Nikola Vaptsarov Naval Academy
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18-th Annual General Assembly of the International Association of Maritime Universities

Global perspectives in MET: Towards Sustainable, Green and Integrated Maritime Transport

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The **18th Annual General Assembly** of the International Association of Maritime Universities together with the **Scientific conference** was held in Varna, Bulgaria, 11-14 October 2017 supported by Nippon Foundation. The Conference consist of two main workflows depending on the status of authors: researchers/lectures and students.

On the Conference "**Global perspectives in MET: Towards Sustainable, Green and Integrated Maritime Transport**" were presented researchers/lectures and students from Maritime Universities.

The research papers were arranged in three thematic sections:

- Education and Training in Maritime Professions, and Support for Seafarers
- Sustainable Maritime Transportation Systems
- Environmental Protection, Green Industry and Blue Growth.

Also the research papers are issued in 3 volumes.

- The first volume includes all the papers that pass the refereeing procedure. They are included in the index of scientific citation.
- The second volume includes all the papers that have not been put on a refereeing procedure.
- The third volume includes the papers presented on the student's conference.

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INTERNATIONAL MASTER OF MARITIME MANAGEMENT STUDIES – HOW TO COMBINE EMPLOYERS, EMPLOYEES AND UNIVERSITY´S INTEREST?

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Abstract Satakunta University of Applied Sciences (SAMK) has now been providing a Masters programme for bachelor level Master Mariners for more than ten years in Finnish language. The results have been promising from the student´s point of view. The students who have graduated from the program have been the best earning graduates from Universities of Applied Sciences in last salary investigation made by the statistic reseachers in Finland. Among the Master level graduates from SAMK a research indicated that the Master of Maritime Management graduates had been able to benefit best of all also from their skills acquired in working life. Their employer´s satisfaction was not researched, but their best progress in working life of all SAMK graduates indicate that also employers have been satisfied. More than 75 percent of the graduates were 2 year after graduation in leading position in land organization related to shipping. The only problem was that the University get its finance from graduates and the students were able to make good progress in their studies otherwise, but they had severe difficulties in finding enough time for their mandatory Master´s thesis, which forms a half of their studies. Those students who have been able to combine their thesis with their work in an early stage have usually succeeded best and graduated in time. January this year we started the same program in English language and we needed to contradict the problem on a far greater scale. With 41 international student´s we needed to find a solution for the problem and not just make the students and their employer happy, but also the University. We needed to do that also because we will have now yearly intake of students instead of every second year, like previously. The authors made changes in the curriculum, combined the beginning of the thesis and method courses with the first course in Organization of Shipping, and integrated them. The students have to

present their organization and its structure for other students already when they come to the first contact lectures in Helsinki. The next presentation they make soon after for the authors only, through videoconference from distance, is that they need to make research in their own organization in order to find the most essential development needs. More than 90 percent of the students have already found the subject for their thesis after the presentation and confidential discussion with the authors. The next step soon after is the starting of the integrated method course. When the students already have their subject ready when they enter the method course, they get most out of it. They are able to choose the suitable methods for their research subject. As they enter the method course, they are already aware what we expect from them: A detailed research plan delivered together with their research contract between student, the employer and University – with a deadline of 3 weeks. As we have success stories by graduated students who have been able to make valuable and highly beneficial research and development work through their thesis, at least the Finnish employers have already found the value of their employee's participating in the Master´s studies. Those who planned and made it work will highlight the new method in this now international program in detail in this article.

Keywords: Research in MET, e-learning, methodology in teaching.

Introduction

The Satakunta University of Applied Sciences (SAMK) has proved a Master´s program for bachelor level Master Mariners for more than ten years in Finnish language. 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 a "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 (Lempinen, 2009). The 30 credits have to be used well to be able to build the knowledge needed in land-based organization. The 30 credits have to be used effectively as they do have to support also the research that the student will do as half of the studies consists of the research.

The results have been promising from the student´s point of view. Many students who have graduated in time are in leading positions in shipping companies, stevedoring companies and maritime administrations. The students who have graduated from the program have been the

best earning graduates from Universities of Applied Sciences in last salary investigation made by the statistic research in Finland. Among the Master level graduates from SAMK a research indicated that the Master of Maritime Management graduates had been able to benefit best of all also from their skills acquired in working life. Their employer´s satisfaction was not researched, but their best progress in working life of all SAMK graduates indicate that also employers have been satisfied. More than 75 percent of the graduates were 2 year after graduation in leading position in land organization related to shipping.

Connecting the employers and employee to thesis

Although the master program has been successful, the problem is that the University get its finance from graduates and the students were able to make good progress in their studies otherwise, but they had severe difficulties in finding enough time for their mandatory Master´s thesis, which forms a half of their studies. Those students who have been able to combine their thesis with their work in an early stage have usually succeeded best and graduated in time. January this year we started the same program in English language and we needed to contradict the problem on a far greater scale. With 40 international student´s, we needed to find a solution for the problem and not just make the students and their employer happy - But also the University. We needed to do that also because of the popularity of the Master´s program. We will have now yearly intake of students instead of every second year, like previously.

The authors of this article made changes in the curriculum, combined the beginning of the thesis and method courses with the first course in Organization of Shipping, and integrated them. The students had to present their organization and its structure for other students already when they came to the first contact lectures in Helsinki. The next presentation they made soon after for the authors only, through videoconference from distance, was that they needed to make research in their own organization in order to find the most essential development needs. There was a clear difference and effect - More than 90 percent of the students have already found the subject for their thesis after the presentation and confidential discussions with the authors. The only students who still after this exercise and confidential discussions did not a topic, were those who did not for some reason want to tie their thesis to their employer. Reasons for this vary – Some students have already found new employer who

still is not familiar enough in order to provide subject for the thesis or the employee is not familiar with his/her work or company´s development needs.

After evaluation of the thesis subjects the students have discovered, there is a clear finding. The employers in general have offered demanding development topics for the students. There is clearly two main reasons for this: 1) when the students were given an assignment to study development needs of the company, most of them took it seriously enough and contacted the management of the company on a high level, They had clearly indicated that they have something to offer and they have University support for their efforts. The message was that the development work needs to be something more that what is generally done at the bachelor level studies. 2) The other reason is two folded. First the students are already known to have expertise which is highly useful for the company´s purposes and secondly, the employers have become better aware of the Master program itself and the purpose of the thesis work as a large part of it. For this we need to thank our graduates and the reputation they have gained in working life over the years.

Method course integration into thesis

The next step after the thesis subject had been chosen, was to start the integrated method course. When the students already have their subject ready when they enter the method course, they get most out of it. Students are able to choose the suitable methods for their research subject when their topic has already been chosen. As they enter the method course, they are already aware what we expect from them: A detailed research plan delivered together with their research contract between student, the employer and University.

As we have success stories by graduated students who have been able to make valuable and highly beneficial research and development work through their thesis, at least the Finnish employers have clearly found the value of their employee in participating in the Master´s studies.

One ship owner needs to be mentioned especially – Finnlines, although owned by Italian Grimaldi family, the management team of the company in Finland was immediately prepared to offer valuable and interesting topics for the students to develop. This also envisages that the

communication in the company group works well. The daughter company Finnsteve Ltd. had previously gained excellent results when their management level persons had studied in the Master degree program and connected their thesis with their work. (Innovations in maritime research through co-operation between University and employer of the student writing his/her master thesis, 2015)

The roles of the companies and University in promoting the students together is crucial. (Lempinen, 2009) Contact with not just students, but also their employers is vital for successful result. It is important that the methodology is not accepted and understood by the employer's representative. Therefore, this needs to be certified. This is done by the students agreement which consists also the thesis Plan, where the methodology, which the student will use in his/her development work/research, is described in the thesis plan which is also signed together with the agreement, by the employer, student and the University.

The support from the alumni´s

When the students have their thesis subject, thesis plan and methodology chosen it is time to take the next step. To act according to the thesis plan and to begin the real work. Supported by the employer and supervisors they will get on their way. However, there is still need for additional support, which the alumnies can provide. (Sandell, 2014) We have previously used the best alumnis by providing the new student group a day together with the best students from previous group.

The core idea of this practice is to bring together the students, which are in the beginning of their studies, the graduating students and some of the alumnies. The student's employers are also invited to the seminar day to hear the best and latest research results from the graduating students. The seminar day is organized to fulfill several goals. First of all, it is important way to bring the new research to the knowledge of all students and their employers who are also free to participate in the seminar. Secondly, it is organized for the students and the alumni´s to be able to network with each other. Thirdly, the students who are now in the beginning phase of their studies, are able to hear concrete stories how the best students have conducted their research work together with their employers and University. It is also important for them to hear how they have planned their studies and been able to connect it to their work, and

connected and scheduled this with their family life. Hearing how they have overcome all the difficulties and how they have won their obstacles in research helps those in the beginning of the research.

This practice has previously been essential for the students and helped them onwards in their research process. The students have been able to make their thesis plans more concrete in an early phase of the research. After the day with the alumni´s, the students start to prepare the thesis and collect the materials, prepare the interviews etc. After this he/she presents the research materials and how he/she is going to apply the chosen research methods to the materials and the development work. This seminar is organized with the fellow students present. In these seminars the students discuss and change opinions how to apply the research methods, how to conduct surveys, interviews etc. and they will be commented by the supervisors and fellow students.

Conclusions

Thesis in Master programs is a development work, which is usually combined to developing ship owner´s business. They are often combined tightly to the activities, which the ship owner should carry out and invest in anyway. During the studies, the ship owner´s employee receives support in development work from the University that helps to develop the business and solve the problems. This benefits also the teachers as supervisors as they gain knowledge that they would not normally get just by doing research in their chambers and lecturing in class.

Effective combining of the students, their employer and the University demands a lot of efforts and work. But it gives also a lot for all. In this Master program, the program itself has been a development work itself, which has taken ten years this far. The development work of the program is still not finished and but general understanding of the objectives by the employers has helped the process especially in recent years as well as the results and progress of the alumni´s in the shipping world. In addition, the research results conducted by the students advertises the study program when they are constantly used to enhance maritime safety and efficiency of the industry when the results are implemented to the work in shipping companies and maritime administration.

References

Innovations in maritime research through co-operation between University and employer of the student writing his/her master thesis. Sandell, Peter Ivar. 2015**.** 2015. IAMU GA 2015 proceedings. pp. 327-330.

Lempinen, Kangasniemi **.** 2009. *Aikuiskoulutuksen uusi maasto 2010-luvulla, Ylempi ammattikorkeakoulututkinto osana innovaatioympäristöjä.* 2009. pp. 49-62.

Sandell, Peter Ivar. 2014. *Onnistuneita kehittämishankkeita yrityksen näkökulmasta. uusia malleja työelämän kehittämiseen - Tutkimuksellinen kehittämistyö Ylempi AMK tutkinnossa.* s.l. : Satakunnan ammattikorkeakoulu, 2014. pp. 18-21.

USING THE ENGINE ROOM SIMULATOR FOR TEACHING AND TRAINING THE TEAM HOW TO ACT IN MAJOR ACCIDENTS AND DISASTERS

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Abstract Making practical decisions is always the best way to train engineers, both for the merchant and the naval fleet. However, the difficulties for access to real vessels makes simulator training more and more necessary for the final part of every education stage. The implementation of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers — (STCW'78) with the Manila Amendments (2010) at the Naval Academy ensured a high level of competence for the trained personnel and unification of maritime education in Europe.

