 |
| | Post Graduate | 1 | 2,4 |
| Years of Experience | 1-5 year | 5 | 11,9 |
| | 6-10 years | 8 | 19 |
| | 11-20 years | 14 | 33,3 |
| | 21 years or more | 15 | 35,7 |
| Type of Yacht | Sailing Boat | 20 | 47,6 |
| | Motor Yacht | 22 | 52,4 |
| Nature of Service | Private | 25 | 59,5 |
| | Commercial | 17 | 40,5 |
| Flag | Turkish | 24 | 57,1 |
| | USA | 9 | 21,4 |
| | UK | 6 | 14,3 |
| | Germany | 1 | 2,4 |
| | Malta | 2 | 4,8 |

Maslach's scale as described in Table 4, Table 5 and Table 6.

There are some significant differences on the level of emotional exhaustion regarding to different age groups as shown in the table. The respondents of age between 26 and 35 experienced lower level of emotional exhaustion and significantly have higher values compared to the group of age of 45 or more. There are no significant differences between age groups on the level of depersonalization and personal accomplishment subscales. The respondents of all age group experienced lower level of personal accomplishment and depersonalization subscales.

There are some significant differences on the level of emotional exhaustion and depersonalization subscales regarding to the work experience of the respondents. The respondents that have 21 years or more work experience reached lower level of emotional exhaustion compared to the respondents who have 6-10 years of work experience and 11-20 years of work experience. The respondents who have 21 years or more work experience have lower level of depersonalization compared to the respondents that have 1-5 years of work experience and 11-20 years of work experience. The respondents who have high 1-5 years of work experience experienced higher level of personal accomplishment.

**Table 3** Internal Consistency and Other Descriptive Findings

| Dimension | Items | N | Scale | | | |
|---|---|---|---|---|---|---|
| | | | Mean | Variance | Std. Deviation | Alpha (α) |
| Emotional Exhaustion | 8 | 42 | 10,2143 | 24,904 | 4,990 | 0,787 |
| Depersonalization | 5 | 42 | 3,7381 | 8,783 | 2,963 | 0,572 |
| Personal Accomplishment | 9 | 42 | 11,1429 | 25,101 | 5,010 | 0,725 |

**Note:** Emotional Exhaustion: 0-16 = Low, 17-26 = Moderate, >27 = High; Depersonalization: 0-6 = Low, 7-12 = Moderate, >13 = High; Personal Accomplishment: >39 = Low, 32-38 = Moderate, 0-31 = High.

**Table 4** Professional burnout scores in relation to "age"

| Dimension | Age | N | Mean | Std. Deviation | F | Sig. |
|---|---|---|---|---|---|---|
| Emotional Exhaustion | 18-25 | 1 | 7,00 | - | 3,073 | ,039 |
| | 26-35 | 16 | 12,18 | 2,495 | | |
| | 36-45 | 16 | 10,68 | 3,747 | | |
| | 45+ | 9 | 6,44 | 1,313 | | |
| Depersonalization | 18-25 | 1 | 1,00 | - | 2,698 | ,059 |
| | 26-35 | 16 | 6,25 | 1,855 | | |
| | 36-45 | 16 | 5,00 | 1,456 | | |
| | 45+ | 9 | 3,98 | 1,322 | | |
| Personal Accomplishment | 18-25 | 1 | 14,00 | - | 1,090 | ,365 |
| | 26-35 | 16 | 11,20 | 2,485 | | |
| | 36-45 | 16 | 12,40 | 2,391 | | |
| | 45+ | 9 | 13,30 | 3,858 | | |

**Note:** Emotional Exhaustion: 0-16 = Low, 17-26 = Moderate, >27 = High; Depersonalization: 0-6 = Low, 7-12 = Moderate, >13 = High; Personal Accomplishment: >39 = Low, 32-38 = Moderate, 0-31 = High.

**Table 5** Professional burnout scores in relation to "years of experience"

| Dimensions | Years of Experience | N | Mean | Std. Deviation | F | Sig. |
|---|---|---|---|---|---|---|
| Emotional Exhaustion | 1-5 year | 5 | 11,18 | 3,112 | 4,499 | 0,008 |
| | 6-10 years | 8 | 12,37 | 3,611 | | |
| | 11-20 years | 14 | 12,36 | 3,715 | | |
| | 21 years + | 15 | 9,07 | 2,385 | | |
| Depersonalization | 1-5 year | 5 | 6,75 | 1,223 | 6,142 | 0,002 |
| | 6-10 years | 8 | 5,41 | 2,611 | | |
| | 11-20 years | 14 | 6,56 | 2,739 | | |
| | 21 years + | 15 | 3,97 | 1,611 | | |
| Personal Accomplishment | 1-5 year | 5 | 8,2 | 2,388 | 0,689 | 0,565 |
| | 6-10 years | 8 | 11,4 | 4,701 | | |
| | 11-20 years | 14 | 11,0 | 4,329 | | |
| | 21 years + | 15 | 11,9 | 3,687 | | |

**Note:** Emotional Exhaustion: 0-16 = Low, 17-26 = Moderate, >27 = High; Depersonalization: 0-6 = Low, 7-12 = Moderate, >13 = High; Personal Accomplishment: >39 = Low, 32-38 = Moderate, 0-31 = High.

**Table 6** Professional burnout scores in relation to "type of yacht"

| Dimensions | Type of yacht | N | Mean | Std. Deviation | F | Sig. |
|---|---|---|---|---|---|---|
| Emotional Exhaustion | Sailing | 20 | 11,00 | 3,687 | 0,083 | 0,531 |
| | Motor yacht | 22 | 11,60 | 4,570 | | |
| Depersonalization | Sailing | 20 | 6,00 | 3,819 | 1,522 | 0,367 |
| | Motor yacht | 22 | 6,68 | 4,665 | | |
| Personal Accomplishment | Sailing | 20 | 6,00 | 3,667 | 3,418 | 0,791 |
| | Motor yacht | 22 | 6,07 | 4,457 | | |

**Note:** Emotional Exhaustion: 0-16 = Low, 17-26 = Moderate, >27 = High; Depersonalization: 0-6 = Low, 7-12 = Moderate, >13 = High; Personal Accomplishment: >39 = Low, 32-38 = Moderate, 0-31 = High.

**Table 7** Professional burnout scores in relation to "nature of service"

| Dimensions | Purpose of Service | N | Mean | Std. Deviation | F | Sig. |
|---|---|---|---|---|---|---|
| Emotional Exhaustion | Private | 25 | 8,75 | 2,480 | 0,074 | 0,788 |
| | Commercial | 17 | 9,25 | 2,805 | | |
| Depersonalization | Private | 25 | 3,75 | 1,616 | 0,228 | 0,635 |
| | Commercial | 17 | 3,29 | 1,910 | | |
| Personal Accomplishment | Private | 25 | 8,25 | 2,446 | 3,428 | 0,071 |
| | Commercial | 17 | 10,55 | 3,658 | | |

**Note:** Emotional Exhaustion: 0-16 = Low, 17-26 = Moderate, >27 = High; Depersonalization: 0-6 = Low, 7-12 = Moderate, >13 = High; Personal Accomplishment: >39 = Low, 32-38 = Moderate, 0-31 = High.

There are no significant differences regarding to the subscales of burnout inventory between the groups of respondents who employed in the different types of boat. Both groups experienced lower degree of emotional exhaustion and depersonalization subscales but all of the scores were in the range identified by Maslach et al. (1996) as indicative of high personal accomplishment.

There are no significant differences regarding to the subscales of burnout inventory between the groups of different services. According to measurement both group have lower degree of emotional exhaustion and depersonalization and higher degree of high personal accomplishment.

## 5 CONCLUSION

The present study tries to examine the effects of burnout on the yacht masters. Based upon the findings of this study, burnout is not considered as a serious problem for yacht masters. While there are indications that yacht masters are experiencing some level of stress, these stress levels have not reached the point where burnout is a problem. This may be due to the reason that the working conditions, employee-employer relationships and the dynamics of yachting business can be considerably different compared to the other shipping-related industries.

The analysis of data clearly presents that yacht masters at all age group and the age of the yacht master, the years of working experience, type of boat and nature of services are not related to emotional exhaustion and personal accomplishment scores on the Maslach Burnout Inventory. Although the relevant literature supports the existence of burnout syndrome in the yachting business, findings of the study showed that only a limited number of variables were found significant. Significant differences between the level of emotional exhaustion and depersonalization, and work experience was noted. Lower levels of emotional exhaustion were observed in yacht masters with more working experience. Moreover, yacht masters with 21 years or more work experience had lower level of depersonalization compared to the yacht masters with less years of experience. This may be due to the fact that yacht masters with more years of experience may internalize the main responsibilities and the outcomes of their job so that they may perceive the unusual or unexpected incidents with regards to burnout syndrome as acceptable or normal.

This study was conducted to the yacht masters in low season period. For better scientific results this study has to be performed to yacht masters again after high season conditions. Following a busy season, the perceptions of the yacht masters regarding the dimensions of burnout could be different. The same scale employed in this study can be employed for the yacht masters working basically in certain regions such as Mediterranean, Aegean etc. so that the regional differences leading to burnout in yacht masters can be observed as well. Comparative studies can also be conducted between Turkish and foreign yacht masters in order to point out some possible differences or similarities with regards to burnout syndrome and its indicators. Lastly, qualitative studies such as focus groups, in-depth interviews or Delphi research can be employed for understanding the basic determinants of burnout for yacht masters as well as the main parameters for the level of burnout.

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This research was supported and assisted by Turkish Yacht Masters Association. First of all we would like to thank this association. We thank our colleagues from Dokuz Eylül University Maritime Faculty who provided insight and expertise that greatly assisted the research, Thanks to all those who helped with handing out the surveys.

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# MULTI-LANGUAGE PRESENTATION OF E-LEARNING/DISTANCE COURSE CONTENT

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**Abstract**. Shipping is an international business where crews can be multinational and represent a number of different languages and cultures. However, to ensure safe operation of a vessel, all crew members must be trained to a common standard. This standard is set by the IMO but is implemented by the various countries. However one commonality that is shared is that English is considered the default language in shipping.

The authors have demonstrated their method to produce and deliver distance/e-learning courses using a suite of learning technologies including interactive video lectures, online assessment tools, discussion and tutoring tools and technologies as well as a Learner Management System to house them all. These same technologies can be used to integrate multi-language support into a body of course content material crafted using the authors tool kit and methodologies that can match the IMO learning objective.

Initially the authors explored making our E-Learning content more accessible to those with hearing disabilities or bandwidth restrictions through the use of subtitles in our online lectures. After the process for this evolution was determined, it became evident that the E-Learning content could also be made available to French speaking Canadians with English audio and French subtitles.

With the E-Learning script in text form, it is now possible to create audio in virtually any language that can then be transplanted into the original E-Learning content. The net result being that the E-Learning content of our STCW compliant distance/E-Learning course can now be made available as:

- E-Learning content with English audio and no subtitles;
- E-Learning content with English Audio and alternate language subtitles;
- E-Learning content with alternate language audio and alternate language subtitles.

This paper describes the evolution of multiple language presentation of E-Learning content in a single E-Learning/distance course. As well, it outlines the process of converting the E-Learning content of the authors from English to subtitles and audio of an alternate language. This paper finally explains the rationale for preparing a single course in full compliance with an IMO model course in multiple languages.

**Key words**: E-Learning, distance, learning, multi-language, modern technology, culture

## 1 INTRODUCTION

The unique environment that is the maritime working environment is a challenge in many ways. Due to the multi-national and multi-cultural reality of crewing, there is an agreed upon international standard for communication aboard and between vessels at sea that falls under the heading of maritime English. The challenge exists to train all seafarers to have an acceptable knowledge of maritime English, and additionally to be able to pronounce and understand maritime English such that effective communication can consistently and effectively occur aboard and between vessels.

Deck officer and marine engineers alike receive career specific skills and technical training needed to attain professional certification. On top of this, mariners must also receive training in maritime English.

It is in the interest of the ship owners, the crews, and considering the sensitive and critical nature of the shipping environment, the world as a whole, that both facets of this training are achieved to the highest standard possible.

## 2 EDUCATION

Maritime English may be defined as a set of key phrases in the English language as prescribed by the IMO. These collectively are called the Standard Marine Communication Phrases (SMCP) (IMO, 2001). The ability to communicate effectively using maritime English while at sea is imperative. Maritime English is not only for mariners whose native language is not English, but is a facet of the education of all mariners, English speaking and non-english speaking alike.

The challenge of teaching maritime English to non-English speaking mariners is great. For this reason, it makes intuitive sense to expose mariners to English in a written and audible working context beyond the base instruction of maritime English.

The authors have created a course entitled 'Applied Mechanics for Marine Engineers'. This course was developed to conform to the appropriate sections of the STCW standard governing training and certification of marine engineers as laid out by IMO (IMO, 2012). To course content of this delivery was created as interactive online presentations authored using Adobe Captivate.

While authoring this content, consideration was given to making the content 'accessible' to those who might have limitations in participating in the course. The content is presented with PowerPoint type slides with some animation and audio narration.

Initial accessibility was enhanced by ensuring that font sizes and types were appropriate to make sure that the text was as readable as possible. The narration was clear and understandable and of an appropriate volume ensuring that course participants could comfortably hear and understand it while wearing headphones or using their computer speakers. Consideration was then given to providing subtitles to the videos to permit those who could not listen to the narration (for whatever reason) the opportunity to receive the spoken information on top of the content contained in the slides.

Canada is a bilingual country with a relatively low population spread out over a very large geographic footprint. This electronic delivery of Applied Mechanics for Marine Engineers is still relatively new, but has already been taken by learners from several Canadian provinces. The notion of delivering this course to a more global Canadian population (vis a vis English and French speaking learners) became a real possibility with the notion that the authors could provide French subtitles to the course content with English audio.

Where this course conforms to the international standard that must be applied globally to all marine engineers, the authors rationalized that this could lead to an opportunity to share web-based or electronic course resources with other maritime universities. Additionally, it was envisioned that providing these learning materials to mariners whose primary language was not English would give those learners an opportunity to maintain or enhance their English speaking and comprehension skills.

This may be envisioned as an effort to develop and ensure multilingual competence in the maritime community to the extent that SMCP can reliably be used to communicate at sea. (Multilingual competence may be described as providing mariners with the capacity "to use several languages appropriately and effectively for communication in oral and written language" (Cenoz et. Al, 1998, p. 17)).