Keywords: engine simulator, team working, practical problems, maritime personnel

Introduction

The introduction of new and more sophisticated main and auxiliary machinery management systems on the ship required the development and implementation of special automated training systems. These modern tools have led to time saving and increased lifetime and learning efficiency. They are subdivided into simulators, simulator systems and imitators.

Simulators are used to create habits and skills. They are exact copies of part of the ships systems. The simulator systems are complete replicas of the real-life ship equipment and help form complex skills and habits at the stage training and teamwork. The imitators reproduce various operational effects and are used in conjunction with simulators and simulator systems.

The main link I the training of maritime command staff is the "learner-system" link. The leader-learner relationship is determined by the opportunities for instruction, explanation, display, repetition, data registration, evaluation of decisions and reports. Thus the link depends on the technical solution and the possibilities, through the teamwork of the trainees

operating the system [1].

New technologies require a long-term reorganization of the operation and operation process. With the introduction of training simulation complexes, the manager has the opportunity to guide the learners, to develop the pursuit of independent actions, to control the building of certain skills and habits in emergency situations.

Under real circumstances, the ship mechanic needs to make rapid and rational decisions in a self-contained or grouped manner, in the absence of sufficient information, a limited amount of time, and the variety of possible, sometimes unpredictable, problem situations that may arise.

The task of the publication is to show chronologically the possibilities for practical use of a marine engine simulator for learning and training of the team in case of major accidents.

In the publication, the order of such a task as an example.

Practical Fighting Exercise at the Willingen Frigate in the ERS-TehSim5000 Training Complex	**Evaluation criteria**	
	Yes	**No**
Option 1. Distribution of crew in emergency groups : - Creating a fire party with the available crew on the ship	According to the alarm schedule, the crew distributes to: fire-fighting teams, engine room teams, technical teams and first aid teams. For example: "Fire Party #1 consists of deck bootman, ruler № 3, motorman №2 and chef assistant. Party Leader is the Chief Mate. "	He does not know the alarm schedule. He does not know the basic organizational rules of the ship.
Option 2. Drawing up and action plan in the event of a fire in the engine room.	Draw up a plan including at least the following fire-fighting tactics: These procedures include: 1. Alert and Notification 2. Alarms instructions 3. Saving human life 4. Emergency breathing devices for evacuation 5. Limiting the fire 6. The use of fire doors 7. Using fire and smoke detectors 8. Extinguishing a fire	He does not know the basic organizational rules of the ship.

Mutual trust between the crew, knowledge, habits and skills helps to get the work done and ensure the proper functioning of the ship and its safety [4]. In an emergency, each crew member must perform his/her duties and, in so doing, not to impede or delay the operations involved and to endanger a given life. Mutual trust related to emergency operations can be obtained by:

- Positive results from previous exercises;
- Mutual respect;
- Learning and training.

At a conceptual level, the description of the simulation processes is most effectively performed on the basis of scenario models based on real ones. Usually, there are three types of situation in the simulators: - work situations; - emergencies related to the wrong actions of the trainee on the simulator; -situation related to his/her actions in emergency situations, which are determined by the peculiarities of his/her behavior pattern.

The simulator has the ability to configure different exercises according to requirements, including simulation and integration of real physical for marks – use of a smoke generator. The simulation training system offers a variety of solutions to provide focused sessions and recurring tasks with a variety of scenarios and accidents in a short period of time. The simulator also allows the crew to interact. The aim of the exercise is to achieve confidence and skills by the crew in the engine room as well as professional orientation in the used equipment and systems. An example of this type of training of fire engineers is given in the figure1.

Figure. 1 Reacting to a situation – a fire in a machine room (using a smoke generator)

A real instruction is also given to work with the ship power plant and the response of the

crew in case of a fire in the engine room of the Willingen frigate. [7].

Any response to an emergency must be a team effort in order to ensure success. When all parties involved understand the organizational structure and their roles within that structure, confusion is held to a minimum. Confusion must be avoided if the vessel master and officers (Command) are going to have any chance of directing the appropriate resources to the defined goals (strategies) and objectives (tactics). Additionally, and most importantly, the use of an existing defined fire team organization results in a safer operation for all involved [6].

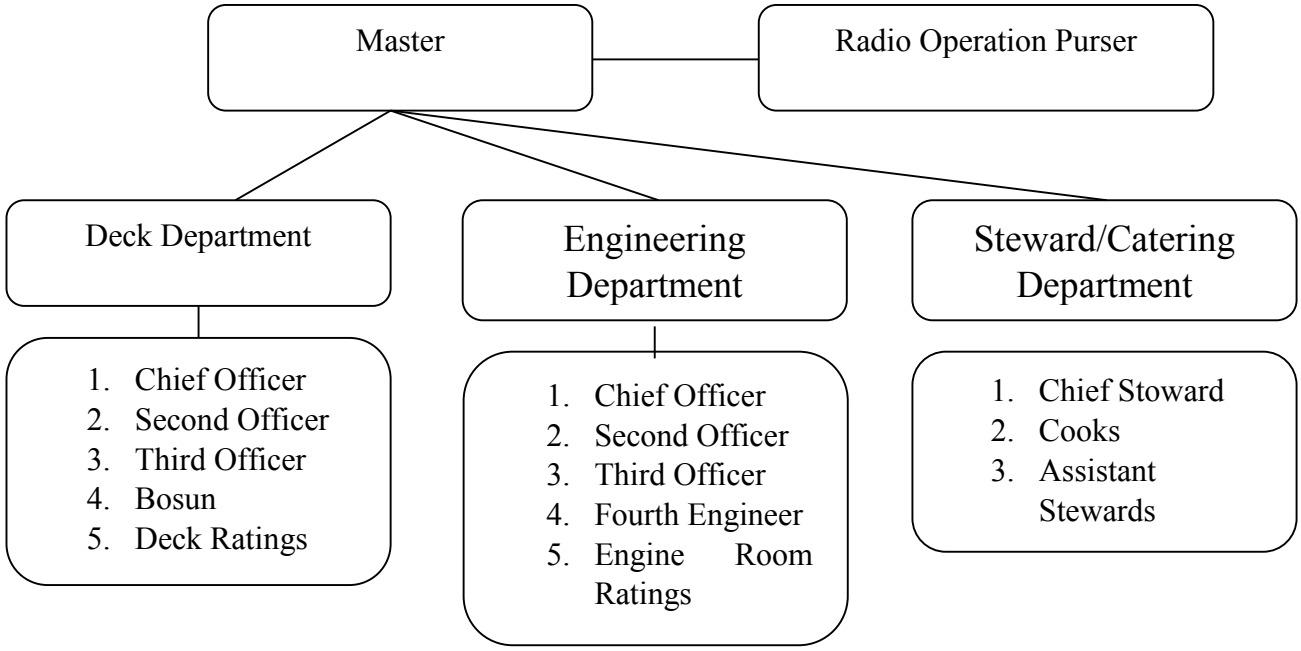

Figure. 2 Organizational structure for fire response

The organizational structure for fire response takes into account the existing organizational structure for day-to-day operation of the vessel (Figure 2). Like an industrial plant, a vessel is organized into various departments, each under control of a department head (chief mate or chief officer, chief engineer, and chief steward). The chief mate or chief officer is second to the master in the chain of command and is usually in charge of safety, lifesaving and fire fighting equipment, and the training of the crew. The station bill lists duties for major emergencies: fire, man overboard, and abandon ship (boat stations). However, more specific information is needed for fire emergen-cies than can be provided on the station bill and muster list (the list of names and ranks or ratings on board). It is up to the master to determine how the existing organizational structure can be modified for emergency response, taking into account the nature of the vessel, the size of the crew, and the abilities

of officers and crew to serve in particular roles. One emergency organizational structure example is shown in Figure 3. There must be flexibility for the organization to respond effectively to changing circumstances. The location of a fire determines which team serves as the primary attack team and which serves as the support team. For example, if the fire were in the engine room, the chief engineer would lead; if the fire were on deck or in the accommodations area, the chief officer or first mate would direct operations. In order to provide a unified response, the master (backed by the chief engineer) has overall command of the response actions, while the chief officer or second engineer (de-pending on where the fire is located) leads the suppression effort.

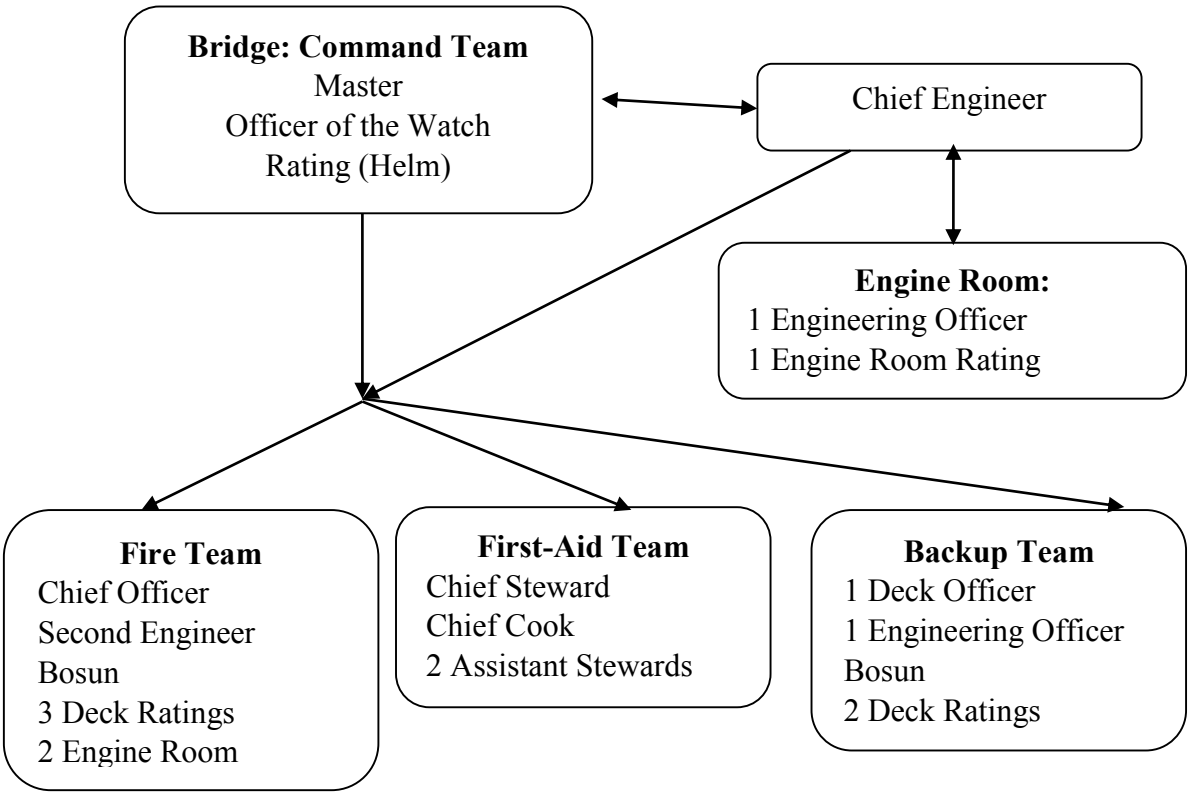

Figure. 3 Modify the basic organizational structure for a vessel emergency

Test, evaluate, and review emergency organizational structures to establish the best structure for the vessel. While emergency response cannot be totally prescriptive, preincident planning, allied with relevant training and drills, gives the best approach to quick and effective response with sufficient flexibility to react to changing circumstances. In preparing and training the emergency teams, it is possible that some members will be involved in or possible casualties of the incident itself. All team members should be crosstrained so vacant positions can be competently filled.