Non-English speaking mariners will be expected to use maritime English in various situations for different purposes, and subsequently mat need to make use of all components or aspects of communicative competence. However, it is often the case that they do not develop all competencies in a second or third language (English, in this case) to the same extent or level (Cenoz et. Al, 1998, p. 9). Therefore, successful foreign language learning requires that the mariner make appropriate selection and use from a strategy repertoire (Green and Oxford, 1995).

Every learning process requires a manner or strategy to be adapted so as to achieve the main purpose of learning. Chamot (1987, cited in Hismangoglu, 2000) defined learning strategies as processes, techniques, approaches and actions that students take to facilitate the learning and recall of both linguistic and content areas of information.

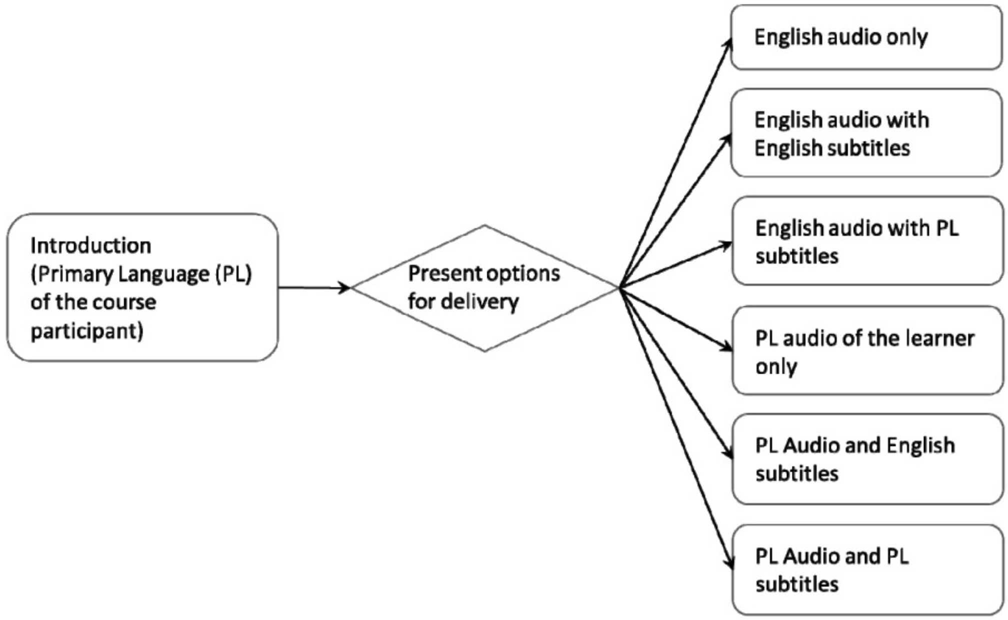


**Figure 1** Multi-Language Delivery Options

Appropriate learning strategies are tools encouraging learners to take responsibility for their own learning and result in improved proficiency and greater self-confidence (Oxford, 1990).

Oxford provided a taxonomy of language learning strategies broken into two main categories, direct and indirect strategies. The direct strategy taxonomy has three sub-categories:

Memory

a. Creating mental linkages
b. Applying images and sounds
c. Reviewing well
d. Employing action

Cognitive

a. Practicing
b. Receiving and sending messages strategies
c. Analyzing and reasoning
d. Creating structure for input and output

Compensation Strategies

a. Guessing intelligently
b. Overcoming limitations in speaking and writing

By having learners participate in a course with at least some facet being delivered in a language in which they are working to develop a proficiency, then many of the above learning taxonomies are being indirectly satisfied.

In short, providing at least some content of required course work in English should enhance the maritime learner in their use of maritime English by having the learners develop an internal toolbox of strategies which they may employ when learning and using maritime English.

## 2.1 Multi-language content delivery

The thought, then, is to consider delivery of certification level course material to mariners where a component or, perhaps, all of the delivery may be provided in english. The learning opportunity itself cannot be compromised in that the content being learned is required for certification advancement and will be examinable.

To ensure an uncompromised learning opportunity, the authors propose that a branched online presentation opportunity be given to the learners using the model presented in Figure 1. For any given presentation of a course delivery, an introduction in the first or native language of the learner be presented using the online content delivery model involving interactive audiovisual web based presentations (Tucker and Cross, 2013). The introduction includes a description of the various options of delivery which may include audio of the presentation in either English or another language as well as the option for sub-titles in either English or another language.

The selections available within a given learning module may be customized by the learning institution based on the desire to further enhance English language skills or to optimize the delivery of the course content.

### 2.2 Challenges

Several challenges are envisaged by the authors in the creation, dissemination and adoption of multi-language course content for training mariners to advance in their certification levels. These may be presented in general terms as:

– Content Creation

– Content Delivery; and

– Content Adoption

The term content creation refers specifically to the creation and translation of multi-language course content. In particular, translation of technical terms often proves challenging and would have to be done as a collaboration between content experts who are used to teaching in the languages involved in the delivery. Once multiple 'scripts' have been prepared in different languages then audio tracks need to be recorded for each, and following that a synchronization of each of the audio tracks with the appropriate subtitles (taken from the scripts) must take place. This is a time and labor intensive process. Additionally, content should be reviewed to ensure that it is context appropriate with respect to culture and geography and course content and examples should be tailored and customized to ensure that it is meaningful to the course participants.

The challenge of content delivery simply refers to the creation of course content by one content expert, and then having someone take that content part and parcel and deliver it elsewhere. Throw into this mix the confusion that may arise among faculty attempting to use content in a course delivery that is in a language that is not their primary language, and the potential for delivery challenges exist.

Finally, the challenge of content adoption refers to issue that, although all countries training mariners in accordance with the STCW convention requirements certainly teach all of the elements outlined in the convention and the model courses. It is most likely that the teaching points are packaged into courses, which are packaged into programs differently from one country to the next. This will most like result in a repackaging of the content if it is to be used by someone other than where it was originally authored.

These challenges are not insurmountable, and it is with confidence that the authors state that this effort is one that can be achieved.

## 3 CONCLUSION

Technology now allows relatively easy development of interactive online multi-language learning content and tools. It is estimated based on the experience of the authors who have been creating this type of course content in a single language that it takes about ten to twenty hours of effort to create about one hour of online delivery depending on the type and nature of the course being prepared. Once this has been done, the written script may be translated and the online presentation material reworked to have it delivered in another language using the above described process.

In short, it is possible to create STCW compliant course material in a multi-language format that may then be used by different MET's to train their learners.

As a point of note, the authors are also considering the use of feminine voices in the online presentation of material. The suite of impacts this might have has not been fully considered as of the writing of this paper, but it is anticipated that the use of female voices in the production of this course content may, at least, assist in the acclimatization of mariners to the concept of female maritime professionals.

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# ROAD NETWORK LINKING THE SEA PORT AS A VITAL TRANSPORT FACTOR DETERMINING ITS SUCCESSFUL HINTERLAND INTERCONNECTION. FACTORS DETERMINING THEY PRIMARY AND SECONDARY ROLE IN THE CASE OF THE PORT OF PLOČE

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**Abstract**. This paper represents part of the research conducted in order to provide solid framework for proper consideration of importance of road infrastructures linking to port. Those road links are identified as primarily or secondarily factor of successful hinterland interconnection. Should they be perceived as primarily or secondarily factor of successful hinterland interconnection depends mostly on the level of development of port hinterland in the context of road vs rail infrastructure. Also, it is highly important to take into account the current situation in the port, and especially the share of total traffic which is drawn from the port by rail or road. This paper examines the importance and all aspects of road infrastructures linking to port in order to provide measurable basis for assessing the port hinterland as a competitiveness determinant of the port. From a methodological point of view, the authors systematize the key road infrastructure and superstructure factors of success. The authors also elaborate on possible outcomes regarding the prominent question: what to target as a short term port development factor when there is potential to quickly achieve higher levels of traffic – road or rail. The authors conclude that the road infrastructure linking to port is of great importance even when there is largely accepted concept that rail is of great importance for port development, and especially when there is a short term potential to relatively quickly achieve higher levels of traffic. This road linking is largely dependent on political factors and hinterland development as it is demonstrated in the paper on the example of Port of Ploče and this is also a significant determinant of port competitiveness. The objective of this paper is to highlight the significance of road infrastructure linking to port and to present its importance for the Port of Ploče development.

**Key words**: road, port, infrastructure, hinterland interconnection

## 1 INTRODUCTION

Port development has been widely elaborated from multiple aspects in the literature. Generally it is accepted that rail infrastructure has prominent role in the development of port systems but there are multiple examples that also road infrastructure is of great importance, especially when there is a need to bridge some short term discrepancies regarding development level of rail infrastructure in port hinterland. Those road links can be identified as primarily or secondarily factor of successful hinterland interconnection in the same time providing solid framework for proper consideration of importance of road infrastructures linking to port. In the following part this is elaborated on the example of Port of Ploče as one of the most important Croatian cargo ports.

## 2 ROAD INFRASTRUCTURES LINKING TO PORT

The port of Ploče is situated in the middle of the eastern coast of the Adriatic Sea. The majority of cargo from port of Ploče is pulled out through rail but at present situation there are multiple limitations and barriers (physical and nonphysical) on railroad [12], so it is therefore valuable to analyze additional opportunities to pull out the cargo, especially in the short term through road infrastructure linking to port, in order to potentiate higher level of output. The backbones of road links that connect the port of Ploče with its hinterland are:

- the "Adriatic highway" ("Jadranska magistrala") that stretches from Trieste and passes through Rijeka and Split to the end point of the Republic of Croatia passing right near the town and the port of Ploče. This transport route is a part of the European road network and it is marked as E 65.
- the transport corridor Vc that stretches from Budapest and includes the road connection: Hungarian border – Osijek – Bosanski Šamac – Zenica – Sarajevo –Mostar – Metković – Ploče (code E-73). It presents the shortest and most fitting traffic link between the Middle Europe and the Adriatic Sea. Also, by this link the port of Ploče is connected with its natural hinterland.

The road from Budapest – Osijek – Slavonski Šamac – Sarajevo – Mostar – Ploče became a part of the corridor V, branch C on the third assembly for the former Pan-European corridors in Helsinki in 1997. Thus the Port of Ploče has become a land and sea routes junction of the Pan-European Corridor V, branch C passing through Hungary, Croatia and Bosnia and Herzegovina, due to its geographical location. Beside a very important role in the transport system of the Republic of Bosnia and Herzegovina, this corridor is significant as well as in the transport system of the Republic of Croatia since it connects the Danube region and the Adriatic. In respect to the position of Croatia as a country which is situated in Central Europe, in the Danube region, on the Adriatic and on the Mediterranean, that corridor is important also as a link between Central European countries, the Adriatic and the Mediterranean.

The Pan – European Corridor V – Vc branch connects the central parts of the European continent and the western Balkans. The overall length of the road corridor is 702 km of which approximately 379 km passes through Bosnia and Herzegovina.[9]

The Port of Ploče as the starting point of the Corridor Vc from the south is connected to the Ploče interchange at the A1 motorway by a system of roads represented by the D425 Croatian state road. The state road D425 is 17.6 km long and connects as well the outskirts of Ploče with the D62 state road.

The Ploče interchange together with the slip road connects the motorway A1 with the port of Ploče and from the state road D8 enables the connection to motorways A10 and A1. The junction of the highway track on the Corridor Vc (motorway A10) as an important traffic interchange enables the contact with the motorway A1, Zagreb – Split – Dubrovnik, and the port of Ploče.[8]

For the development of the Port of Ploče besides the main access roads other national, regional and local roads connecting to these traffic routes are essential, particularly in Bosnia and Herzegovina as the main catchment market of the Port of Ploče. On the following figures the state of road network in Bosnia & Herzegovina is presented.

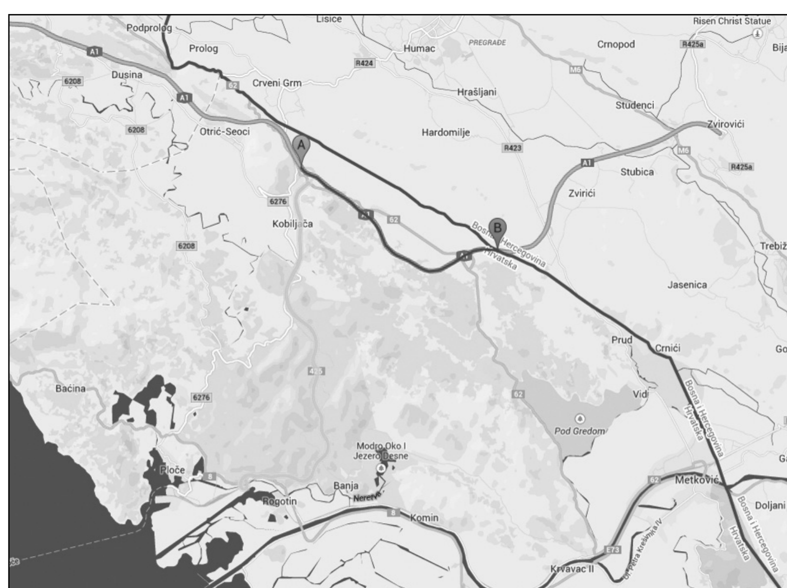


**Figure 1** Connecting roads from port of Ploče to the state border (D425, A1 and A10 section) and furthermore to corridor Vc in Bosnia and Herzegovina

**Source:** www.hac.hr

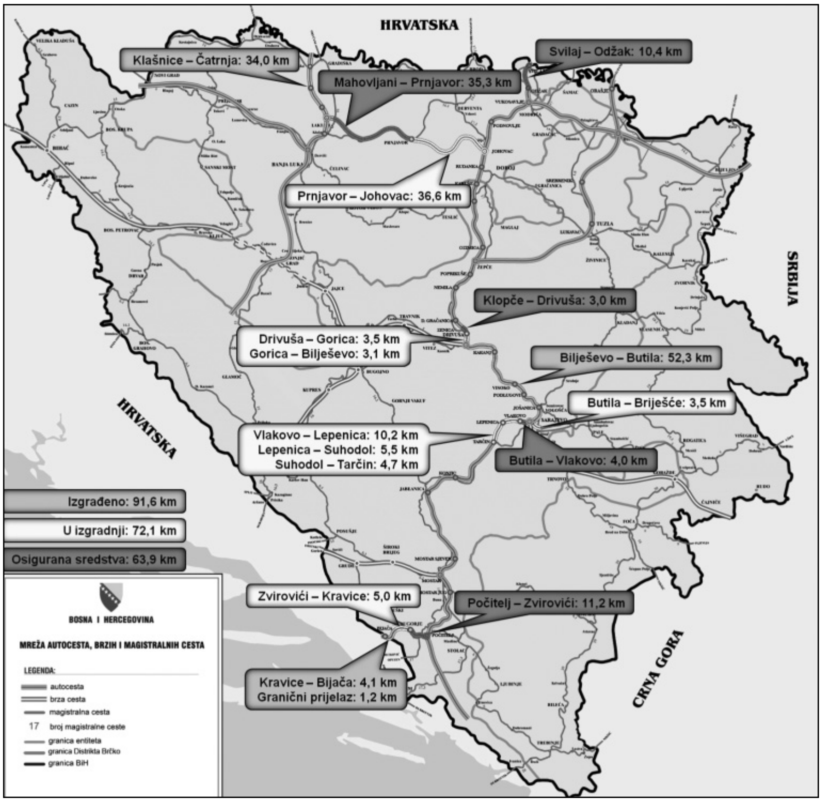


**Figure 2** The network of motorways, express and trunk roads in Bosnia & Herzegovina (green – in operation, yellow – in construction, red – financial resources guaranteed) – 2013.
* Sections Zvirovići – Kravice, Vlakovo – Tarčin and Drivuša – Bilješevo has been finished in 2014.