Conclusion

There is no standard formula to combat fires on board ships. Depending on the circumstances, a set of instructions can be made to develop and complement during the training on the simulation complex. Firefighting operations are accompanied by a number of unforeseen actions and incidents that need to be taken into account when organizing compiling scenarios and patterns of work.

References

1. BAKALOV , I. D., 2016. Morski nauchen forum. Izpolzvane na simulacionen kompleks za provejdane na obuchenie I trenirovki po borba s pojari.pp. 29-32.
2. BELCHEV S.,Uzuntonev T.,Dimitrov R.,2011.Analisys of the formulae for calculating the heat transfer to the coolant fluid in internal combustion engines.XVII technical and scientific conference Transport, ecology- sustainable development. pp 75 – 81
3. ZLATEVA , P., 2014. Toplotehnika. Izmervane na parametrite na dimni gazove na gorivni instalacii s prenosimi gazoanalizatori. pp.7-11.
4. STOQNOV, R. Z., 2014. Rykovodstvo za prakticheski zadachi. I. Bakalov. Obuchenie po syvremenni metodi za borba s povari po razshirena.
5. BRADFORD, 2008. Current Issues and Future Directions in Simulation-Based raining, S. Bell, Adam M. Kanar, Steve W. J. Kozlowski, , Human Resources Management Commons, 2008.
6. BARDARA, 2000. Marine Fire Fighting, John F. Lewis, Donald Merkle, Jon Swain, Robert B. Wright.
7. ERS_5000_ANZAC_Trainee_Manual_en.

Avoiding Collisions At Sea – Pareto Analysis

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ABSTRACT: It has been almost 40 years since the 1972 International Regulations for Preventing Collisions at Sea known as COLREGs were introduced, and regular amendments have been taking place accordingly ever since. Over the last half-century despite improvements in navigational aids such as ARPA and attempts to raise the standards of training through the various STCW conventions, collisions still occur. Many studies and accident reports indicate that the accidents were caused by either human error or are associated with human error as a result of inappropriate human responses. Collisions commonly represent many of these accidents. This paper discusses key issues regarding the application of Collisions Regulations (COLREGs) at sea, reports on the outcome of a recent EU funded eCOLREGs project known as ACTs and a report on a Pareto Analysis supporting the work being carried out in a new project called ACTS Plus which considers more complex cases where there are several rules applied or where there are more than two ships involved in a collision. This paper does not attempt to examine each and every rule included in regulations but the EU Project ACTs and ACTS Plus online platform include some 300 scenarios, many developed and videoed in ship simulators, for those interested to review and explore more. This paper discusses the importance of studying cases where the applications of certain rules or where more than one rule applies are open to misinterpretation.

KEYWORDS: *COLREGs, maritime education and training, collision avoidance, Pareto Analysis*

1. INTRODUCTION

The International Maritime Organisation (IMO) developed the first standard for Vocational Education and Training (VET) programmes for merchant navy officers (STCW) in 1978, and it has been amended in 1991, 1995, 2003 and 2010 respectively. However, there are currently no mechanisms to monitor how their standards are being applied as many VET providers have been found not to follow many requirements. Therefore, there has always been substantial diversity on the knowledge of seafarers affecting the safety of life at sea. The COLREGs provide various rules as to passing, crossing, overtaking manoeuvres to be made; detailing which ships have the right of the way depending on the circumstances and the types of ships involved, and what actions these ships should take. It also describes the rules on the signals (lights, shapes and sound signals). The recent IMO bulletin “maritime knowledge centre” reports that more than 90% of the collisions are attributed to the human factor (IMO, 2010), and this had earlier been reported by Parker (2010). Ziarati (2017) reports that majority of accidents and incidents are related to

collisions. There is a clear indication that Collision regulations are either not understood or ignored although it is a primary set of rules for taking actions to avoid collisions.

It is interesting to note that the earlier studies had been showing that 85% percent of all accidents are either directly initiated by human error or are associated with human error as a result of inappropriate human response (Ziarati, 2006). The human error reported to causing the accidents is now to have apparently increased by 5 percent in recent years. This may be linked to the revolution in automated equipments/systems on board the ships causing the number of accidents to decrease while increasing human element attributed to accidents. The Pareto Analysis methodology of Ziarati (2006) has been applied to identify where maximum benefits could be felt and which Rule if applied correctly could reduce the number of collisions most.

2. COLREGs IN MET

The purpose of Collision Regulations and resources needed have already been discussed (Stitt, 2002: IMO, 1999). However, across the world, countries have diverse methods of teaching the COLREGs as well as having diverse methods to identify the knowledge of their deck cadet/navigational officer's competency in COLREGs. Some by multiple choice questions, some with one to one exams to make sure that those deck cadets/navigational officers know/ understand the COLREGs. Research conducted by the Nautical Institute (Syms, 2002) highlights the suggestions of seafarers, that the improvement of maritime training and education (MET) systems is necessary which will help then to improve the application of COLREGs at sea. The same research (Syms, 2002) also reports that in northern European countries such as United Kingdom, Germany and France, the application and understanding of COLREGs is of a higher standard than when compared to other countries. Ziarati (2006) emphasises that mistakes are usually made not because of deficient or inadequate regulations, but because the regulations and standards, that do exist, are often ignored.

3. RESEARCH INTO TO COLREGS RULES

COLREGs currently have thirty eight rules and four annexes. It applies to all vessels upon the high seas and in all waters navigable by seagoing vessels. From the point of Belcher (2002), COLREGs are intended to operate in an environment where the Navigational Officer on each vessel has a complete understanding of the situation, knowing which rules are in effect, how

those rules are interpreted and what needs to be done in case the action does not occur. Thus, (Belcher, 2002), perceives that the COLREGs operate in an environment of mutual comprehension, understanding and coordination, with clear logical steps ensuring clarity and predictability. MAIB (2004) has conducted a safety study that reviewed 66 collisions and near collisions in their accident database. As a result of the study, the most common contributory factors in all these collisions were poor lookouts (Rule 5) and poor use of radar (rule 7(b), (c)). That means that the standards of lookouts are poor and ineffective and that the radar is not used properly to identify the risk of collision. In fact, COLREGs clearly state the necessity of maintaining a lookout in rule 5 and the use of radar in Rule 7(b), (c):

"Rule 5 - Every vessel shall all the times maintain a proper lookout by sight and by hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make full appraisal of the situation and the risk of collision"

"Rule 7(b) – Proper use shall be made on radar equipment if fitted and operational, including long-range scanning to obtain early warning of risk of collision and radar plotting or equivalent systematic observations of detected objects.

Rule 7(c) – Assumptions shall not be made on the basis of scanty information, especially scanty radar information.

The examples of rule 5 and Rule 7(b), (c) are basic and easy to understand, interpret and comply with compared to other rules of COLREGs. However, it is interesting to see those are the first concerns in the full study report (MAIB, 2004). The same reports also point out that substantial numbers of accidents took place at night and in restricted visibility. The example below shows the collision attributed by poor lookout.

Case 1: Poor lookout - *A dredger collided with a fishing vessel in the Dover Traffic Separation Scheme, in daylight, calm conditions and clear visibility. The dredger had been on passage and following the flow of traffic, and the fishing vessel not engaged in fishing, had been crossing the scheme. The vessels approached each other on a collision course for 10 to 12 minutes with the fishing vessel on the dredger's port bow. The watch keeper on the dredger had seen the other vessel and, having identified it as a fishing vessel not engaged in fishing, was expecting her to alter course at the last minute.*

With regard to the provision of a lookout, STCW 95 states that the officer in charge of the navigational watch may be the sole lookout "in daylight" provided it can satisfy the provisions in STCW for lookout requirements (STCW, 95). Despite this international requirement to maintain lookout at night, the MAIB (2004) research shows that at least three of fourteen vessels had failed to keep a proper lookout at night. That same research also showed that only a bit over 25% used the radar properly along with the officer on the watch with regard to collisions.

In the same report, the reason for not maintaining lookout was attributed as "lack of competency". However, MAIB believes that poor visual lookout is linked to poor employment of ratings on the bridge (MAIB, 2004). MAIB reports that 20% of collisions are due to fatigue and some 80% due to competency factor. Bridge watch keeping practices have inevitably changed in recent years under the influence of automated systems which are being implemented in order to enhance efficiency and safety as well as to overcome the shortage of seafarers. As the advanced automation systems are developed and deployed on board, it influences the international rules and regulations which are under consideration for being updated in parallel to evolved systems on board the vessels. An earlier survey highlighted the concerns regarding the application of COLREGs rules at sea. The questions were directed to seafarers and in the results it was noted that close to 50% of the responses showed that seafarers either ignored or disregarded the COLREGs rules (Syms, 2002). In the same survey 90% of the responders identified the reason as "ignorance", "Poor knowledge of COLREGs" and "lack of training". Another finding of that survey was that the most common reason for making manoeuvres contrary to the COLREGs was reluctance to deviate/slow down.

4. SOME RESULTS FROM PROJECT ACTs

The Fig. 1 shows that there are serious concerns about the fact that the percentage of correct answers to a survey carried out by partners of the EU funded project ACTs (Ziarati et al, 2017) was around 70 but more alarming was that those with no experience of COLREGs did better than expected, in some cases almost performed as well as (in 2 cases better than) the more experienced seafarers and/or MET lecturers! This clearly should be a case for concern.

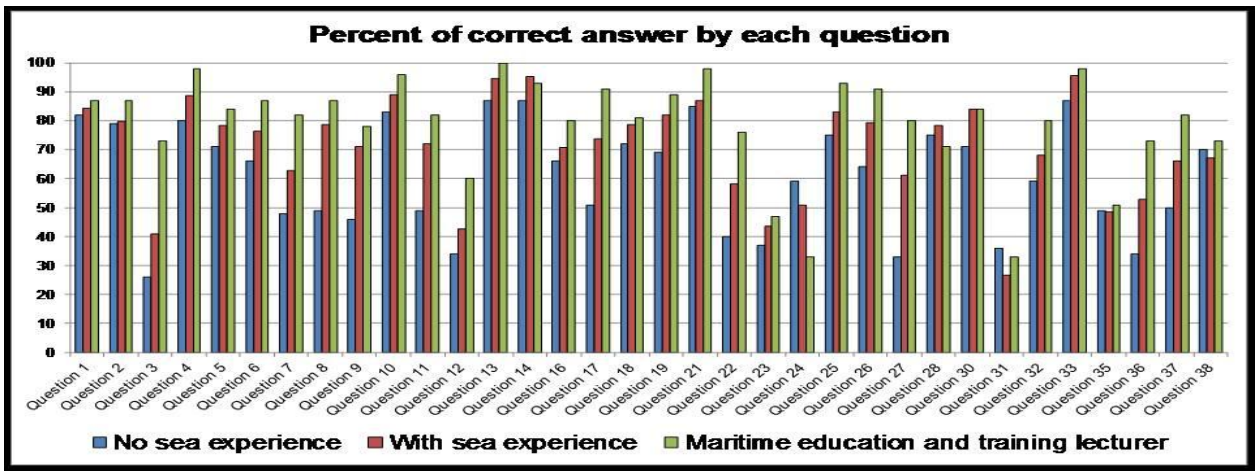

Fig. 1. % of Correct Answers by Respondents – All existing COLREG rules (Ziarati et al, 2017)

The hardest rules to understand in the survey concluded by Ziarati et al (2011, 2017) was found be rule numbers 19, 18 and 10 and to a lesser extent 8 and 9. Fig 2 shows the Pareto analysis for rules difficult to understand by students according to the lecturers.

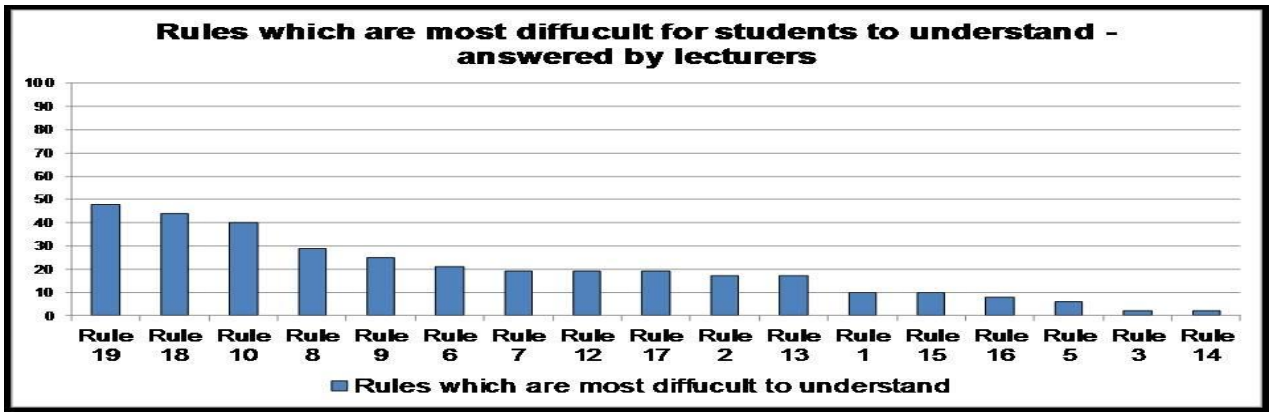

Fig. 2 Pareto Analysis – Identifying the most difficult rules to understand in ranking order

5. THE USE OF VHF AT SEA

Collisions should theoretically be avoided if all navigational officers comply with the International Rules for the prevention of collisions at Sea 1972. It is, however, shocking that these regulations were contravened to varying degrees in different locations across the world, which resulted in many accidents investigated and reported (MAIB, 2004; MARS, 2005). It is reported that the use of VHF is becoming a common practice in collision avoidance although it is not part of the COLREGs (MCA, 2002). The MCA (Maritime and Coastguard Agency) in the UK took this issue seriously and provided guidance for their seafarer network to highlight the

dangers associated with the use of VHF. According to MARS (2005) "*The use of VHF should be kept to minimum and only be used, for instance, an obstruction exists on starboard side for stand on vessel, and however, reduction of speed should be preferred on communicating the intention on VHF"*. It should not normally be the case for navigational officer to use VHF to take action to avoid collisions; however, it does usually happen. The MAIB study (2004) shows that after examination of the use of VHF in the collisions and near misses that it was only used in 14 of the 47 collisions, and was only effective in 3 of those.

Case 2 *- VHF assisted collision - A cargo vessel was outbound from River Humber in poor visibility. The master of the cargo vessel had the con, a helmsman was steering and the bosun was stationed on the forecastle as a lookout. The master saw the target of an inbound vessel on his radar, and he called the unknown fishing vessel using VHF with the intention of requesting to pass "green-to-green" in the channel. He received an instant response but, by then, it was too late. His ship was committed to the manoeuvre, and the fishing vessel was trying to pass red-to-red. They collided, causing extensive damage to the fishing vessel.*

Case 3 *– VHF assisted collision - Two container ships were navigating in China Sea. Risk of collision appeared however both did not realise it until 3 minutes before the accident. The stand on vessel tried to contact via VHF on three minutes prior to collision and got a response after several calls, a disagreement took place and the ships collided.*

Case 4 *- Rule 19: This case study is devoted to an article in Seaways (September 2008) which studied in some depth the problems of interpreting Collision Regulations (COLREGs) Rule 19. The article identifies the Rule 19 to be a continuing problem. The article is by Captain Roger Syms FNI, a Research Associate from the Australian Maritime College. He recollected a discussion with a seagoing officer concerning a discussion he had had with his colleagues, the subject of which was a collision problem in poor visibility. The scenario, somewhat similar to the Scenario 3 presented in the COLREGs survey a few years ago, is: Own ship and the other two vessels involved, one head on and the other to starboard steaming parallel at a range of 0.7 miles, are all proceeding at much the same speed, approximately 17kts. All were container vessels which suggest that all have better than average manoeuvring capabilities. Apparently the discussion as to the correct manoeuvre within the Rules came up with four possible responses: 1. Turn hard to port (according to rule 2b). 2. Reduce speed and turn hard to starboard. 3. Turn*

hard to starboard without reducing speed and 4. Do nothing. Let us now examine each of these proposed responses, in reverse order.

Option 4: Do nothing - This is simply not an option. A collision situation is developing with the vessel dead ahead, in such circumstances the own vessel has to take action. Once our vessel has determined that a "risk of collision exists" as per Rule 19(d), "she shall take avoiding action in ample time". Furthermore, Rule 19 (d) (i) states that we should 'avoid altering to port', which leaves us with only one remaining option, to alter to starboard.

Option 3: Turn hard to starboard without reducing speed - This is a correct response within the Rules 19 (d) and avoiding altering to port as per 19 (d) (i). It is clear that a drastic hard-over action is probably not necessary. Any reasonably apparent movement to starboard, anything say, beyond 50˚ will be sufficient to indicate to the vessel ahead that we are following the Rules and will result in allowing the vessel to starboard to draw ahead.

Option 2: Reduce speed and turn to starboard - In taking such action own ship is again clearly indicating that she is complying with the relevant sections of Rule 19.

Option 1: Turn hard to port (according to Rule 2b) - That this can be considered an option is cause for concern! Rule 2(b) suggests that actions beyond and contrary to the Rules may be necessary in order to 'avoid immediate danger'. At this point in time the vessel ahead is six miles and a little over 10 minutes away. This can hardly be construed as immediate danger. Second, even in the unlikely event that it could be construed as immediate, this situation cannot be viewed as in extremis, where no other options for safe compliant manoeuvres are available. In this case, as we can see, there are two perfectly good ones, both of which comply perfectly with the requirements of Rule 19.

Why not starboard? - So the question has to be asked, why would presumably competent seafarers contemplate such a dangerous manoeuvre to port? Or, put more correctly, why are they so reluctant to move to starboard? No apology should be made for moving into conjecture here and opt for Rule 19 (d) (ii), which states that what also should be avoided, when vessels are not in sight, is 'an alteration towards a vessel abeam or abaft the beam'. This may be convincing because a good 80% of the seafarers invariably get this wrong. It is one of the most commonly misconstrued rules in the book. The plain fact is that, in this case, Rule 19 (d) (ii) does not apply.

Why? Because the vessel to starboard does not comply with Rule 19 (d): 'A vessel (our own ship) ... shall determine if a close quarters situation is developing and/or risk of collision exists.' This vessel is proceeding parallel with us at 0.7 miles, and will remain so into infinity. She will remain at the same distance, therefore the risk of close quarters and/or collision does not even begin to exist. If this is yet another potential fatal misconstruction of 19 (d) (ii), what can be done in mitigation? Other than chucking out the whole sorry 1972 COLREGs mess and starting again, hence the argument that at least the current wording of 19 (d) should be reconstructed to remove this all too common confusion? What is needed is a set of words which make it absolutely clear that 'avoiding an alteration towards' refers to a vessel abeam or abaft beam, only when it is perceived as a close quarters or collision risk, and not, as seems to so many at sea, to apply to any vessel abeam or abaft the abeam in any circumstance. Yet again there is a Rule governing conduct in the most difficult circumstances a vessel can find herself in, zero visibility, still misunderstood by the majority of those at sea. It's high time something is done about it. Furthermore, with the advent of big data and artificial intelligent (AI) tools (Akdemir et al, 2014) it seems logical to use these tools and data to develop a decision making system for deciding which collision rule applies in certain circumstances and also involve other personnel in a ship operating company in the decision making process. In more complicated cases such as rule 19 and so forth or when several rules have to be considered an AI tool becomes more than just a feasible option.

6. CONCLUSIONS

It is clear that there are real concerns as respondents with no seafaring experience did better than expected. It is pertinent to note that results of survey were based on a sample of some 1500 people but even so the outcome is not encouraging. A new survey may have to be initiated to verify the outcome of the ACTs survey which could shed more light on the level of understanding and application of COLREGs. The introductory part of the paper has identified serious issues with COLREGs. Use of VHF has also been a case for concern. If COLREGs are understood better and interpreted correctly the probable effect will be the more confident navigational duties that officers can perform. It reduces the use and dependency on VHF.

The MET programmes are the parts of the broken segment if the COLREGs today are not as effective as it should be. There is no room for seafarers in charge of vessel to be 80% correct, what should be required are 100% confidence and no less. A set of standards for officers and

higher ranks across Europe may be helpful to justify the understanding of seafarers so that COLREGs can operate in an environment of mutual comprehension, understanding and coordination. The Project ACTs Plus online course with over 300 scenarios many of which were developed in ship simulators and videoed would help all seafarers to interpret COLREGs and apply them correctly when there is possibility of a collision. The COLREGs need to be updated to meet the improved technology demands. The more automated systems may well be included where needed. The national authorities may take the COLREGs more seriously and issue similar guidance (MCA, 2002) to their seafarer network to spread the word of COLREGs and discourage the use of VHF at sea. This paper was primarily written to warn against treating all rules equally. This is because as shown by the Pareto Analysis some of the Rules, particularly for instance Rule 19, are more challenging and hence further work as demonstrated by Case 4 above is recommended. Also it is of paramount importance to consider scenarios where more than one rule applies.

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REFERENCES

- Belcher, P., 2002. A sociological interpretation of the COLREGs. The Journal of Navigation. 55(213-214). pp.3.
- IMO, 2010. Maritime Knowledge Centre. Current awareness centre. November. p.7
- IMO, 1999. Officer in charge of the navigational watch (Model Course 7.03).1999 Edition.
- MAIB, 2004. Bridge Watchkeeping Safety Study: a case study of maritime accidents. Maritime Accident Investigation Branch.
- MARS, 2005. Use of VHF in Collision Avoidance 1. [Online] Available at: <www.nautinst.org/MARS>. Report no: 200518 [Accessed on 12 April 2011]
- Parker, C., 2010. Fairplay. The psychology of marine engineering.370 (11), pp.26
- Stitt, A.P.A., 2002. The COLREGS – Time for a rewrite?. Journal of navigation. 419-430. pp.2.
- Ziarati, R., 2006. "Safety at Sea – Applying Pareto Analysis" Proceedings of World Maritime Technology Conference (WMTC 06), Queen Elizabeth Conference Centre.
- Ziarati, R., Lahiry, H., Mohovic, D., Baric, M., Velikov, N., Teege, T., Akdemir, B., 2017. Avoiding collisions At Sea – Pareto Analysis, MariFuture, January 2017.