**Source:** http://wiki.openstreetmap.org/wiki/WikiProject_Bosnia_and_Herzegovina


**Figure 3** The network of highways, state and regional roads in Bosnia and Herzegovina

**Source:** Projekat: Autoceste na koridoru Vc u Federaciji BiH; Izvještaj o dinamici projekta Br. 17 (completed with 30.06.2014.), Mostar, 2014.

The state road M17 (international code E73) that follows the Corridor Vc route through Bosnia and Herzegovina begins at the Croatian/BiH international state border Metković and consists of the following route: Čapljina – Počitelj – Mostar – Jablanica – Konjic – Hadžoći – Sarajevo – Zenica – Žepče – Maglaj – Doboj – Odžak – Bosanski Šamac. The total length of the state road M17 from Čapljina to Bosanski Šamac is 400 kilometres. Along this state road 17 counting sites are allocated on 13 sections. The section between Bilješevo and Jošanica southward to the town of Sarajevo comprises the dual carriageway part of the route respectively the section of the highway A1 of the total length of 46.6 kilometers.[2]

The route of the Pan – European Corridor V – Vc branch continues through the Republic of Croatia by the motorway A5 with the total planned length of 88 km. The motorway A5 stretches by the following sections: BiH/Croatia border – Svilaj – Sredanci – Đakovo – Osijek – Beli Manastir – Croatia/Hungary border. Currently 53,5 km of the motorway is constructed, i.e. the section Sredanci – Đakovo (21 kilometres) and the section Đakovo – Osijek (32.5 kilometres).[8]

The construction of the motorway Sredanci – Đakovo – Osijek included Osijek in the Croatian motorway network creating better connectivity with all transport and economic centres. In addition, the new highway opened the revitalization process of the large south route and the central part of Pannonia region.

After the border crossing Duboševica/Udvar the Corridor Vc continues throughout the Republic of Hungary, whose territory passes 196 km of the route. The route consists of the following sections: Udvar – Boly – Szekszard Dunaujvaros – Erd – Budapest. The Motorway M6 (E73), was built as full profile from the interchange Boly to Budapest of the total length of 183 km. For the completion of the Hungarian section of the motorway it is necessary the construction of the section between Boly and the border with the Republic of Croatia.

## 3 CONCLUSION

An important prerequisite for the efficient operation of port of Ploče as a transit port for the Bosnia and Herzegovina but also for Central European countries and for further economic development of the areas in its hinterland is the appropriate, efficient and high-capacity road transport links between the hinterland and the port. The importance of quality road infrastructure could be proved by the fact that about 80% of the containerised cargo use road transport. Beside that, internal road infrastructure should be developed as well as access roads to the motorway network.

The transport corridor Vc (Ploče – Sarajevo – Osijek – Budapest) should have adequate modern transportation infrastructure that would enable the expansion of the port of Ploče and the entire transport route. Corridor Vc is a link North – Central and Southern Europe, and represents excellent value in the context of economic and trade integration of Central Europe. The road infrastructure linking to port is of great importance even when there is largely accepted concept that rail is of great importance for port development, and especially when there is a short term potential to relatively quickly achieve higher levels of traffic. It can also be stated that this road linking is largely dependent on political factors and hinterland development and this is also a significant determinant of port competitiveness in general.

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# RESEARCH ON THE APPLICATION OF WEARABLE DEVICES IN THE MANAGEMENT OF SEAFARERS' FATIGUE

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**Abstract.** Global concerns on the issue of fatigue at sea are widely evident across the shipping industry. Fatigue-induced human errors have already been identified and widely accepted as major contributing factors in most maritime accidents. It is confirmed that sleep and rest are the most crucial elements affecting human fatigue and subsequent impaired work performance. A deep and uninterrupted sleep is important for a normal seafarer who wants to have a good performance at work. Although many studies and research projects concerning fatigue have been undertaken in recent years, there are so far no effective or sufficient measures to deal with the problem because of sophisticated challenges and lack of knowledge.

This paper attempts to explore an approach to set up a new strategy of fatigue management for seafarers based on smart phone application combined with wearable devices. Smartphone-based interactive information platform and wearable devices, such as mi band wristband which has the function of sphygmomanometer, wrist movement monitor and sleep monitor, are introduced and used to collect and record each physiological data naturally and conveniently. These data is stored in the smart phone in real time via Bluetooth and can then be uploaded and stored in the Cloud once the smart phone is connected to the internet. Moreover, the data can be analyzed by the smart phone Apps and a report implying the fatigue level can be proposed based on the analysis. Besides, with the interactive information platform, it will be easy for the manager of the shipping company to discover the fatigue risks of their seafarers and it could be convenient for them to manage fatigue.

**Key words:** seafarers, fatigue monitoring, wearable devices

# 1 INTRODUCTION

Fatigue is a common problem in the general population (Bensing, et al, 1999; David, et al, 1990). Prevalence of fatigue in the general working population has been estimated to be as high as 22% (Bültman et al., 2002). Among the general working population, fatigue has been associated with accidents and injuries (Bonnet and Arand, 1995; Hamelin, 1987). There is also a clear link between fatigue and ill health (Andrea, et al, 2003; Folkard, et al, 2005; Huibers, et al, 2004; Leone, et al, 2006), as well as impaired work performance (Charlton and Baas, 2001), sick leave and disability (Janssen, et al, 2003; van Amelsvoort, et al, 2002).

A great amount of research has shown that fatigue is still a major issue at sea. It was regarded as the first concern of seafarers in a study concerning ship manning (National Research Council, 1990). It was revealed in a US Coastguard study that 16% of critical vessel accidents and 33% of personal injury accidents were caused by fatigue directly or indirectly (McCallum, et al, 1996). It was also found in the study that fatigue's contribution to groundings and to collisions was 36% and 25% respectively (McCallum, et al, 1996). However, the values were much higher in another Japanese study: 53% for groundings and 38% for collisions (Det Norske Veritas, 1999).

Fatigue varies from one person to another due to individual attributes as well as circumstances, among which sleep is a factor that can not be ignored. It is certain that sleep and rest are the most crucial elements affecting human fatigue and subsequent impaired work performance. It has been confirmed that quality, quantity and duration of sleep are three key components for a good sleep. A deep and uninterrupted sleep is important for a normal seafarer who wants to have a good performance at work (IMO, 2001). For most people, any less than five hours sleep can lead to drowsiness the next day. According to the Research of the US Coast Guard, people need 7-8 hours of sleep per 24-hours to perform at their best.

# 2 FATIGUE MONITORING METHODS

Most people are aware of the dangers of driver fatigue but our ability to recognize the signs diminishes as we become more fatigued. Therefore the monitoring of fatigue becomes very important for the prevention and reduction of the effect of fatigue. The researchers all over the world have proposed many methods and means for the monitoring of fatigue. Pan Xiaodong, Li Junxian (Pan and Li, 2011)developed a method to develop the driver s' fatigue based on the eye movement of the drivers; Sun Hui (Sun, 2013) introduced a algorithm for on-time fatigue monitoring based on electroencephalogram (EEG); Xiong Yunxia (Xiong, 2014) introduced a fatigue monitoring system based on pulse signal; Mao Zhe (Mao, 2006) developed a method for the recognition of fatigue based on the analysis of the physiological feature of the driver, such as blood pressure, body temperature, breathing frequency, etc..

As to the monitoring and assessment of seafarers' fatigue, the following methods were used: a questionnaire survey of working and rest hours, physical and mental health; Physiological assays assessing fatigue; Instrument recordings of sleep, ship motion, and noise; Self-report diaries recording sleep quality and work patterns; Objective assessments and subjective ratings of mental functioning; Pre- and post-tour assessments and Analysis of accident and injury data.

Even though many methods or techniques were developed to overcome the limitation of fatigue monitoring, there are still some disadvantages, among which inconvenience is the most serious one due to the size and procedure of the equipment used in these methods.

# 3 FATIGUE MONITORING BASED ON MI BAND

The miniaturization of electrical and electronic equipment is certainly not a new phenomenon, and its effects have long been evident in the healthcare sector. Wearable devices are of emerging interest due to their potential influence in certain aspects of modern healthcare practices, most notably in delivering point of care service, by providing remote monitoring, ambulatory monitoring within the healthcare environment, and support for rehabilitating patients, the chronically ill and the disabled. Among all these equipment, Smartband is the most famous one as it is very simple to operate by non medical professionals in uncontrolled environments.

## 3.1 Introduction of the device and the APP

In the research, Mi band is chosen as the monitoring device. Mi band is the wearable device produced by Xiaomi, a very popular Internet company in China. The band is composed of a military-grade accelerometer, a low-power Bluetooth chip, wristband and rechargeable battery. The data is stored in the band and can be synchronized if the band is connected with smart phone or tablet computer. The data can be stored in the band for 7 days if it is not synchronized to the smart phone.

The APP used in the experiment is Mi Fit which is developed by Xiaomi company. The APP is consisted of several elements, namely data collection unit, data storage unit, data analysis unit and share and feedback unit.

The users can access and read the data via the APP installed in a smart phone. The data is analyzed in the database, giving the result in the form of bar chart. The body movement is collected when the wearer is asleep and the wake-sleep situation can be indicated indirectly by measuring the motion state and amount of exercise continuously. Moreover, the data can be uploaded and stored in the Cloud if the phone is networked. As a new feature, the achievement of your exercise, as well as your sleep quantity and quality, can be shared with your friends via facebook, twitter and wechat.

## 4 DATA COLLECTION

The data collected by Mi Band includes sleep onset latency (SOL), wake after sleep onset (WASO), total sleep time (TST), deep sleep time (DST) and light sleep time (LST). The total sleep time, as well as percentage and distribution of deep sleep time and light sleep time, can be read directly in the APP, as shown in Figure 1. The statistic of these data can be stored and displayed for as long as 30 days, as shown in Figure 2. Moreover, deep sleep time can be demonstrated by bar chart in a

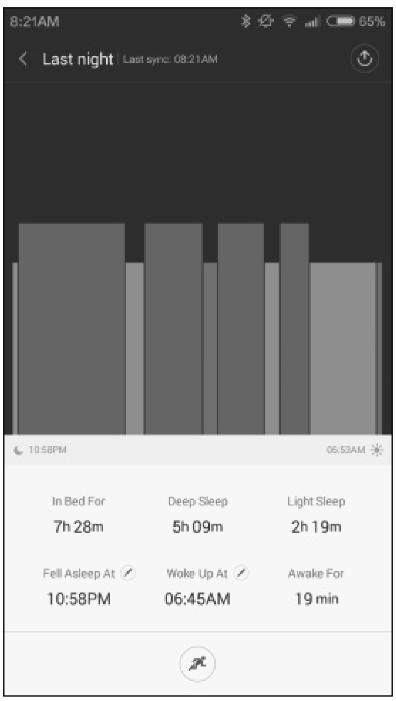


**Figure 1**
Total sleep time

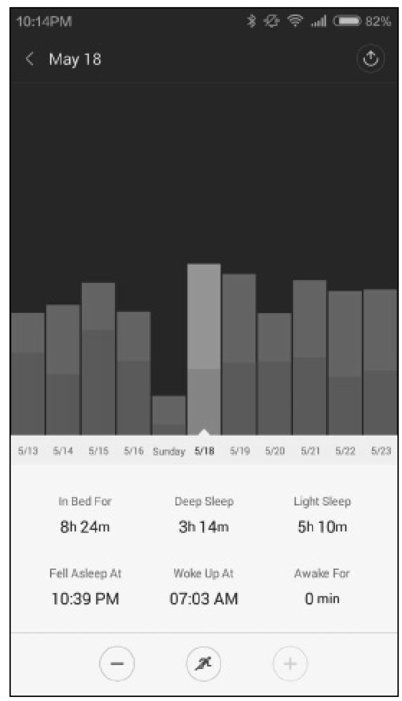


**Figure 2**
Record of sleep time for 11 days

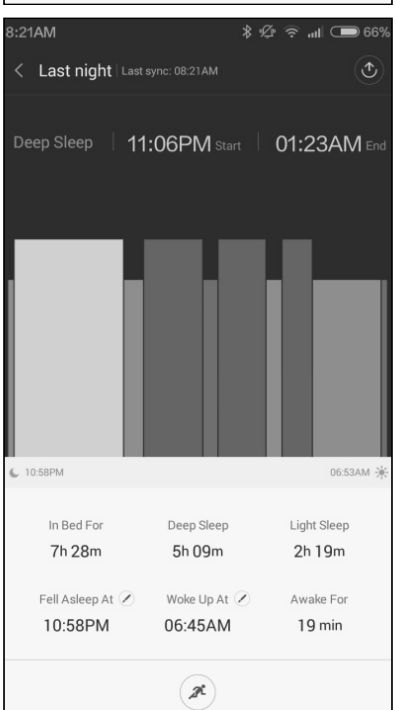


**Figure 3**
Distribution of deep sleep time

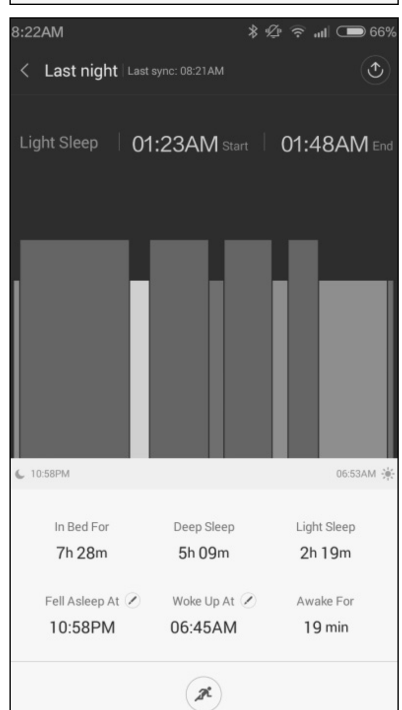


**Figure 4**
Distribution of light sleep time

daily basis, shown as Figure 3. Similarly, each light sleep time can be displayed by bar chart like Figure 4.