THE IMPORTANCE OF CELESTIAL (ASTRONOMICAL) NAVIGATION COURSE IN MARITIME EDUCATION- IMPLEMENTATIONS IN TURKEY

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Abstract text: Maritime education is a very comprehensive and international education. With the STCW Convention, the compulsory courses, content and curriculum have been determined for maritime education institutions. In Turkey, according to the STCW Convention and Regulation on the Shipmen Training and Examination, which courses should be given, the curriculum and its contents have been determined. One of these courses is celestial navigation. With the development of GPS, DGPS and ECDIS, which play an important role in the progress of the technology and accordingly fixing the location, it can be considered by many people that celestial navigation is not essential anymore. But this is a wrong belief. Because it should not be forgotten that the technology can also be disabled and malfunctioned. In case the GPS in the ship is damaged and can not be repaired, it may become compulsory to apply celestial navigation. Therefore, celestial navigation must take place at the beginning of the topics that need to be emphasized. The aim of this research is to emphasize the importance of navigating celestial in maritime education and to mention about the implementations in Turkey. According to the results of the research, it is observed that almost all of the associate and undergraduate education institutions providing maritime education in Turkey give necessary importance to celestial navigation and it is taught as a compulsory course.

Keywords: celestial navigation, maritime education, STCW Convention

Introduction

Maritime education shows many differences when compared to other educational areas. Maritime education not only addresses to not only the field of social sciences, it also addresses to the field of science. In addition; the lectures that should be given in maritime education, their content and curriculum have been determined in STCW Contract. In this respect; all educational institutions giving maritime education have to give education in

accordance with STCW. The lectures, their content and curriculum that should be given in the institutions giving maritime education have been determined with the Regulation on the Shipmen Training and Examination published by the Ministry of Transport, Maritime Affairs and Communication General Directorate of Sea and Inland Waters Arrangement depending on STCW in Turkey. Again; which labs should be existent and the materials that should take place in these lab have been determined with the same Regulation. According to this; the lectures taking place in the educational curriculum at deck operation level are sequenced as the following in the Regulation on Shipmen Training and Examination; Math, Physics, Chemistry, Shipping, Safety at Sea and Ship Safety Educations, Navigation, Maritime English, Electronics, Electricity, Meteorology, Ship Building, Watchkeeping Standards, Computer Programming and Usage, Cargo Handling and Ship Stability, International Maritime Conventions, Ship Maneuvering, Maritime Law, Maritime Communication, Maritime Management, Safety and Quality Management and Leadership and Team Work Skills. In addition; the lectures that should be given at deck management level have also been determined with the Regulation on Shipmen Training and Examination.

When STCW and the Regulation on Shipmen Training and Examination are examined, it is observed that all the lectures necessary for a deck officer and ship master have been clearly and obviously determined. All given lectures have a separate importance within themselves. However; it is also clear that one of the concepts coming to mind related to shipping is navigation. Within this respect; it could be said that the lecture of navigation has a separate importance among all the lectures. Navigation is “a science showing the methods and instructions necessary for taking a ship from a position to another within the shortest time and in safety” (Yağız, 1998). Navigation is also separated into different branches among itself. Types of navigation are as follows in terms of their methods; terrestrial navigation, electronic navigation and celestial navigation (Yağız, 1998).The purpose of this study is to emphasize the importance of celestial navigation being one of the branches of navigation.

The Importance of Celestial Navigation and the Implementations in Turkey

Celestial navigation is one of the oldest known navigation methods. One of the navigation methods most frequently applied in geographical explorations, ocean transitions and in periods in which GPSs have not been found is celestial navigation. “It is specified in written resources that the Chinese have prepared their maps in 4000 BC and Babylonians have prepared their maps in 1200 BC, Phoenicians have navigated in the shores of Mediterranean

in the same periods and they assign directions according to the stars in Homer's Odyssey (8 BC)" (Aktuğ, http:// www. kaptanhaber.com/ haber/31917/ neden-hala-goksel-seyir.html, Access Date: 04.05.2017). "It is expressed in the work called "The Aeneid" written by Virgil in 19 BC that Palinurus the Quartermaster found the direction by looking at the stars" (Aktuğ, http:// www. kaptanhaber.com/ haber/31917/ neden-hala-goksel-seyir.html, Access Date: 04.05.2017).

"When we look at today, it is seen that celestial navigation has started to disappear and it is the least used navigation method" (Aktuğ http:// www. kaptanhaber.com/ haber/31917/ neden-hala-goksel-seyir.html, Access Date: 04.05.2017). "Especially together with the usage of GPS, DGPS and ECDIS, it could be said that celestial navigation methods have stayed in the background and their usage ratio has decreased"(Aktuğ, http:// www. kaptanhaber.com/ haber/31917/ neden-hala-goksel-seyir.html, Access Date: 04.05.2017). "However; there are also the institutions in which its usage is obligatory. For instance; within the scope of Ship Inspection Report (SIRE) Programme applied by Oil Companies International Maritime Forum, it is foreseen that the compass errors should be checked via the celestial objects or the electronic positioning process in open sea should certainly be verified with celestial navigation"(Aktuğ, http:// www. kaptanhaber.com/ haber/31917/ neden-hala-goksel-seyir.html, Access Date: 04.05.2017). "As per "The Convention of the Standards of Training, Certification and Watchkeeping for Seafarers (STCW-78)"; the teaching of the principles of celestial navigation to the officers who shall take charge in the trade ships is obligatory in all over the world in the institutions giving shipping education" (Aktuğ, http:// www. kaptanhaber.com/ haber/31917/ neden-hala-goksel-seyir.html, Access Date: 04.05.2017). "A new part has been added to STCW related to celestial navigation within the scope of "2010 Manila amendments" and the subjects necessary to be taught have been clarified" (Aktuğ, http:// www. kaptanhaber.com/ haber/31917/ neden-hala-goksel-seyir.html, Access Date: 04.05.2017). It is seen that the subjects related to the celestial navigation take place in the subjects necessary to be obligatorily taught among the lectures regarding the deck operation level taking place in the Regulation on Shipmen Training and Examination in Turkey. It is also seen that celestial navigation is among must courses in the vocational schools of higher education in which shipping programs take place, vocational maritime higher schools and faculties of maritime studies giving education in Turkey. For example; celestial navigation takes place among the must courses given as 5 hours per week in Kocaeli University Karamürsel Vocational Higher School- Maritime Transport and Business Program (Lesson

Plan of Karamürsel Vocational Higher School- Maritime Transport and Business Program, 2016). When the lesson plan prepared in 2014-2015 Education Year by Yalova University Yalova Vocational Higher School- Maritime Transport and Business Program, it is seen that there is the lecture of celestial navigation in both terms as Celestial Navigation-I and Celestial Navigation-II (http:// www. yalova.edu .tr/tr/icerik /737/737/ program-hakkinda.aspx). When the lesson plan of Istanbul Technical University Maritime Faculty-Department of Maritime Transport and Business Engineering after the term 2013-2014 is examined, it could be observed that the lecture of Celestial Navigation takes place as 2,5 credits (http: //www. sis.itu.edu.tr /tr/dersplan/plan/DUI/201410.html). Again; Celestial Navigation also takes place as a must course in the Lesson Plan of Dokuz Eylül University Maritime Faculty (http://debis.deu.edu.tr/ders-katalog/2016-2017/tr/bolum_1160_tr.html).

Conclusion

Maritime education is a comprehensive and wide education type. The subjects and lectures necessary for a deck officer and ship master to know both within the context of operation and technique have a wide range. There is no doubt that each lecture and each subject taking place in this range has a significant importance. Navigation has a separate place among these lectures; because one of the concepts which are associated with maritime is shipping and the other one is navigation. In this respect; it could be said that the lecture of navigation has an importance place. Celestial navigation being a branch of navigation and not being used so much today is another important area. The purpose of this study is to emphasize the importance of celestial navigation and the implementations in Turkey. When the implementations conducted in Turkey are examined, it could be seen that the lecture of celestial navigation takes place as a must course in almost all of the institutions giving associate degree and undergraduate degree education. This situation is an important approach in terms of maritime education; therefore, it is understood that the necessary importance is given to celestial navigation by the educational institutions in Turkey.

It should not be forgotten that the method of navigation that will be applied in the event of the failure of the electronic devices notifying location during the navigation at sea, especially at open sea and ocean will be celestial navigation; for this reason, the more importance is given to the electronic navigation today, the more it should be given to celestial navigation within the same direction. Celestial navigation methods should not be only used in the detection of compass errors or sunrise-sunset times. Watchkeeping officers should get benefit from the

celestial navigation at least once during their watch as a positioning method. Within this context; importance should be given to celestial navigation as much as the electronic navigation and terrestrial navigation by the watchkeeping officers and it should be benefited frequently during the navigation.

References

AKTUĞ, Şems, 2017. Neden Hala Göksel Seyir. http:// www. kaptanhaber.com/ haber/31917/ neden-hala-goksel-seyir.html, Access Date: 04.05.2017.

http://debis.deu.edu.tr/ders-katalog/2016-2017/tr/bolum_1160_tr.html

http: //www. sis.itu.edu.tr /tr/dersplan/plan/DUI/201410.html

http://www.yalova.edu.tr/tr/icerik/737/737/program-hakkinda.aspx

Lesson Plan of Karamürsel Vocational Higher School, 2016. Maritime Transport and Business Program

YAĞIZ Fethi,1998. Seyir-I (Basic Navigation). ISBN-975-96590-0-X. Tasarım Matbaacılık, İstanbul

In the Spirit of Cooperation: A Before and After Story in Maritime Education

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Abstract This paper explores the impact of cultural immersion and awareness on two groups of maritime students from Massachusetts Maritime Academy in USA, who traveled to South Africa, Singapore and Malaysia as part of an experiential learning program in January 2017. We believe that cross cultural skills are best developed through experiential learning e.g. by studying or working in a foreign culture where one learns by trial and error. Students spent three weeks in these locations under faculty supervision and received a wide ranging exposure into maritime business and education. In South Africa, they were also engaged in imparting STEM (Science, Technology, Engineering and Mathematics) education in local high schools in Durban. One of the most important aspects of STEM education and maritime career awareness is to expose young people to it while they can still make curriculum choices that will support a future career in the maritime industry. In Singapore and Malaysia, the students were exposed to various facets of maritime business in partnership with local maritime colleges and maritime business interests. Prior to departure, the students were assessed on their Cultural Intelligence (CQ), which is an individual's capability to function effectively in situations characterized by cultural diversity. CQ is similar to IQ (Intelligence Quotient) in that it measures a set of capabilities necessary for personal and professional success. CQ, however, is unique because it focuses specifically on the skills and capabilities needed to succeed internationally and in multicultural domestic situations. Upon their return to the US, the students were assessed one more time, revealing some very interesting findings about the impact of these trips on their cultural intelligence and awareness. The before and after assessment scores were compared with worldwide norms. This paper discusses this very interesting experiential learning program and its impact on the CQ scores of students in a maritime education program and identifies further scope of research.

Keywords: Maritime education, Cultural intelligence, Experiential learning, STEM training

1. Introduction:

Based on the generally accepted premise that learning occurs through application, experiential learning is a critical component of education in Massachusetts Maritime Academy (MMA). The International Maritime Business (IMB) major has integrated this carefully into the curriculum, ensuring proper integration between the experience and the educational value that can be derived from it. All sophomore students are engaged in a five week faculty led program which is divided into three segments. This includes a pre-departure awareness and understanding, a three week travel program in an international location, and a weeklong post-travel reflection activity involving a presentation and final report submission. In the learn-do-learn tradition of MMA, the centerpiece of this course is the three week field study in a selected country absorbing the practical and cultural implications of international maritime business. An important element of this exercise was an assessment of cultural intelligence quotient (CQ).

CQ is an individual's capability to function effectively in situations characterized by cultural diversity. This includes situations that are diverse in national, ethnic, and organizational culture. It also includes diversity in gender, age, academic major, functional background, and interests. Thus, cultural intelligence has broad implications for personal and professional effectiveness across a variety of situations. CQ, is considered to be unique because it focuses specifically on the skills and capabilities needed to succeed internationally and in multicultural domestic situations (Ang and Van Dyne 2008). The importance of a proper CQ assessment for the purpose of understanding and enhancing a maritime student's world view can hardly be overemphasized. Research indicates that those kinds of awareness and abilities can be measured and evaluated. First introduced by two business researchers, Christopher Earley and Soon Ang in their 2003 book, '*Cultural intelligence: Individual interactions across cultures'*, it measures the capability to function effectively in a variety of national, ethnic and organizational settings. In a world, where crossing geographical boundaries is routine, and in a profession like maritime business where the sun never sets, CQ is a vital skill.

All students participating in experiential learning were required to participate in a CQ personal development program which is detailed out in Section 2. This program is developed by the Cultural Intelligence Center and we partnered with them to conduct the pre and post departure CQ assessments. Section 3 describes student learning experiences in South Africa, Singapore and Malaysia outlining their purpose and scope. Section 4 outlines the assessment findings used to

test the impact of the study tour on the CQ of participating students and conclusions. The purpose of this paper is to demonstrate that, with the help of strategic partners, it is possible to create opportunities that will significantly strengthen the CQ of maritime students.

2. The CQ Personal Development Program:

The CQ personal development program by the Cultural Intelligence Center is designed to:

• Trigger reflection while participants completed surveys

• Guide participants in understanding the feedback

• Encourage students to take specific action steps aimed at enhancing CQ

• Facilitate awareness and use of CQ capabilities after completion of the program

Each student received a personal feedback report. Each report included definitions of the four CQ factors, descriptive examples of high cultural intelligence capabilities, and definitions of seven individual cultural value orientations. Reports included comparisons of the individual's CQ scores with the world wide norms and feedback on the individual's cultural value orientations.

The four CQ factors are listed below:

1. CQ Drive is a person's motivation, interest, and confidence in functioning effectively in culturally diverse settings. It includes:
    a) Intrinsic Interest: Deriving enjoyment from culturally diverse experiences.
    b) Extrinsic Interest: Gaining benefits from culturally diverse experiences.
    c) Self-Efficacy: Having the confidence to be effective in culturally diverse situations.
2. CQ Knowledge is a person's knowledge about how cultures are similar and how cultures are different. It includes:
    a) Business: Knowledge about economic and legal systems.
    b) Values & Norms: Knowledge about values, social norms and religious beliefs.
    c) Socio-Linguistic: Knowledge about language and communication norms.
    d) Leadership: Knowledge about managing people and relationships across cultures.
3. CQ Strategy is how a person makes sense of culturally diverse experiences. It includes:
    a) Planning: Strategizing before a culturally diverse encounter.
    b) Awareness: Sensing the perspectives of self and others.
    c) Checking: Checking assumptions and adjusting mental maps when experiences differ from expectations.

4. CQ Action is a person's capability to adapt verbal and nonverbal behavior so it is appropriate across cultural contexts. It includes:
    a) Speech Acts: Modifying the manner of communications (e.g., direct, indirect).
    b) Verbal: Modifying verbal behaviors (e.g., accent, tone).
    c) Non-Verbal: Modifying non-verbal behaviors (e.g., gestures, facial expressions).

A week prior to departure, both groups of students traveling to South Africa and Singapore-Malaysia took the pre-departure online CQ assessment. Upon completion of the assessment, each student received a personal feedback report. The report included definitions of the four CQ factors and comparisons of the individual's CQ scores with the world wide norms and feedback on the individual's cultural value orientations. The amount of previous intercultural experience was deemed to be low or moderate as most students had never stepped out of the country.

The next step involved the creation of a CQ developmental plan by each student focusing on specific ways to use CQ strengths and concrete action steps for enhancing weaker CQ capabilities. Students were required to submit their CQ developmental plans to faculty prior to departure.

A week after returning from the foreign destinations where students spent three weeks, they were required to take a second CQ assessment. Each student received a personal feedback report as well as a group report was provided comparing the pre and post trip assessment scores in comparison with worldwide norms. The comparisons showed significant improvement in CQ assessment scores, thereby quantifying the impact of the experiential learning trips on student CQ. The feedback reports gave students tangible evidence that they have improved their CQ capabilities as a result of this experience.

3. Experiential learning and cultural immersion in South Africa and Singapore-Malaysia

South Africa

Fourteen IMB cadets traveled on their experiential learning tour to South Africa to support schools in STEM education initiatives by teaching math and science subjects. This was part of supporting government initiatives to introduce learners to the maritime industry as well as direct them towards STEM subjects which is the direction to take when eventually seeking a career in the maritime world. These were schools who had introduced Nautical Sciences and Maritime Economics in their curriculum. The students were hosted by the eThekwini Maritime Cluster (EMC). EMC is placed at the center of port activity in Durban. The aim of the trip was to enhance cultural awareness,

engage in work experience benefitting STEM education and learning about port infrastructure in South Africa. Our cadets related very well with South African school children from all walks of life, many of them whom face extremely difficult challenges in their education. They taught in various schools and there was a rich cultural exchange.

Various studies and surveys reveal that STEM education is certainly an area of high importance to the growth of any economy [2]. Further, STEM education is central to life especially in the maritime fields. One of the most important aspects of encouraging STEM education and maritime industry career awareness is to expose young people to it while they can still make curriculum choices that will support their future careers. South Africa, has a government program known as 'Operation Phakisa' to encourage careers in the maritime field. Our cadets were able to support this initiative by providing Maritime and STEM education to schools that were most in need. South Africa has relatively low international rankings in STEM education. Hence, this partnership was highly welcome and appreciated by the local hosts. Our students therefore enhanced the possibility of young people joining the maritime field in South Africa.

Singapore and Malaysia

Our main corporate partner in Singapore was ABS (American Bureau of Shipping) and the academic partner in Malaysia was NMIT (Netherlands Maritime Institute of Technology). In this initiative, twelve students spent three weeks in these locations during the months of January and February, 2017 under faculty supervision. Students were given preparatory assignments to familiarize themselves with the port infrastructure in that region. [3] They learned about the cost advantage of Malaysian ports versus the tremendous efficiency of Singapore. They were exposed to various maritime businesses in these locations and were required to make presentations on regional port competitiveness. They received the ABS business overview from various disciplines such as engineering, operations, Operations Efficiency Performance (OEP) allowing them to grasp the functions of a world leader in maritime business. Several field and institutional trips were arranged that included Keppel, SembCorp Marine, Port of Singapore Authority, Singapore Maritime Foundation, Singapore Maritime Academy, Maersk Broker Asia, PSA marine, Scorpio Asia, Kerry Logistics, MT Maritime Management, Integra Singapore.

The cadets followed a well defined schedule on location. They were expected to visit various maritime business interests, participate in industry talks and seminars, make presentations before

our global partners and also involve themselves in civic engagement programs as worthy ambassadors of MMA and the IMB program.

The aforementioned IMB experiential learning program is an excellent tool to demonstrate global civic engagement of our students. Civic engagement "involves the participation of faculty, staff and students in the civic life and institutions of the community (local, regional, statewide, national and global) through reciprocal partnerships with public, private and non-profit organizations, to address critical social issues and align curriculum, scholarship, research and creative activity with the public good" (Massachusetts Board of Higher Education 2014). Our partners in two different parts of the world were educational institutions in the maritime field and business organizations in the private and public sector engaged in maritime/international business. The students engaged with these partners in a mutually rewarding learning experience. This ranged from teaching STEM subjects in high schools in South Africa to interacting and learning from maritime business professionals in Singapore and Malaysia. During their stay in the two locations, they also experienced complete cultural immersion. Some of these students had never stepped out of the US prior to this trip. Upon completion of the trip, students were required to take another CQ assessment. The next section summarizes the findings of the assessments.

4. Results of the CQ Assessments

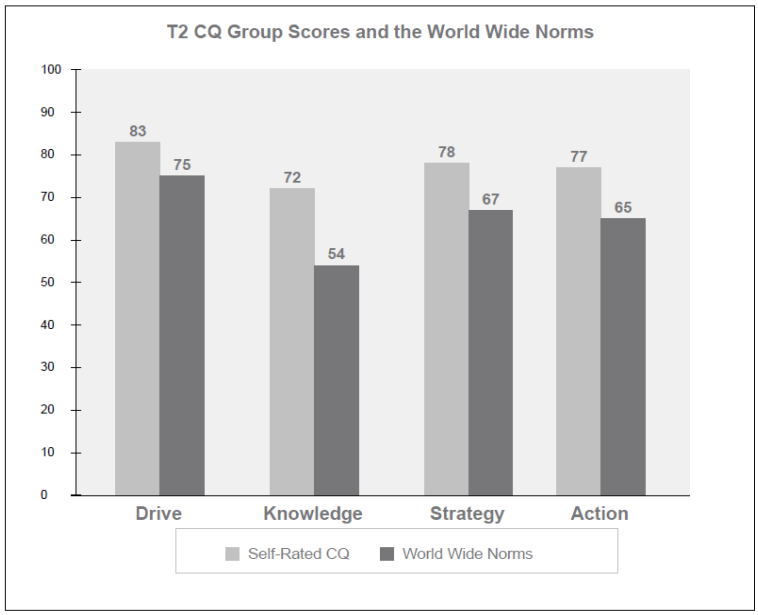
We ran a second CQ assessment on each group of students upon return to the US. The results of the assessment were summarized by the Cultural Intelligence Center.

As the results suggest, there was clearly an improvement in the CQ scores of students after the trip, the most marked areas being CQ knowledge (knowledge about how cultures are similar or dissimilar) and CQ action (capability to adapt verbal and nonverbal behavior so it is appropriate across cultural contexts).

As in the previous case, there was clearly an improvement in the CQ scores of students after the trip to Singapore/Malaysia, and interestingly enough, the most marked areas were CQ knowledge (knowledge about how cultures are similar or dissimilar) and CQ action (capability to adapt verbal and nonverbal behavior so it is appropriate across cultural contexts).