## 5 EXPERIMENT ON THE MONITORING OF SLEEP

### 5.1 Experiment setup

In the experiment, 2 vessels were selected and 12 ratings joined the experiment as volunteers, among whom 6 from deck department and 6 from engine department. During the experiment, each person should wear the Mi band the whole day for one week, even when taking a shower.

As a comparison, the volunteers were also asked to record and grade their sleep quality (SQ) in a daily basis. The value for each grade is within the interval of [0,100]. The grades for the sleep quality were divided into five levels $v_1$, $v_2$, $v_3$, $v_4$, $v_5$, namely very bad, bad, medium, good and very good, as shown in table 1. So the appraisal set is obtained as follows:

$$V= \{v_1, v_2, v_3, v_4, v_5\} =$$
$$\{ \text{very bad, bad, medium, good and very good} \}$$

**Table 1** levels of sleep quality

| Level | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ |
|---|---|---|---|---|---|
| Score | <60 | 60~70 | 70~80 | 80~90 | 90~100 |

### 5.2 Selection of indexes

According to Pittsburgh sleep quality index (PSQI), 7 important indexes were selected as the features for classification and prediction, which include sleep onset latency (SOL), wake after sleep onset (WASO), total sleep time (TST), sleep efficiency (SE, TST/(WASO+SOL+TST)), awake sleep ratio (ASR, WASO/TST), deep sleep time ratio (DSTR, DST/TST) and light sleep time ratio (LSTR, LST/TST).

### 5.3 Result and analysis

The result of sleep quality of each person can be demonstrated by a line chart, as shown in Figure 5. And the sleep quality of these 12 volunteers was classified, as shown in Figure 6. From the result, it is clear that the sleep quality of half of the volunteers were moderate.

As a comparison, some statistical analysis was done on the grades given by these volunteers. The analysis indicated that almost half of the volunteers thought their sleep quality were moderate, which is consistent with the data obtained by the Mi band. Therefore, it can be speculated that the Mi band can be used for the monitoring of seafarers' sleep and further for the evaluation of their fatigue degree.

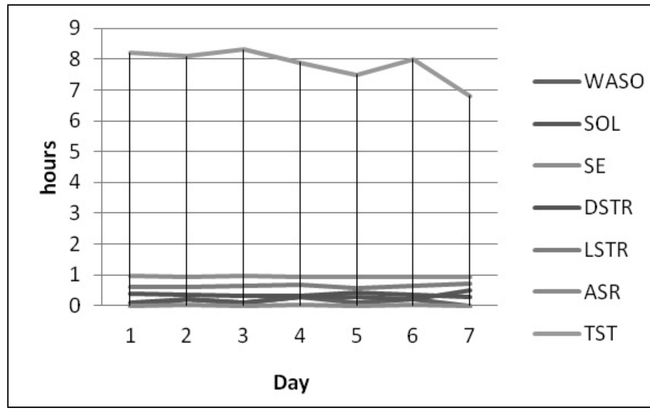


**Figure 5** Result of the indexes

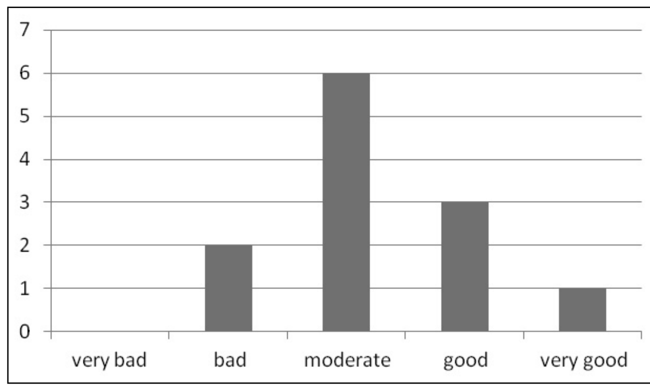


**Figure 6** Distribution of each level of sleep quality of volunteers

## 6 CONCLUSION

The paper tried to demonstrate that the Mi ban, a wearable device, can be used in the monitoring of seafarers' sleep and for the evaluation of their fatigue degree. By contrasting the data obtained by Mi band with the appraisal grade given by the volunteers in the experiment, it proved that the data obtained by the band has high accuracy.

However, there are still some problems as to the design of the experiment. Firstly, the number of volunteers is not large enough, which has weak persuasiveness on the result of the experiment. Secondly, the experiment time is not long enough. The experiment will be carried out for 30 days in the future research. Last but not least, more work still need to do on the principle for each level of sleep quality.

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# MARITIME TRAFFIC ANALYSIS OF THE IZMIT BAY BY IWRAP

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**Abstract.** Izmit Bay has a growing trade volume which result with increase in the vessel traffic and establishment of new ports. According to recent statistics, the amount of handled cargo is approximately 61 million tonnes. Due to its crucial geographical position, it is the most significant and the biggest natural bay in Turkey. Therefore, vessel condition, environmental factors and other navigational issues that influence risk has an important role in the region. A compulsory pilotage service is provided and VTS services about to commence. Heavy ferry traffic encounters with transit traffic, run from one side to other of the bay which create immense danger for cargo vessels. A suspension bridge construction commenced and will be completed soon to shorten travelling distance around the bay. Bridge construction and legs of the bridge narrowed the marine traffic lane at the entrance of the bay. Navigators have to struggle with the risks based on their own experience. Hence, VTS services intended to improve navigation safety and regulate maritime traffic. There are few major marine accidents in the past despite of increasing dense maritime traffic. Nevertheless, there are not many academic study focus on maritime traffic, navigational risk and risk mitigating counter measure in the region. In this study, probabilities of marine accidents that would influence safe of navigation in Izmit Bay are investigated by utilizing IALA Waterways Risk Assessment Program (IWRAP). IWRAP is a quantitative risk assessment model developed by IALA to quantify ship based risk by utilizing AIS data. Result of the study provide an understanding for dangerous parts of the bay in terms of collision and grounding probabilities.

**Key words:** Izmit Bay, maritime traffic, marine accident, IWRAP

## 1 INTRODUCTION

At present, 87, 6% percent of Turkey's foreign trade is carried out by maritime transportation. Hereby the commercial maritime transportation and ports consequently gained importance. In 2010, the total cargo handled in Turkish ports was about 115 million tonnes with an increase of 83% compared to 2003 and significant amount of the total cargo handled was import – export goods. Moreover, total amount of container transportation has increased up to 128% between 2003 and 2010 while the total amount in 2003 was 2.5 million TEU and 5.7 million TEU in 2010 (Erdoğan, 2011). Together with the 40 port management facilities and handling 62 million tons of cargo according to 2013 data, Izmit Bay has a significant share in these statistics.

Izmit Bay has a significant potential in terms of logistics sector due to its geographical position and also the city Kocaeli is the leading industrial centre in Turkey. The bay is geographically located between Istanbul and Kocaeli, it is also the east part of the Marmara Sea. The city of Kocaeli has a fairly significant role in Turkey's export and import because of the large hinterland in east and west directions which covers Kocaeli, Adapazarı and Istanbul. It is comprising various types of industries such as petroleum industry, automotive industry, clothing industry, pharmaceutical industry, chemical industry, cement industry, food industry and iron – steel industries etc (Bayraktutan & Özbilgin, 2013)

According to Eurostat statistics in 2011, Izmit is the $11^{th}$ largest port in EU along with 55 million tonnes of total goods handled in gross weight (Lund, 2013). In 2012 and 2013, the port has handled 61.4 and 61 million tonnes of cargo respectively which corresponds %15,86 of total cargo handled in Turkish ports per year according to statistics of Turkish Chamber of Shipping (Deniz Ticareti 2013 İstatistikleri, 2014).

Izmit bay has a significant role in maritime trade of Turkey with 40 port facilities for various type of cargo such as LPG, chemical tanker, container, 50 ship yards, 8 fishing vessel shelter and 6 marina. Each year more than 10 thousand ship call the bay and 180 thousand ship movement with dense crossing local traffic, creates high risky in terms of navigational safety (Yurtören, Aydoğdu , Seta, & Atasoy, 2014). Hence due to the importance of Izmit Bay, in this research IWRAP Mk2 has been utilized to analyse the maritime traffic in the Izmit Bay for the commencement of Vessel Traffic Service (VTS) in the area. In 2014, the first Ports and Waterways Safety Assessment (PAWSA) workshop was held in Izmit and this IWRAP research is intended to be a crosscheck of PAWSA results.

In the literature, there are numerous number of academic studies regarding Golcuk earthquake and environmental pollution in Izmıt Bay. For instance Reilinger et al. (1999) conducted a study to predict ground motions arising from aftershock seismic activity with using GPS monitoring and elastic half-space model (Reilinger, et al., 2000). Barka (1999) tried to find out the Characteristics and background of Golcuk Eatrhquake and made an estimation about ground motions after the earthquake (Barka, 1999).

Deger et al. analysed the ground motions and its effects then detected the slimming plates of earth crust (Ozbakır, Ozeren, Ergintav, & Karabulut, 2014). On the other hand, Pekey et al. (2004) conducted a study about ecological risk assessment in Izmit Bay (Pekey, Karataş, Ayberk, Tolun, & Bakoğlu, 2004).

While it's possible to extend the list of such studies, there is just one study in the literature regarding maritime traffic of Izmit Bay. Yurtoren el al. (2014) conducted a study to analyse maritime traffic by using Automatic Identification System (AIS) data via Environmental Stress (ES) model (Yurtören, Aydoğdu , Seta, & Atasoy, 2014). There is no any other study available in the literature about Izmit Bay concerning maritime traffic, ship accidents or navigational safety issues. In this study, we aimed to determine the yearly probability of collision and grounding by using IWRAP (IALA Waterways Risk Assessment Program) via AIS data which has taken from Directorate General of Coastal Safety in 2014. And then analyse the bottleneck of maritime traffic to provide an insight to maritime authority, VTS and suggest counter measures for enhancement of the maritime traffic.

## 2 AIS (AUTOMATIC IDENTIFICATION SYSTEM) AND IWRAP

Risk analysis in maritime traffic is a necessity due to the extremely high risks involved. Determining and taking precautions of two main accident type which are grounding and collision has a fatal importance for ensuring safety at seas.

Before AIS was developed, ship tracks were plotted via radar images. Those images were used to determine traffic flow and traffic density in a specific area. This method is no longer used in conjunction with technological advances. Developing Automatic Identification System (AIS) was a milestone in risk analysis of maritime traffic.

AIS is the most reliable system to provide ship position and ship dynamic data with the current technology that use in maritime (Yurtören, Aydoğdu , Seta, & Atasoy, 2014). All ships over 300 gross tonnes which are navigating in international waters, all ships over 500 gross tonnes which are navigating inland waters and all passenger ships regardless of their tonnage must carry AIS in accordance with the regulations (IMO, 2014).

AIS is a system that came in to force as a result of IMO's (International Maritime Organization) performance advices in 1997. AIS is a transponder system working on VHF band. This system includes three types of information which are static, dynamic and voyage related information of the ship. IMO and MMSI (Maritime Mobile Service Identity) numbers, ship's call sign and name, type of the ship, length and beam, location of position fixing antenna such as GPS/DGPS static information. Time of signal transmit in UTC, course over ground, speed over ground, heading, navigational status (Not under command, constrained by draught, etc) are dynamic information. Ship's draught, type of cargo, destination port and ETA to destination port, number of persons on board, route plan-waypoints (optional) are voyage related information. (Mokhtari, Wall, Brooks, & Wang, 2007). The system automatically transmits those information to shore and other ships around. IMO's AIS resolutions are intended for ensuring safe navigation, environmental protection and integrating ships to Vessel Traffic Service Systems (VTSS) (Yurtören, Aydoğdu, Seta, & Atasoy, 2014).

The AIS was used in many risk assessment studies since it has first been utilized because of its usefull and reliable information. For instance Commander Brian J. Tetreault (United States Coast Guard ) conducted a study about enhancing maritime safety and security by enhancing Maritime Domain Awareness (MDA) by using AIS tracking (Tetreault, 2005). Kurt D. Schwehr and Philip A. McGillivary analysed the contribution of AIS to oil-spill tracking and pollution monitoring (Schwehr & McGillivary, 2007). Moreover, Ingo Harre conducted a study about AIS, described the genesis of the systems, their operational and technical aspects, discussed the standard and extended applications and also its potential (Harre, 2000). In 2009, Heather M. Perez et al. analysed Texas State waters in terms of marine vessels emission estimation by using Automatic Identification System (AIS) (Perez, Chang, Billings, & Kosub, 2009). Along with the usefull and reliable data, it was inevitable to use AIS data on maritime traffic analyses.

The IALA working group was tasked to develop a generic port and waterway risk assessment model capable of being adapted for use in any specific port or waterway. In January 2002, Minimum Safe Distance" (MSD) tool was represented but there were some missing parts of this tool because the tool was not capable of calculating the collision and grounding probabilities in a specific waterway. In 2004 IWRAP Mk1 was developed as a result of these needs. IWRAP Mk I had been tested on the Straights of Bosporus, Tampa Bay, and parts of the St. Lawrence River but the results were not realistic and much higher than actual accident statistics in those Bays. In 2008 IALA developed and validated IWRAP Mk2 which was based on BaSSy ToolBox (GRISK). IWRAP Mk2 is capable of taking into account the risk reduction effect of Aids to Navigation and gives satisfactory results (IALA, 2009).