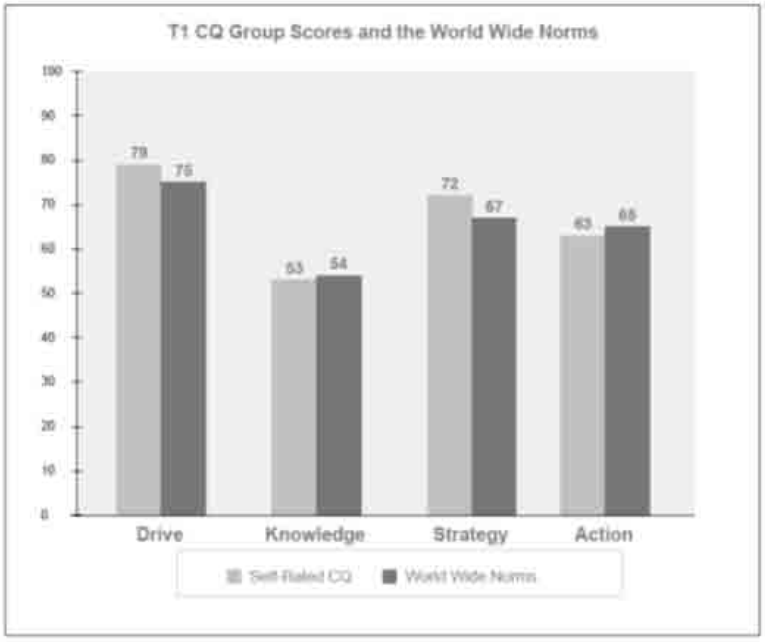
This cultural competence assessment will be a valuable addition to existing student learning assessment tools. We will be incorporating this CQ assessment in all our future experiential learning initiatives.

Fig 1: Comparative assessment of the T1 and T2 scores of the South Africa team with worldwide norms



The following summarizes the CQ scores for this group compared to the World Wide Norms

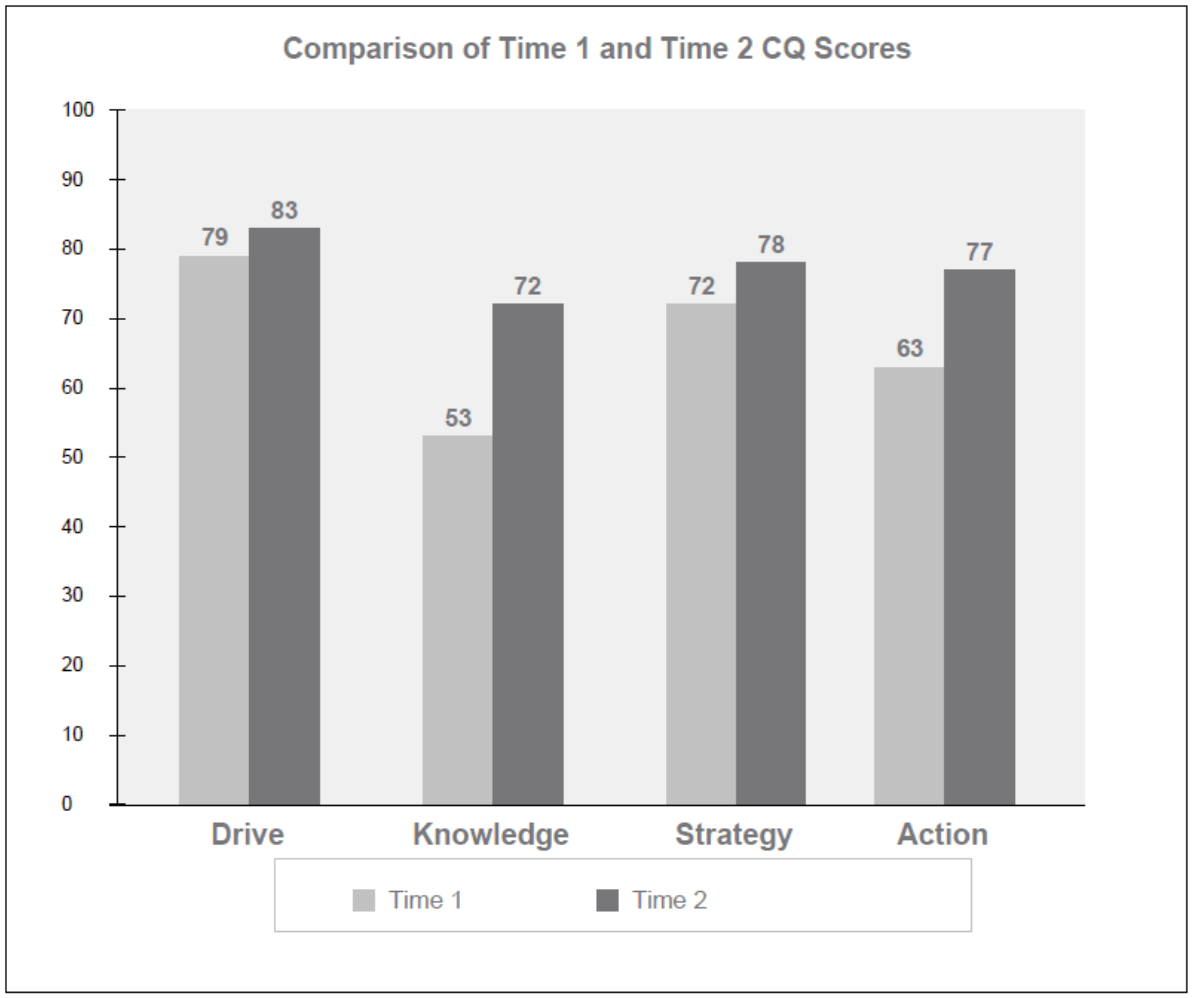
CQ Drive	Average Self-Rated CQ Drive is GREATER THAN World Wide Norm by 8 points
CQ Knowledge	Average Self-Rated CQ Knowledge is GREATER THAN World Wide Norm by 18 points
CQ Strategy	Average Self-Rated CQ Strategy is GREATER THAN World Wide Norm by 11 points
CQ Action	Average Self-Rated CQ Action is GREATER THAN World Wide Norm by 12 points



The following summarizes the CQ scores for this group compared to the World Wide Norms

CQ Drive	Average Self-Rated CQ Drive is GREATER THAN World Wide Norm by 4 points
CQ Knowledge	Average Self-Rated CQ Knowledge is LESS THAN World Wide Norm by 1 points
CQ Strategy	Average Self-Rated CQ Strategy is GREATER THAN World Wide Norm by 5 points
CQ Action	Average Self-Rated CQ Action is LESS THAN World Wide Norm by 2 points

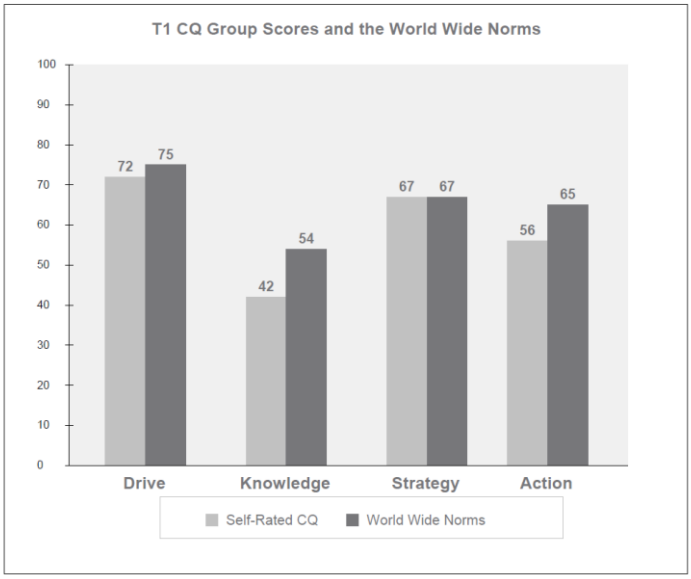
Fig2: Comparison of the T1 and T2 CQ scores of the South Africa team



The following summarizes the comparison of Time 1 and Time 2 CQ scores for this group

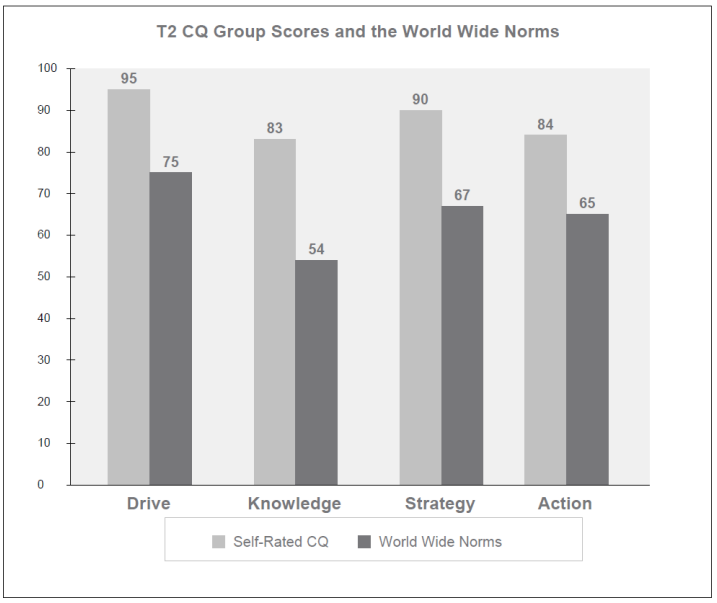
	Avg Scores	% Changed
CQ Drive	79 -> 83	5%
CQ Knowledge	53 -> 72	36%
CQ Strategy	72 -> 78	8%
CQ Action	63 -> 77	22%

Fig 3: Comparative assessment of the T1 and T2 scores of the Singapore Malaysia team with worldwide norms



The following summarizes the CQ scores for this group compared to the World Wide Norms