IWRAP is a quantitative safety assessment model which enables user to conceive yearly collision and grounding frequencies of a selected waterway. IWRAP software is recommended by International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) and approved by IMO.

IWRAP utilize AIS data to calculate yearly collision and grounding frequencies. While calculating these, IWRAP uses mathematical equations and Bayesian Belief Network (BBN).

At present the main approach used for static collision probability assessment is rooted in the researches carried in the 1970s by Fujii et al. (Fujii, Yamanouchi, & Mizuki, 1974) and MacDuff (MacDuff, 1974). According to this researchs, the probability of a collision is defined as follows:

$$N_o = N_G \times P_C \tag{1}$$

In the equation, $N_o$ stands for "Frequency of Collision", $N_G$ is the number of candidates that are geometrically on a collision course and $P_C$ is "Causation factor" which means the probability of falling to avoid a collision while on a collision course.

## 2.1 Crossing Collision

Determining the collision canditates ($N_G$) while crossing is calculated via formula given below (Friis-Hensen, 2008):

$$N_G^{crossing} = \sum_{i,j} \frac{Q_i^{(1)} Q_j^{(2)}}{V_i^{(1)} V_j^{(2)}} D_{ij} V_{ij} \frac{1}{\sin\theta} \quad for\ 10^0 < |\theta| < 170^0 \tag{2}$$

$Q_i^{(1)}$ is number of movements of ship class $i$ in the selected period of waterway 1.

$Q_j^{(2)}$ is number of movements of ship class $j$ in the selected period of waterway 2.

The ship in waterway 1 is approaching the ship in waterway 2 with the relative speed of $V_{ij.}$

$$V_{ij} = \sqrt{\left(V_i^{(1)}\right)^2 + \left(V_j^{(2)}\right)^2 - 2V_i^{(1)} V_j^{(2)} \cos\theta} \tag{3}$$

$V_i^{(1)}$ = Velocity of ship class $i$ in waterway 1
$V_j^{(2)}$ = Velocity of ship class $j$ in waterway 2
θ = The crossing angle between two waterways

$D_{ij}$ is the geometrical collision diameter shown in (4):

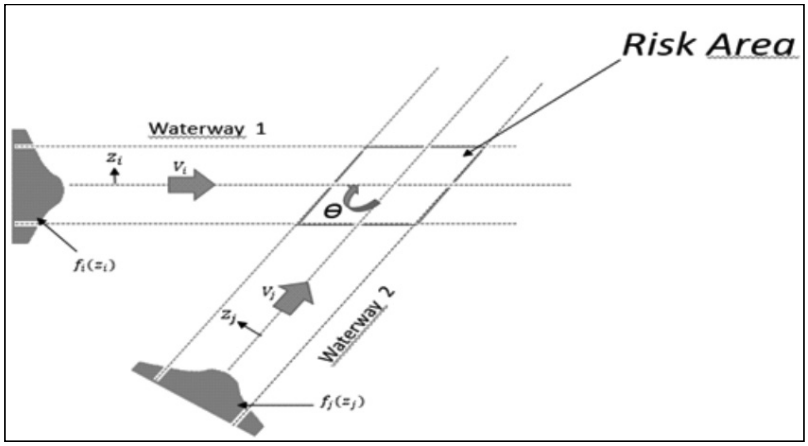



**Figure 1** Crossing Waterways Risk Area

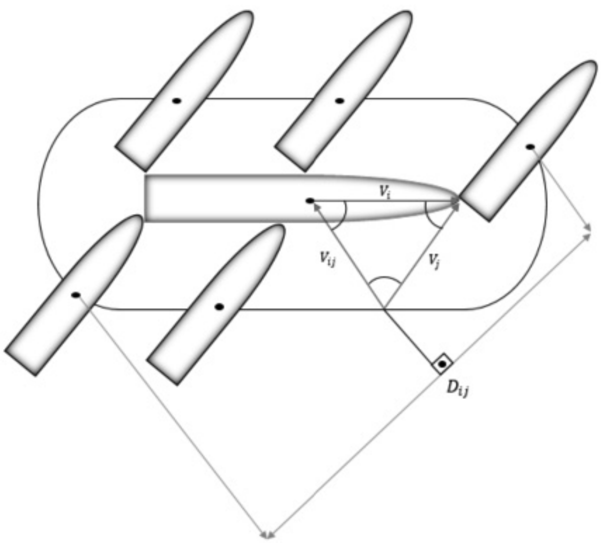


**Figure 2** Geometrical Collision Diameter $D_{ij}$

$$D_{ij} = \frac{L_i^{(1)}V_j^{(2)} + L_j^{(2)}V_i^{(1)}}{V_{ij}} sin\theta + B_j^{(2)} \left\{1 - \left(sin\theta \frac{V_i^{(1)}}{V_{ij}}\right)^2\right\}^{1/2}$$

$$+ B_i^{(1)} \left\{1 - \left(sin\theta \frac{V_j^{(2)}}{V_{ij}}\right)^2\right\}^{1/2} \quad (4)$$

$L_i^{(1)}$ = Length of vessel class *i* in waterway 1
$L_j^{(2)}$ = Length of vessel class *j* in waterway 2
$B_i$ = Breadth of vessel class *i* in waterway 1
$B_j$ = Breadth of vessel class *j* in waterway 2

## 2.2 Head on Collision

The number of head on collision candidates is calculated below (Friis-Hensen, 2008):

$$N_G^{head-on} = Lw \sum_{i,j} P_{G_{i,j}}^{head-on} \frac{V_{i,j}}{V_i^{(1)}V_j^{(2)}} \left(Q_i^{(1)}Q_j^{(2)}\right) \quad (5)$$

$L_w$ = Length of the waterway

$$P_{G_{i,j}}^{head-on} = \Phi\left(\frac{B_{i,j} - \mu_{i,j}}{\sigma_{i,j}}\right) - \Phi\left(-\frac{B_{i,j} + \mu_{i,j}}{\sigma_{i,j}}\right) \quad (6)$$

$\Phi$ = Standard normal distribution function.
$P_{Gi,j}$ = Probability of two ships colliding each other in a head on situation
$\mu_{ij} = \mu_i + \mu_j$ is the mean sailing distance between two ships passing the waterway.
$\sigma_{ij} = (\sigma_i + \sigma_j)^{1/2}$ is the standart deviation from the joint distribution.

$B_{ij} = \frac{Bi+Bj}{2}$ is the average vessel breadth.

## 2.3 Overtaking Collision

The relative speed between two vessels in overtaking situation is given below:

$$V_{ij} = V_i^{(1)} - V_j^{(2)} \quad (7)$$

$$P_{G_{i,j\,(overtaking)}} = P\left[y_i^{(1)} - y_j^{(1)} < \frac{B_i^{(1)} + B_j^{(1)}}{2}\right] -$$

$$- P\left[y_i^{(1)} - y_j^{(2)} < -\frac{B_i^{(1)} + B_j^{(1)}}{2}\right] \quad (8)$$

For normally distributed traffic $\mu_{ij} = \mu_i - \mu_j$ number of overtaking collision candidates is calculated as if they are head – on collision (Friis-Hensen, 2008).

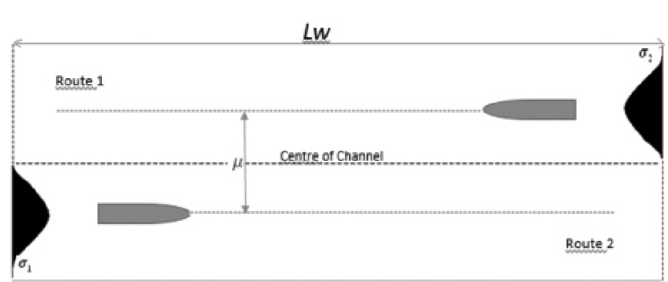



**Figure 3** Parallel Waterways

### 2.4 Merging and Bending Collisions

A merging collision is a type of crossing collision but ship tracks have the probability of 0.5 to intersect. A bend collision occurs when the vessel do not turn at a bend of a waterway and come come across with another vessel at a collision course. The probability of bending collision is only 0.01 (Friis-Hensen, 2008).

### 2.5 Causation Factor

Causation probability can be estimated in two ways, these are the scenario approach and synthesis approach. Scenario approach is used if the probability is calculated on the basis of available accident data. The advantages of scenario approach are its simplicity and related robustness. In synthesis approach, specified error situations are supposed to occur in the vessel. They may cause an accident if they take place before or at the same time with the critical situation. Probability of those error situations are found by application of a Bayesian Belief network or by the use of a fault tree (Kujala, Hanninen, Arola, & Ylitalo, 2009).

The Causation Factor $P_c$ is a factor which accident candidates has to be multiplied with to find estimated frequency of maritime accidents. The causation factor can be estimated via two methods which are scenario-based approach and Bayesian Belief Network (BBN) respectively (Trucco, Cagno, Ruggeri, & Grande, 2008).

$$P_C = \frac{N_C}{N_T} \tag{9}$$

$N_C$= Number of maritime accidents calculated for a selected period (eg. 5 years)
$N_T$= Number of maritime traffic in the selected period.

The study carried out by *Kwang İl Kim* and others shows that the causation factors in Mokpo waterway in the period of 2006 – 2010 are 8.4 × $10^{-5}$, 8.1 × $10^{-5}$, 7.1 × $10^{-5}$, 9.3 × $10^{-5}$, 1.7 × $10^{-5}$ respectively and total average causation factor in this selected period is found 6.4 × $10^{-5}$ (Kim, Park, & Jeong, 2011).

According to Kocaeli Port Authority Reports, there have been two collision accidents in Izmit Bay in the five year period 2009 to 2013 and in the same period, total ship moves was about 900.000.

According to formula, the collision causation factor for Izmit bay is found to be 2/900.000 = 2,22 × $10^{-6}$

## 3 APPLICATION OF IWRAP TO IZMIT BAY

In order to analyse maritime traffic and the accident probabilities in Izmit Bay, the IALA Waterways Risk Assessment Program (IWRAP) tool has been utilized. The data of all vessels were collected via AIS. 3 months of AIS data has been obtained from General Directive of Coastal Safety Authority. Due to the size of the area and the number of ships and ship movements, three days of AIS data which correspond to 1.3 million data has been utilized in the study.

### 3.1 Research Area

Izmit Bay is geographically located between Istanbul and Kocaeli, it is also the eastern part of the Marmara Sea (Figure 4).

### 3.2 Investigation of Maritime Traffic

Yearly total number of ships visiting Izmit Bay is given with the Table 1.

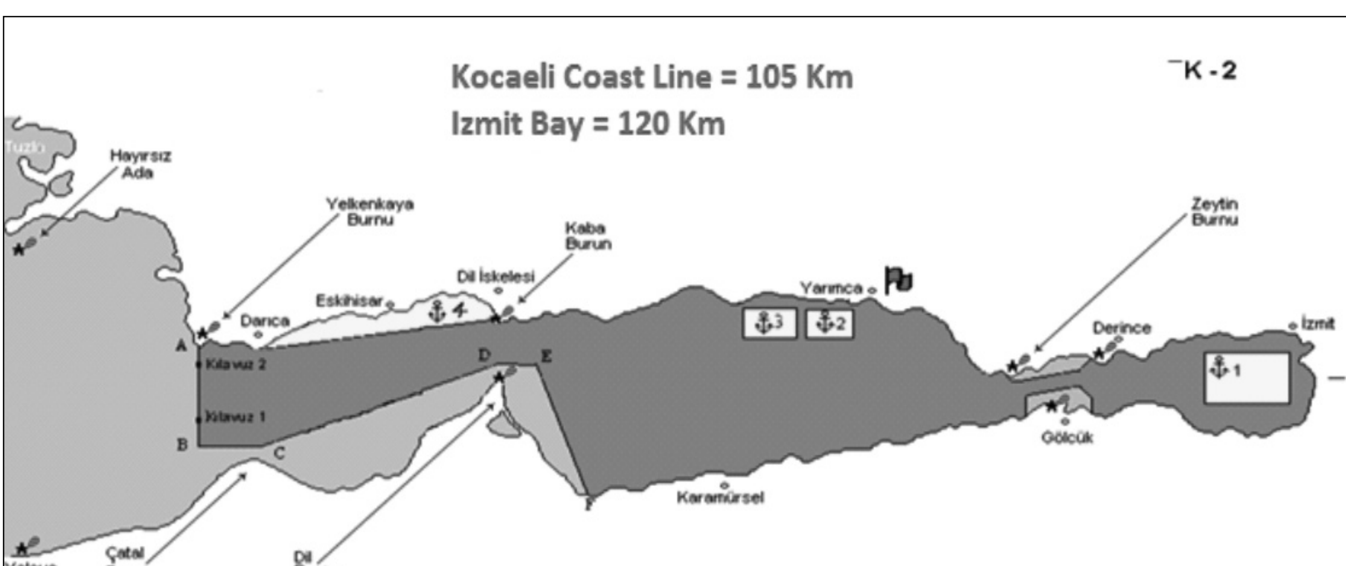



**Figure 4** Izmit Bay

**Table 1** Annual Ship Counts of Kocaeli Ports (Kocaeli Harbour Master, 2014)

| Kocaeli Harbour Master<br>Annual Ship Counts of Kocaeli Ports | | | | | | |
|---|---|---|---|---|---|---|
| **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| 13.237 | 12.457 | 11.575 | 11.133 | 10.573 | 10.644 | 10.627 |

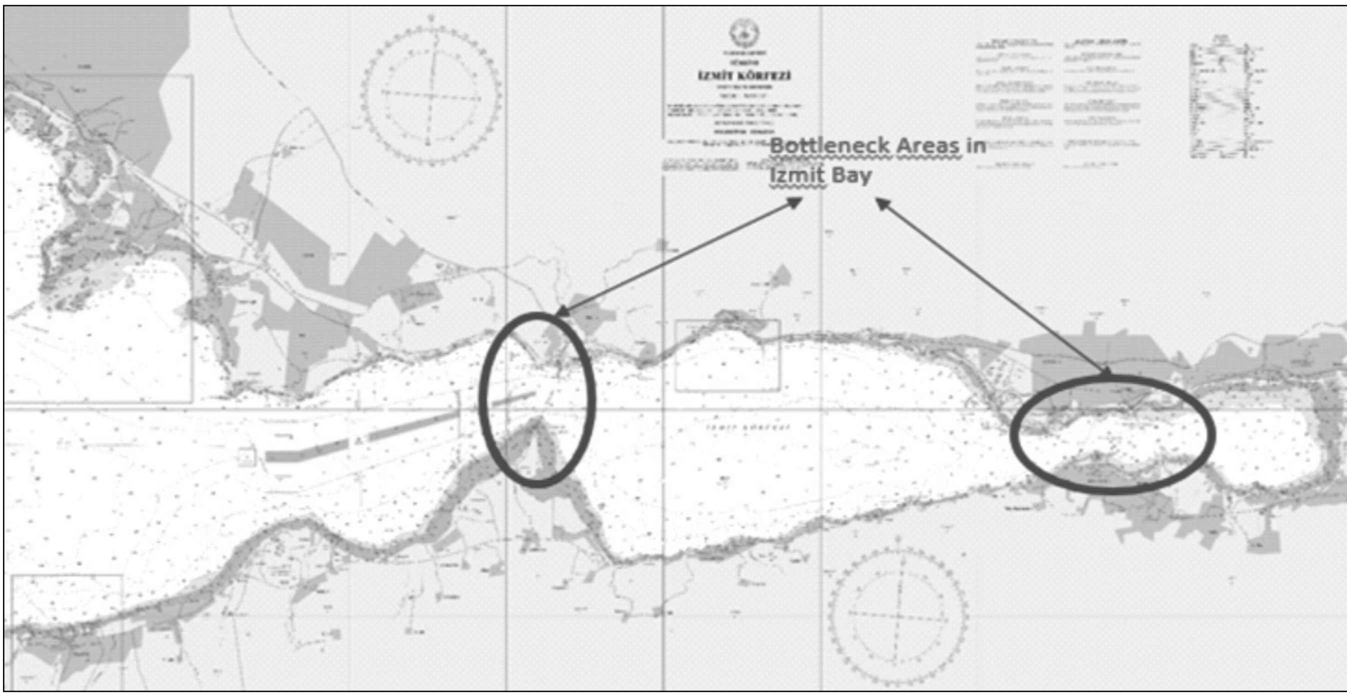



**Figure 5** Izmıt Bay Bottleneck Areas

The number of annual ship movements in Izmit Bay is more than 180.000 together with the local traffic (Yurtören, Aydoğdu, Seta, & Atasoy, 2014). This huge traffic flow, creates a dense traffic in bottleneck areas especially in Kaba burun – Dil burnu and Zeytin Burnu – Derince – Gölcük.

In order to calculate the probability of collisions and groundings, navigation legs which are very similar to waypoints had to be created and then in each leg, density of traffic flow has been calculated by IWRAP.

In figure 6, created legs for scenario 20 and the density of traffic flow on each leg is shown.

After creating legs the IWRAP calculates the density of traffic flow and incident probabilities and based on this calculation, program calculates probability of collisions and groundings.

The program calculates crossing, overtaking, head on, merging and bending collisions and probability of groundings as well.

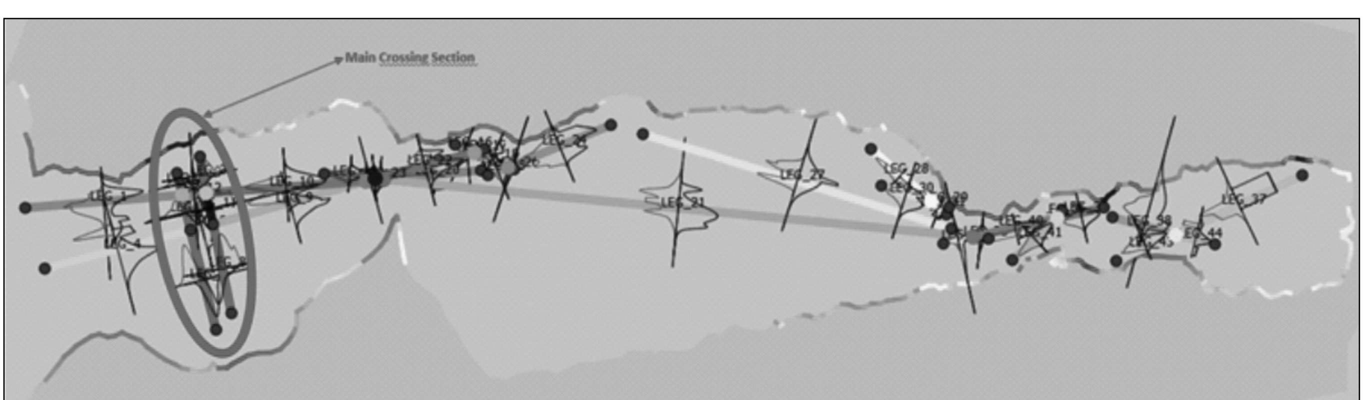



**Figure 6** Main Crossing Section and Traffic Density in scenario 20

IWRAP has been utilized with 30 different leg scenarios. Mean value of this 30 scenario has been taken. Two of them has been shown in the research as an example (Figure 7 and Table 2, 3).

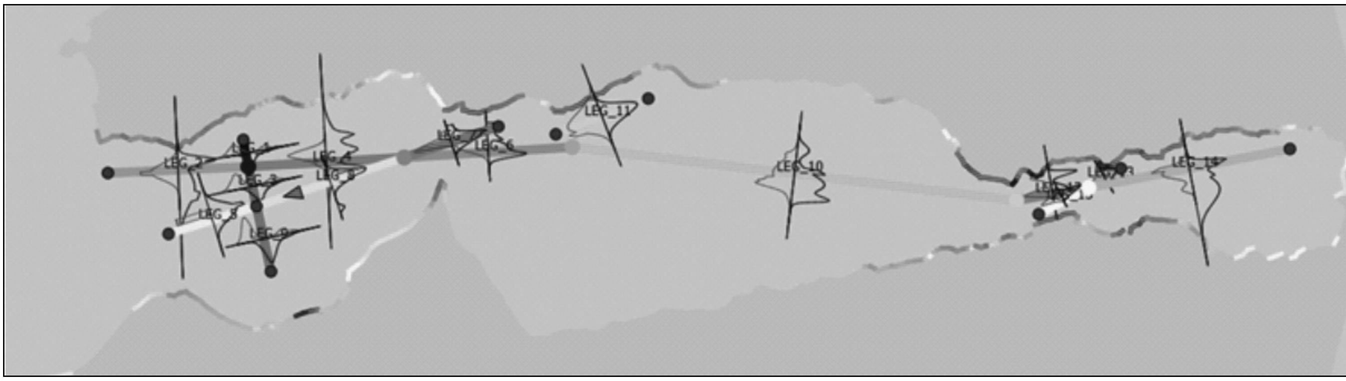


**Figure 7** IWRAP Scenario 10. Distribution of Legs

**Table 2** IWRAP Scenario 10 Results

| | Izmit 10 Unit | |
|---|---|---|
| Powered Grounding | 1,3965 | Incidents/Year |
| Drifting Grounding | 0,358 | Incidents/Year |
| **Total Groundings** | **1,754** | **Incidents/Year** |
| Overtaking | 0,0769 | Incidents/Year |
| Head On | 0,161 | Incidents/Year |
| Crossing | 0,041 | Incidents/Year |
| Merging | 0,0088 | Incidents/Year |
| Bend | 0,0251 | Incidents/Year |
| **Total Collisions** | **0,313** | **Incidents/Year** |

**Table 3** IWRAP Scenario 20 Results

| | Izmit 20 Unit | |
|---|---|---|
| Powered Grounding | 1,893 | Incidents/Year |
| Drifting Grounding | 0,371 | Incidents/Year |
| **Total Groundings** | **2,264** | **Incidents/Year** |
| Overtaking | 0,0544 | Incidents/Year |
| Head On | 0,149 | Incidents/Year |
| Crossing | 0,0374 | Incidents/Year |
| Merging | 0,015 | Incidents/Year |
| Bend | 0,0036 | Incidents/Year |
| **Total Collisions** | **0,2599** | **Incidents/Year** |

The main ship crossing section is between Eskihisar and Topcular. Local ferry traffic and the inbound – outbound ships traffic intersect in this area. While total annual crossing collision number is 0,291 according to IWRAP scenarios in Izmit Bay, 0,166 of these collisions occur in the area between Eskihisar and Topcular.

While scenario 10 results are relatively higher than scenario 20 in terms of yearly collision numbers with 0.313 to 0.259, scenario 20 clearly indicates more groundings compared to scenario 10 with 2,264 groundings to 1,754.

To make a clear vision of total annual grounding and collision numbers, 30 different scenarios with different leg distributions are created and IWRAP utilized. Mean value of those different scenarios has been taken as a final result of IWRAP.

Created scenarios result table is shown in the graph below. IWRAP has been utilized with 1.3 million data which covers 3 days of ship movement data. The only difference between scenarios are leg distributions which is illustrated before by the example scenarios 10 and 20 (Table 4).

**Table 4** Different Leg Scenarios and results table

| Scenario Number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Powered Grounding | 1,286 | 1,413 | 1,745 | 1,585 | 1,519 | 1,984 | 1,619 | 1,427 | 1,739 | 1,396 |
| Drifting Grounding | 0,312 | 0,462 | 0,421 | 0,364 | 0,343 | 0,298 | 0,386 | 0,302 | 0,398 | 0,358 |
| **Total Groundings** | **1,598** | **1,875** | **2,166** | **1,949** | **1,862** | **2,282** | **2,005** | **1,729** | **2,137** | **1,754** |
| Overtaking | 0,067 | 0,052 | 0,085 | 0,053 | 0,075 | 0,048 | 0,085 | 0,068 | 0,063 | 0,077 |
| Head On | 0,154 | 0,163 | 0,148 | 0,155 | 0,167 | 0,163 | 0,145 | 0,147 | 0,136 | 0,161 |
| Crossing | 0,038 | 0,041 | 0,046 | 0,038 | 0,021 | 0,031 | 0,028 | 0,048 | 0,043 | 0,041 |
| Merging | 0,006 | 0,012 | 0,018 | 0,032 | 0,013 | 0,020 | 0,018 | 0,021 | 0,013 | 0,008 |
| Bending | 0,021 | 0,018 | 0,033 | 0,022 | 0,043 | 0,038 | 0,020 | 0,012 | 0,023 | 0,025 |
| **Total Collisions** | **0,286** | **0,286** | **0,33** | **0,3** | **0,319** | **0,3** | **0,296** | **0,296** | **0,278** | **0,313** |

| Scenario Number | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| Powered Grounding | 1,562 | 1,894 | 1,256 | 1,764 | 1,347 | 1,614 | 1,473 | 1,198 | 1,374 | 1,893 |
| Drifting Grounding | 0,385 | 0,414 | 0,347 | 0,462 | 0,276 | 0,384 | 0,265 | 0,482 | 0,289 | 0,371 |
| **Total Groundings** | **1,947** | **2,308** | **1,603** | **2,226** | **1,623** | **1,998** | **1,738** | **1,68** | **1,663** | **2,264** |
| Overtaking | 0,081 | 0,054 | 0,058 | 0,071 | 0,076 | 0,049 | 0,061 | 0,067 | 0,048 | 0,054 |
| Head On | 0,153 | 0,128 | 0,174 | 0,143 | 0,138 | 0,164 | 0,161 | 0,149 | 0,151 | 0,149 |
| Crossing | 0,051 | 0,033 | 0,022 | 0,03 | 0,034 | 0,028 | 0,043 | 0,046 | 0,039 | 0,037 |
| Merging | 0,028 | 0,022 | 0,019 | 0,024 | 0,031 | 0,024 | 0,017 | 0,019 | 0,016 | 0,015 |
| Bending | 0,032 | 0,038 | 0,033 | 0,029 | 0,031 | 0,048 | 0,037 | 0,031 | 0,028 | 0,0036 |
| **Total Collisions** | **0,345** | **0,275** | **0,306** | **0,297** | **0,31** | **0,313** | **0,319** | **0,312** | **0,282** | **0,258** |

| Scenario Number | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|
| Powered Grounding | 1,598 | 1,547 | 1,657 | 1,958 | 2,021 | 1,252 | 1,542 | 1,478 | 1,638 | 1,427 |
| Drifting Grounding | 0,326 | 0,399 | 0,344 | 0,452 | 0,452 | 0,305 | 0,256 | 0,359 | 0,366 | 0,341 |
| **Total Groundings** | **1,924** | **1,946** | **2,001** | **2,41** | **2,473** | **1,557** | **1,798** | **1,837** | **2,004** | **1,768** |
| Overtaking | 0,064 | 0,086 | 0,081 | 0,057 | 0,054 | 0,063 | 0,052 | 0,028 | 0,056 | 0,086 |
| Head On | 0,121 | 0,137 | 0,182 | 0,166 | 0,142 | 0,155 | 0,157 | 0,138 | 0,152 | 0,175 |
| Crossing | 0,033 | 0,040 | 0,025 | 0,026 | 0,036 | 0,039 | 0,036 | 0,039 | 0,035 | 0,033 |
| Merging | 0,022 | 0,020 | 0,027 | 0,016 | 0,013 | 0,018 | 0,022 | 0,031 | 0,024 | 0,026 |
| Bending | 0,034 | 0,022 | 0,013 | 0,031 | 0,029 | 0,033 | 0,022 | 0,024 | 0,034 | 0,037 |
| **Total Collisions** | **0,274** | **0,305** | **0,328** | **0,296** | **0,274** | **0,308** | **0,27** | **0,26** | **0,301** | **0,357** |

**Table 5** Total Mean Values of 30 Scenarios

| **Total Mean Values of 30 Scenarios** | |
|---|---|
| Mean Powered Groundings | 1,573 |
| Mean Drifting Groundings | 0,364 |
| **Total Mean Groundings** | **1,937** |
| Mean Overtaking Collisions | 0,0639 |
| Mean Head On Collisions | 0,1524 |
| Mean Crossing Collisions | 0,036 |
| Mean Merging Collisions | 0,0204 |
| Mean Bending Collisions | 0,0281 |
| **Total Mean Collisions** | **0,3** |

After scenarios created, mean value of all scenarios has been taken as final result. Mean value has been found for groundings as 1,937 and for collisions as 0,3 per year.

After completing 30 scenarios, we created a separate scenario pack with 5 different scenarios in terms of leg distribution and those scenarios include only the Eskihisar – Topcular area. As shown in the figure below, approximately 60% of the collision incidents and about 80% of groundings occur in this specific area.

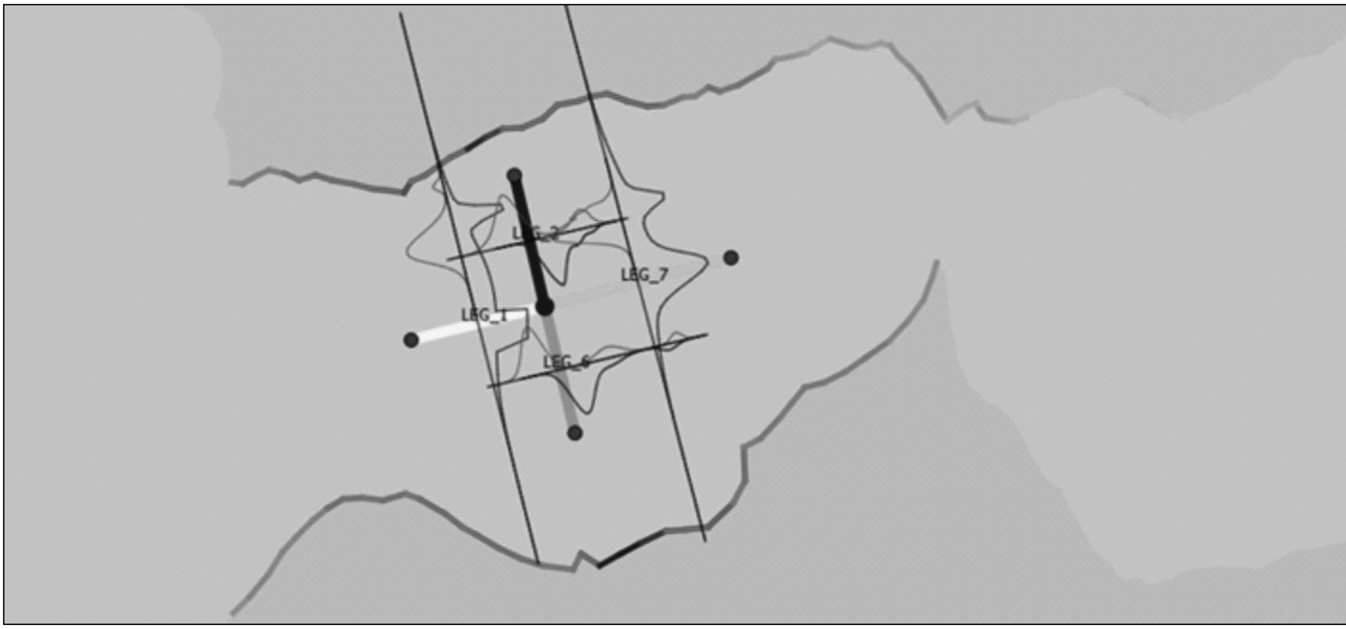



**Figure 8** IWRAP Scenario 31 Eskihisar – Topcular. Distribution of Legs

**Table 6** IWRAP Scenario 31 Results

| | Izmit 31 Unit | |
|---|---|---|
| Powered Grounding | 1,665 | Incidents/Year |
| Drifting Grounding | 0,069 | Incidents/Year |
| **Total Groundings** | **1,734** | **Incidents/Year** |
| Overtaking | 0,0538 | Incidents/Year |
| Head On | 0,108 | Incidents/Year |
| Crossing | 0,004 | Incidents/Year |
| Merging | 0 | Incidents/Year |
| Bend | 0 | Incidents/Year |
| **Total Collisions** | **0,166** | **Incidents/Year** |

In order to find mean value for Eskihisar-Topcular area, 5 scenarios with different leg distributions have been utilized. Results are below (Table 7):

**Table 7** IWRAP Scenarios Eskihisar-Topcular Results

| | | | Scenario Number | | |
|---|---|---|---|---|---|
| | **31** | **32** | **33** | **34** | **35** |
| Powered Grounding | 1,665 | 1,548 | 1,475 | 1,746 | 1,697 |
| Drifting Grounding | 0,069 | 0,073 | 0,056 | 0,064 | 0,076 |
| **Total Groundings** | **1,734** | **1,621** | **1,531** | **1,81** | **1,773** |
| Overtaking | 0,0538 | 0,0474 | 0,0615 | 0,0674 | 0,0463 |
| Head On | 0,108 | 0,097 | 0,136 | 0,112 | 0,101 |
| Crossing | 0,004 | 0,011 | 0,002 | 0,005 | 0,003 |
| **Total Collisions** | **0,166** | **0,1554** | **0,1995** | **0,1844** | **0,1503** |

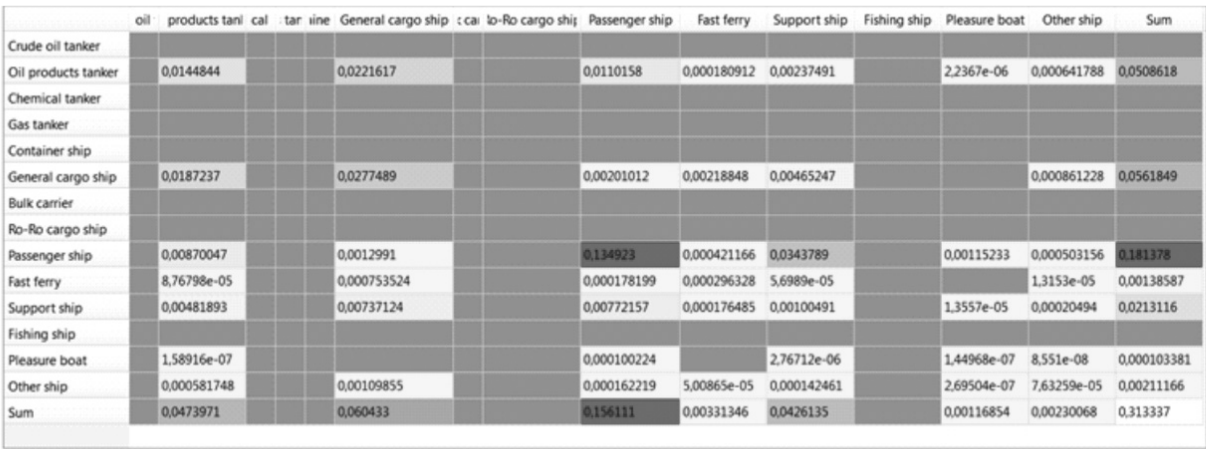
Mean value of Eskihisar-Topcular area with 5 scenarios is found 0,171 collisions per year and 1,693 groundings per year.

Looking at the real accident numbers taken from Kocaeli Harbour Master reports, while collision frequencies matchs up with IWRAP results, grounding frequencies are slightly different.

**Table 8** Izmit Harbour Master Accident Statistics

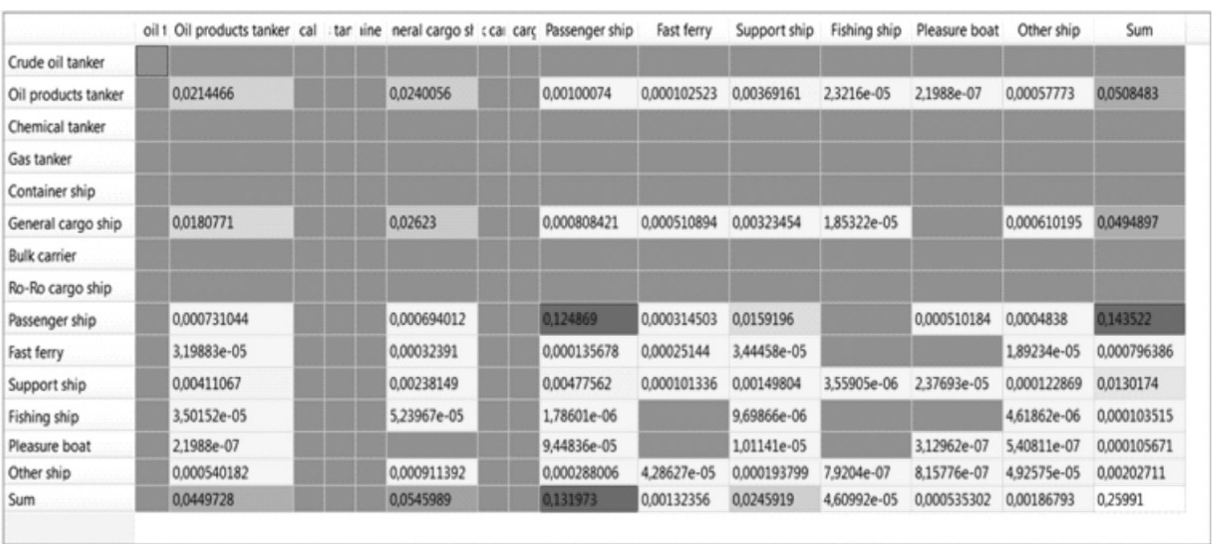
| Izmit Harbour Master Accident Statistics (2009-2013) | | | | | | |
|---|---|---|---|---|---|---|
| | **2009** | **2010** | **2011** | **2012** | **2013** | **Total** |
| Collision | - | 1 | - | - | 1 | 2 |
| Groundings | - | 2 | - | - | - | 2 |

In ship-ship result table of IWRAP, we can see the collision candidates by its type (Figures 9, 10).



| | oil | products tanl | cal | tar | ine | General cargo ship | cai | o-Ro cargo shi | Passenger ship | Fast ferry | Support ship | Fishing ship | Pleasure boat | Other ship | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crude oil tanker | | | | | | | | | | | | | | | |
| Oil products tanker | | 0,0144844 | | | | 0,0221617 | | | 0,0110158 | 0,000180912 | 0,00237491 | | 2,2367e-06 | 0,000641788 | 0,0508618 |
| Chemical tanker | | | | | | | | | | | | | | | |
| Gas tanker | | | | | | | | | | | | | | | |
| Container ship | | | | | | | | | | | | | | | |
| General cargo ship | | 0,0187237 | | | | 0,0277489 | | | 0,00201012 | 0,00218848 | 0,00465247 | | | 0,000861228 | 0,0561849 |
| Bulk carrier | | | | | | | | | | | | | | | |
| Ro-Ro cargo ship | | | | | | | | | | | | | | | |
| Passenger ship | | 0,00870047 | | | | 0,0012991 | | | 0,134923 | 0,000421166 | 0,0343789 | | 0,00115233 | 0,000503156 | 0,181378 |
| Fast ferry | | 8,76798e-05 | | | | 0,000753524 | | | 0,000178199 | 0,000296328 | 5,6989e-05 | | | 1,3153e-05 | 0,00138587 |
| Support ship | | 0,00481893 | | | | 0,00737124 | | | 0,00772157 | 0,000176485 | 0,00100491 | | 1,3557e-05 | 0,00020494 | 0,0213116 |
| Fishing ship | | | | | | | | | | | | | | | |
| Pleasure boat | | 1,58916e-07 | | | | | | | 0,000100224 | | 2,76712e-06 | | 1,44968e-07 | 8,551e-08 | 0,000103381 |
| Other ship | | 0,000581748 | | | | 0,00109855 | | | 0,000162219 | 5,00865e-05 | 0,000142461 | | 2,69504e-07 | 7,63259e-05 | 0,00211166 |
| Sum | | 0,0473971 | | | | 0,060433 | | | 0,156111 | 0,00331346 | 0,0426135 | | 0,00116854 | 0,00230068 | 0,313337 |

**Figure 9** IWRAP Scenario 10 Detailed Schema



| | oil t | Oil products tanker | cal | tar | ine | neral cargo sl | cai | carg | Passenger ship | Fast ferry | Support ship | Fishing ship | Pleasure boat | Other ship | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crude oil tanker | | | | | | | | | | | | | | | |
| Oil products tanker | | 0,0214466 | | | | 0,0240056 | | | 0,00100074 | 0,000102523 | 0,00369161 | 2,3216e-05 | 2,1988e-07 | 0,00057773 | 0,0508483 |
| Chemical tanker | | | | | | | | | | | | | | | |
| Gas tanker | | | | | | | | | | | | | | | |
| Container ship | | | | | | | | | | | | | | | |
| General cargo ship | | 0,0180771 | | | | 0,02623 | | | 0,000808421 | 0,000510894 | 0,00323454 | 1,85322e-05 | | 0,000610195 | 0,0494897 |
| Bulk carrier | | | | | | | | | | | | | | | |
| Ro-Ro cargo ship | | | | | | | | | | | | | | | |
| Passenger ship | | 0,000731044 | | | | 0,000694012 | | | 0,124869 | 0,000314503 | 0,0159196 | | 0,000510184 | 0,0004838 | 0,143522 |
| Fast ferry | | 3,19883e-05 | | | | 0,00032391 | | | 0,000135678 | 0,00025144 | 3,44458e-05 | | | 1,89234e-05 | 0,000796386 |
| Support ship | | 0,00411067 | | | | 0,00238149 | | | 0,00477562 | 0,000101336 | 0,00149804 | 3,55905e-06 | 2,37693e-05 | 0,000122869 | 0,0130174 |
| Fishing ship | | 3,50152e-05 | | | | 5,23967e-05 | | | 1,78601e-06 | | 9,69866e-06 | | | 4,61862e-06 | 0,000103515 |
| Pleasure boat | | 2,1988e-07 | | | | | | | 9,44836e-05 | | 1,01141e-05 | | 3,12962e-07 | 5,40811e-07 | 0,000105671 |
| Other ship | | 0,000540182 | | | | 0,000911392 | | | 0,000288006 | 4,28627e-05 | 0,000193799 | 7,9204e-07 | 8,15776e-07 | 4,92575e-05 | 0,00202711 |
| Sum | | 0,0449728 | | | | 0,0545989 | | | 0,131973 | 0,00132356 | 0,0245919 | 4,60992e-05 | 0,000535302 | 0,00186793 | 0,25991 |

**Figure 10** IWRAP Scenario 20 Detailed Schema

As shown in both tables, passenger ship collision probabilities are extremely high and refers to at least 40% – 50% of all possible collisions. The mean results of 30 different scenarios are the same with scenarios 10 and 20 values.

## 4 CONCLUSIONS

This paper gives a brief information about Izmit Bay and application of IALA Waterways Safety Assessment Program (IWRAP) to area. 1.3 million data which corresponds to 3 days of AIS data was imported to IWRAP and scenarios are repeated 30 times with creating different legs, default causation factors was used. After all 30 scenarios are completed, Eskihisar-Topcular area is found to be the highest risky are and a new 5 scenarios utilized to obtain detailed information about this area. According to IWRAP results, annual collision ratio in Izmit Bay is 0,3. Yearly grounding frequencies are found 1,937. Local traffic between Eskihisar and Topcular creates a crossing line to main inbound – outbound traffic so 50% of total collisions and 80% of total groundings in Izmit Bay occurs in this particular area. Passenger ships are the main collision candidates with approximately 50% of total collisions. IWRAP results are compared with real statistics taken from Kocaeli Port Authority and its found that results are compatible with real life situations in terms of collision frequencies. The results of this research has coincide with the results found in 2014 Izmit Bay PAWSA workshop which was utilized for identifying Vessel Traffic Service (VTS) control areas.

**Acknowledgement**

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# QUALITY OBT – QUALIFIED SEAFARERS

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**Abstract.** A rapid increase of number and tonnage of the certain type of the merchant vessels causes the vital problem for maritime safety because of the the lack of experienced seafarers, and especially officers for such types of the vessels.
One of the most important STCW Convention requirements for certification of the officers in charge of a navigational or an engineering watch is on-board training(OBT). (STCW Convention Regulation II/1 and Regulation III/1.)
The training record book is an objective evidence of the OBT for a future officer, but the quality of this OBT fully depends on the Company's Safety and Quality Management System procedure i.e. if the OBT control instrument is present in the SMS and QMS or not and if it is controlled by the third part – Port State Administration.

**Key words:** on-board training, STCW Convention and Code as Manila amendments, ISM code (Res. A 741(18)), Procedures for Port State Control (Res. A 1052(27), SMS and QMS training officer, training record book, company's responsibility, cadets program

## 1 DEFINITIONS AND HISTORY OF THE PROBLEM

The Manila Amendments to the Annex to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 make many references to the on-board training. Whilst it is evident that the Convention requires the on-board training, it does not require parties or companies to employ officer trainees or provide the on board accommodation for officer trainees. However, the Convention stipulates the minimum amount of seagoing service which is required from an officer trainee before becoming eligible for a certificate of competency. It is axiomatic that if companies are not engaged in training or do not provide the on-board accommodation for officer trainees the provision of a well-skilled maritime workforce is endangered.

STCW Convention and Codes defined what "the on-board training" means:

– Chapter II/1 STCW Code:
  Onboard training

Every candidate for certification as officer in charge of a navigational watch of ships of 500 gross tonnage or more whose seagoing service, in accordance with paragraph 2.2 of regulation II/1, forms part of a training programme approved as meeting the requirements of this section shall follow an approved programme of onboard training which:

1. ensures that during the required period of seagoing service the candidate receives systematic practical training and experience in the tasks, duties and responsibilities of an officer in charge of a navigational watch, taking into account the guidance given in section B-II/1 of this Code;

2. is closely supervised and monitored by qualified officers aboard the ships in which the approved seagoing service is performed; and

3. is adequately documented in a training record book or similar document.

– Chapter III/1 STCW Code:
  Onboard training

Every candidate for certification as officer in charge of an engineering watch in a manned engine-room or as designated duty engineer in a periodically unmanned engine-room of ships powered by main propulsion machinery of 750 kW or more whose seagoing service, in accordance with paragraph 2.2 of regulation III/1, forms part of a training programme approved as meeting the requirements of this section shall follow an approved programme of onboard training which:

1. ensures that, during the required period of seagoing service, the candidate receives systematic practical training and experience in the tasks, duties and responsibilities of an officer in charge of an engine-room watch, taking into account the guidance given in section B-III/1 of this Code;
2. is closely supervised and monitored by a qualified and certificated engineer officer aboard the ships in which the approved seagoing service is performed; and
3. is adequately documented in a training record book.

The Chapter 6 of the ISM Code(IMO Res. A.741(18)) requires that:

The Company should establish and maintain procedures for identifying any training which may be required in support of the safety management system and ensure that such training is provided for all personnel concerned.

IMO has been raising the on-board training problem since 2007 at MSC82 and STW38 in relation to a discussion of the general review of the STCW Convention. At the time, a number of opinions were expressed. The International Confederation of Free Trade Unions (ICFTU) was keen to ensure that the quality of officer's training was not compromised. Intermanager wanted the period of seagoing service to be increased and suggested a common requirement for ships in international trade to employ two or more trainee officers. ICS advocated for guidelines to be issued, rather than any mandatory requirements to carry trainees. But some Countries did not support the suggestion for a change in the sea service requirements or for trainees to be placed onboard as a requirement.

At MSC83, India submitted a proposal to ammend the relevant conventions to introduce a mandatory requirement for ships on international voyages to carry trainees. China (and other countries) expressed the opinion that provision of trainees would solve the problem of the manpower shortage, improve quality of seafarers' training and reduce accidents. Japan (and other countries) expressed the opinion that the proposal should not be supported and was insufficient to solve the global shortage. Singapore suggested that shipowners should be encouraged to provide berths and that non-binding guidelines should be issued. Intertanko supported the training proposal in general, but mentioned that introducing the mandatory requirements would be 'premature', and encouraged general measures to improve the on-board training to be considered. The issue was referred to STW.

At MSC85 India submitted another paper, which included a new agenda item for the SLF Sub-Committee 'on mandatory accommodation for training berths onboard all new ships'. This proposal was to require all new ships designed for international voyages to include dedicated accommodation slots for trainees. The proposal suggested amendments to the relevant IMO/ILO instruments to introduce the requirements. The paper was forwarded to SLF for consideration in the context of

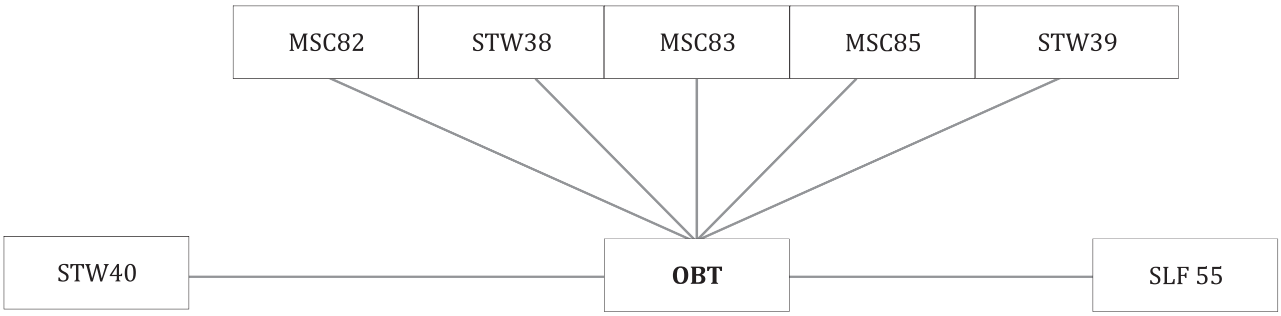


**Figure 1** Historic review of OBT discusion

reforms to the Tonnage Measurement Convention and the STW Sub-Committee for consideration in the context of the review of the STCW Convention.

STW39 concluded that mandatory placement of cadets and provision of berths was not the appropriate way forward and it would be impractical and expensive for smaller shipping companies to implement such provisions. South Africa expressed support for the concept but raised doubts over administration and enforcement of the requirements. STW suggested non-binding recommendations on this issue with incentives offered to shipping companies to supply berths to trainees and cadets.

India submitted a new item to amend the 1969 Tonnage Convention to exempt accommodation of training berths from tonnage calculations in the work program of the SLF sub-committee for consideration by MSC85.

During STW40 Norway and others expressed concern as the tonnage of a ship is used for purposes relating to safety of life at sea and protection of the environment (as well as for calculating dues).

STW 40 agreed that one step forward could be the adoption of a resolution urging Member Governments to encourage shipowners to ensure that adequate certified accommodation for trainees/cadets was available on board ships, in particular, new-buildings at the Manila Diplomatic Conference. India prepared a draft resolution on accommodation for trainees, which was adopted in Resolutions 12 and 13 at the Manila diplomatic conference.

SLF55 recommended an Assembly resolution on 'Reduced gross tonnage for crew and trainee accommodation spaces' (SLF 55/INF.2, annex 5). This problem was not solved at the Assembly meeting. This issue is ongoing through SDC, and at SDC2 Germany submitted a draft resolution on this issue. SDC expressed concerns that the parameter may lower the safety requirements of ships which are just over 500 tons, and a recommendatory instrument wouldn't encourage the shipowners to improve seafarer's accommodation conditions onboard the ships and increase training accommodations.

## 2 REQUIREMENTS AND OBT NONCONFORMITY

STCW 95 introduced a compulsory 12-months seagoing service for every candidate for certification as deck officer of watch. A cadet must perform bridge watch keeping duties under the supervision of a qualified bridge watch keeping officer for at least six months of this period. The cadet's achievements during the on-board training must be documented and approved by the Administration's training record book.

There were two areas where Maritime Administrations rushed to implement the new STCW requirements: seagoing service periods and STCW compulsory courses. From the National Maritime Administration's point of view these were the easiest tasks to be accomplished, because they do not require manpower or logistic efforts from the Administration. This 12- months sea-service period for cadets created problems for maritime education and training establishments. The first one was a substantial reorganization of curricula, in order to allocate time for on-board training. The second main problem is finding owners and ships. This problem is a result of the lack of national flag ships and of the non-assistance of the National Maritime Administration in solving of this problem. Moreover, the students lose the contact with their university/college for several months, and they have major difficulties to re-enter in the studying programme.

There are only few large ship-owners having onboard training programmes with a serious involvement of the cadets in training activities.

For example NYK Cadetship Training Program:

Cadets in principle undergo a 12-month onboard training program (depends upon the nationality), the first three months of which will be spent on a training ship stuffed with specialized instructors to ensure that all cadets receive the same basic training. Upon completion of 3 months on training ship, they are transferred to other NYKSM managed vessels enable complete their remaining seatime required to appear for the competency exam.

The “learn-while-you-work” training programme has been designed based on a study made by *International Maritime Training Centre* (*IMTC*) (formerly the *Indian Maritime Training Centre*) faculty and feedback from managements of various companies, Masters, Company Training Officers (CTO) and cadets.

Many ship-owning and management companies have expressed the feeling that Ship’s Officers have sound theoretical knowledge but lack in practical experience. The present educational system prepares a cadet well for theoretical studies, right from pre-sea training through to competency examinations. The Structured Shipboard Training Programme (SSTP) for Deck Cadets complements this with practical learning on board through a task-based curriculum, which enables effective application of theoretical knowledge.

From March 2015 Indian Government will provide financial suport and loans to the cadets to enable them complete the on-board training on foreign ships. This initiative will help over 10,000 students annually. The Indian government has launched this scheme due to the face that many cadets could not get on-board training due to lack of berths on Indian ships.

## 3 IAMU VISION

The IAMU was created in 1999 by a group of maritime universities from across the world

The role of the IAMUis to be the global leader in maritime society building through networking and excellence in MET.

One of the IAMU mission is to develop and support effective MET systems for passing on maritime skills and knowledge to future generations of global seafarers that ensure safety at sea, maritime security and the protection of the environment.(IAMU Basic Agreement, Article III)

The OBT is one of the main elements of the MET since the IAMU has concentrated on the problem of on-board training. The OBT was the key irem of the IAMU Papers and IAMU Projects for many times.

The IAMU Forum on Maritime Education and Training (MET) was held in Tokyo, in March, 2014. One of the question of the meeting agenda was submission to IMO HTW2 IAMU “IAMU understanding of some Human Element issues“. This document provides the Sub-Committee with information on the outcome of the IAMU Forum on Maritime Education and Training (MET) in Higher Education, which was held in Tokyo in February, 2014. The Forum was devoted to the industry trends and implementation of a quality standards system (QSS) for on-board training (OBT), which is mandatory for the MET process in accordance with requirements of the STCW Convention, 1978, as amended, and the STCW Code.

This Paper (HTW 2/INF.2 ) was submitted to IMO during IMO HTW2 in February, 2015.

During the IAMU AGA 2014 in Tasmania, IEB Extraordinary Meeting in London, February, 2015 and 1st IEB in Croatia in April, 2015 the necessity to submit a new IAMU Paper “On-board Training” was discussed. The goal of the paper is demonstration IAMU vision of this problem to the Maritime Community and attempt to structure and organize not only the OBT, but the Control of the OBT implementation on board of the vessels.

1. OBT organization
2. STCW Requirements
   – Regulation I/14 – Responsibility of Companies
   – Regulation I/8 – Quality Standards – link between OBT and STCW
   – Regulation I/10 Recognition of Certificates
3. Safety at Sea – ISM Code and OBT (Chapter 6 of ISM Code)
4. Security at Sea – ISPS Code and OBT
5. Port State Control and OBT
6. ……….. etc.

**Figure 2** IAMU OBT Scheme

*1. Developing a MSC Circular with a title, for example, UNIFIED INTERPRETATION TO PROVISIONS of Manila Conference Resolution 13, STCW 78 and ISM Code related to the provision of suitable accommodation for trainees onboard their ships both existing and new, and/or*

*2. Using STCW Regulation I/8, Quality Standards, to develop the due interpretations, and/or Taking account of ILO MLC 2006 provisions related to accommodation of the seafarers (= cadets).*

*3. Proposing amendments to ISM Code (para 6.5): “The Company should establish and maintain procedures for identifying* ***and planning*** *any training which may be required in support of the safety management system and ensure that such training is provided for all personnel concerned”*

## 4 CONCLUSION

The theme of the World Maritime Day 2015 is “Maritime education and training”.

The theme was adopted to focus attention on the wide range of maritime education and training, in particular its adequacy and quality, as the bedrock of a safe and secure shipping industry, which needs to preserve the quality, practical skills and competence of qualified human resources, in order to ensure its sustainability.

The 1978 STCW Convention and Code, as amended, set the international creterion for the seafarers' training and education. While compliance with its standards is essential for serving on board ships, the skills and competence of seafarers, and indeed, the human element ashore, can only be adequately supported, updated and maintained through effective maritime education and training.

There is a good chance to erase OBT problem as 2015 is the Year of MET.

This problem can be solved by close collaboration of IAMU, ICS/ISF(Shipowners), ITF and ILO.

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