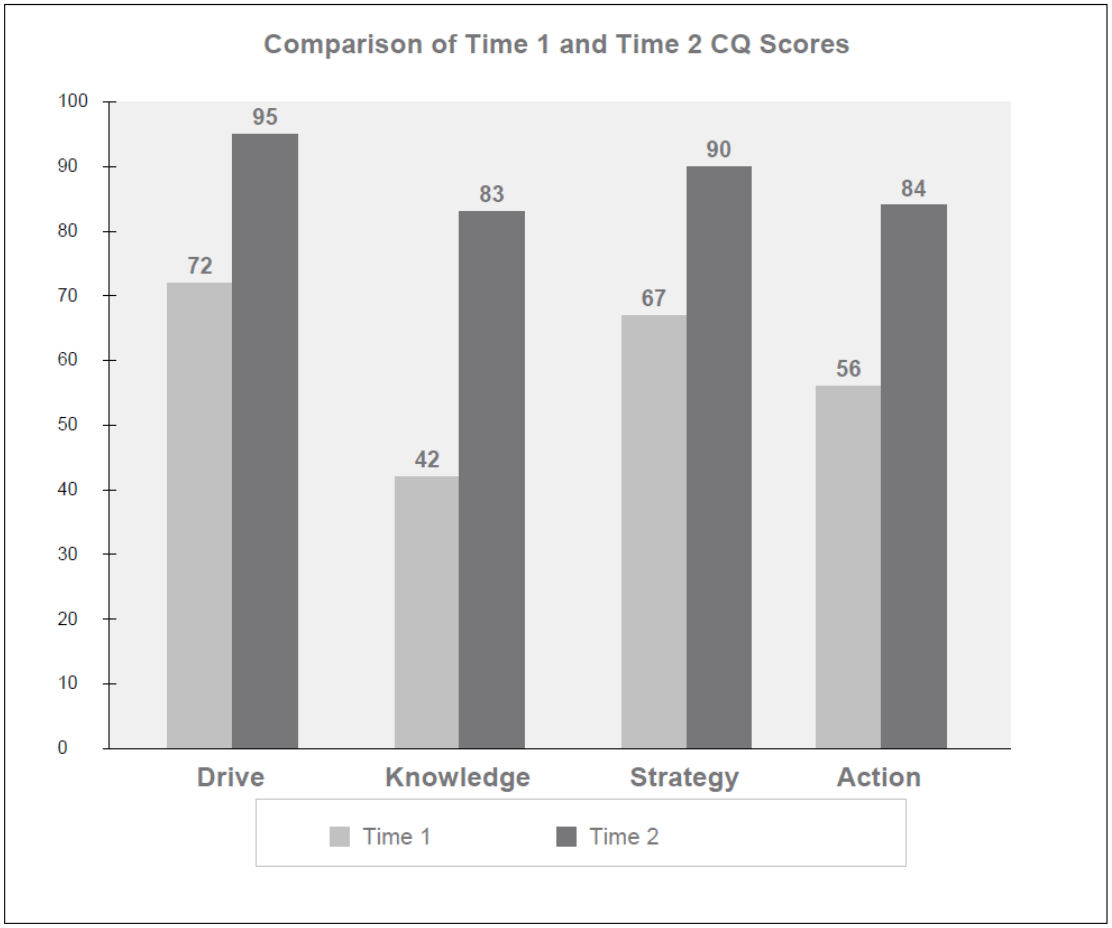
CQ Drive	Average Self-Rated CQ Drive is LESS THAN World Wide Norm by 3 points
CQ Knowledge	Average Self-Rated CQ Knowledge is LESS THAN World Wide Norm by 13 points
CQ Strategy	Average Self-Rated CQ Strategy DIFFERS FROM World Wide Norm by 0 points
CQ Action	Average Self-Rated CQ Action is LESS THAN World Wide Norm by 9 points



The following summarizes the CQ scores for this group compared to the World Wide Norms

CQ Drive	Average Self-Rated CQ Drive is GREATER THAN World Wide Norm by 20 points
CQ Knowledge	Average Self-Rated CQ Knowledge is GREATER THAN World Wide Norm by 29 points
CQ Strategy	Average Self-Rated CQ Strategy is GREATER THAN World Wide Norm by 23 points
CQ Action	Average Self-Rated CQ Action is GREATER THAN World Wide Norm by 19 points

Fig4: Comparison of the T1 and T2 CQ scores of the Singapore Malaysia team



The following summarizes the comparison of Time 1 and Time 2 CQ scores for this group

	Avg Scores	% Changed
CQ Drive	72 -> 95	32%
CQ Knowledge	42 -> 83	98%
CQ Strategy	67 -> 90	34%
CQ Action	56 -> 84	50%

5. Conclusion

Our assessment exercise validates Montrose who wrote, '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' (Montrose 2008).

The maritime sector is probably the most global sector with a very diverse workforce. It is increasingly important for the maritime professional to demonstrate proficiencies on the four measures of CQ discussed in this paper. As our case studies in experiential learning have demonstrated, this could be an important tool for enhancing CQ capabilities of our students. Based on the generally accepted premise that learning occurs through experience, international experiential learning can be a critical component of education in maritime institutions developed through partnerships between member institutions of IAMU.

References:

ANG, S. and VAN DYNE, L. ed 2008. *Handbook of Cultural Intelligence*. M.E. Sharpe.

EARLEY, C. and ANG,S. 2003. *Cultural intelligence: Individual interactions across cultures.* Stanford University Press.

STUDY GROUP ON CIVIC LEARNING AND ENGAGEMENT. 2014. *Preparing citizens report on civic learning and engagement*, Massachusetts Board of Higher Education.

MONTROSE, L.2008. *International study and experiential learning: The academic context. Frontiers:* The Interdisciplinary Journal of Study Abroad. Retrieved from: http://www.frontiersjournal.com/issues/vol8/vol8-08_montrose.htm

TEACHING MARITIME LEADERSHIP TO THE MILLENNIAL GENERATION AND BEYOND

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Abstract

The Millennial Generation or Gen Y - those born approximately during the years 1980-2000 - have entered the workforce or will be entering soon. This generation will be moving into leadership positions in the very near future. The generation born in about the year 2000 and beyond is now being called Generation Z. The Gen Z students will be entering our universities next year and we need to be ready for them. They are as different from Millennials as the Millennials are from Gen X, the generations that preceded them. Unless the educators understand these distinctions, the lessons may go unlearned or at least under-appreciated by those who will be entering the maritime workforce and assuming leadership roles in the next few years.

While technical competence is paramount for all sea-farers, the ability to assume leadership roles is much more difficult to quantify and to teach. Today's students entering maritime universities around the world often have different learning styles and different values from those who have dedicated their lives to teaching both the technical skills and the leadership skills required for today's mariners.

Keywords: Leadership Development, Maritime Leadership, Millennials, Gen Z

Introduction

If you want happiness for a lifetime, help the next generation. /Chinese proverb/

There can be as many definitions of the word leadership as there are people trying to define it. We know it when we see it, but how do we teach it? The way students learn today, not only soft sciences such as leadership, is very different from the way most faculty and mentors developed

their own skills. In order to effectively develop leaders for today and for the future of the maritime industry, we must learn more about who we are teaching, how they learn and what we mean by Maritime Leadership. The Maritime Model of Leadership has been defined in previous IAMU presentations (Kreta 2015) in this way:

> *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.*

For our students to truly comprehend the significance of this model, we, as faculty and mentors, must better know our students.

What is a Millennial?

The term "Millennial" was coined for the children born just before the turn of the century. Especially in the US, the groups of those born at certain times, and with typical attributes, have been grouped into approximate generational terms. The Center for Generational Genetics (2016), a research and consulting firm out of Austin Texas, states that there are "three key trends that shape generations; parenting, technology and economics". The Center's research leads them to distinguish the following five generations based on birth years:

- Gen Z, i-Gen, or Centennials: Born 1996 and later
- Millennials or Gen Y: Born 1977 to 1995
- Generation X: Born 1965 to 1976
- Baby Boomers: Born 1946 to 1964
- Traditionalists or Silent Generation: Born 1945 and before

Other organizations have slight variations of dates and names, but essentially, the individuals in these groups tend to share common experiences and goals, and perhaps most importantly to us – learning styles. Here are some attributes of each generation as far as shared experiences:

- Gen Z, iGen, or Centennials: Born 1996 and later
    - September 11, 2001, the World Trade Center attack in New York, is mostly part of their history, not their experience
    - These are our current typical college age students
- Millennials or Gen Y: Born 1977 to 1995
    - Have become the largest generation in the US workforce
    - First to come of age in the new millennium
- Generation X: Born 1965 to 1976
    - Short period between Baby Boomers and Millennials, with Gen X picked as a nickname for a group that seemed hesitant to be defined
    - Parents of Gen Z entering College today
- Baby Boomers: Born 1946 to 1964
    - Born after WW II, ended with the emergence of the birth control pill in 1964
    - Approximately one-third of the current US population
- Traditionalists or Silent Generation: Born 1928-1945 and before
    - Were children of the great depression and WW II
- G.I Generation: Born 1901-1928
    - Often called "the greatest generation" this generation fought in WW II

Images

We have watched technology define communication styles over the last decade or so. While many of us may fondly remember the formality of the business letter, the recent generations have quickly moved from business letter to email to text to images (emoji's). What this evolution shows us is not only a casualness, and separation of style from other generations' long held traditions, but also that speed and the ability to interpret differently are important to this generation. We may remember (and believe in its truth) the expression that a picture tells a thousand words, but it would have never occurred to most of us to use a smiley face in correspondence to show our appreciation.

Nevertheless, in this always connected generation, images are the communication language of choice. If we want to connect with this generation, and to teach them, we must adapt to their learning and communication style. We are not suggesting that we all must drop our traditional

modes of communication and teaching, and pick up text messaging as our teaching method. What we are suggesting is that we must realize the real value, strength and purpose of imaging and use that to our advantage when promoting the lessons of maritime leadership. And the most powerful image we have is not on a cellphone or computer or social media page – it is ourselves.

Our students must look at us and see the traits we try to imbue in them, those of a strong and effective maritime leader, such as those stated above; one who is ethical, responsive and goal-oriented, who strives for excellence, demonstrates integrity, and is confident, ever-learning and adaptive. Our students learn from us every day – inside and outside the classroom - so we must practice this every day, in the significant and in the simple decisions we make every day – the way we dress, talk, act, work and play.

And if and when we fail to show those traits, they must see us take responsibility for our actions. When our students see in us the example of what they need to be, then they will trust and respect us, and allow us to influence them in positive ways. Then we can become mentors, and then, and only then, can we teach them.

What can we do to really mentor and teach our students? Tim Elmore has been studying and writing about the younger generations in books and blogs for some time. In his book, Generation i-Y (2015), he suggests we as mentors need to be "velvet covered bricks." Velvet on the outside – responsive, accepting and supportive, while hard as a brick on the inside – lead by principles, set boundaries, and hold them to standards. He provides six strategies to bring out the best in leadership skills of this new generation.

- Cultivate a relationship
- Earn the right to be heard
- Communicate belief
- Teach like a mentor
- Remove the fear of failure
- Challenge them with hard assignments

Little things are important

In many ways, the role of a mentor is akin to being a coach. John Wooden, perhaps the most famous and successful college basketball coach in American history, always started from the basics to provide the fundamental skills to be a great basketball team. In his book, Wooden (1997) recalls that on the first day of practice, he would teach his players how to put on their socks. As players complained about this basic lesson, he told them that a rolled sock could lead to blisters, which could lead to performance issues for an individual player, which could lead to the overall performance of the team. Leadership is part of being an effective player on a team, and it starts with the way one prepares for his or her position.

Mindset

In her best-selling book titled "*Mindset*", Dr Carol Dweck (2016) discusses whether success (or failure) in areas such as art, math and sports are due to an innate natural ability or a function of mindset. Her research has shown that those with the *growth* mindset, those who strive for excellence, and are motivated by getting better, rather than by the fear of failure, are those who reach their highest potential – the greatest level of success. We must show our students, that regardless of their self-perceived talents and strengths or weaknesses, they all have the potential to be leaders in our maritime industry, and keep motivating them to become so. Our industry requires this of us as maritime educators.

The qualities defined in the Maritime Model of Leadership are not going away with the coming of the newest generation. In fact, they are possibly more important for our future leaders to possess as they break into an industry that is routed in these traditions with future employers who value these qualities. As current educators, we primarily find ourselves as members of the Baby Boomer & Generation X generations. We tend to see the world in binaries; black or white, conservative or liberal. As discussed above, the younger generations seem to enjoy paradoxes and fluidity. They seem to combine worldviews and they resist forces that push them into predetermined molds. Thus, the question of how to teach these qualities to the younger generations persists. Since the mindset of the student has changed since we were students, it is important then for our teaching strategy to

change as well. Along with the growth mindset, we suggest combining Leonard Sweet's EPIC style of preaching with Tim Elmore's "Seven Steps for Leading When You Can't Understand Them" in order to achieve success.

EPIC Model

Leonard Sweet (2015) introduces the idea of EPIC preaching as a realization that traditional methods no longer reach the younger generations. In the twenty-first century, which he says is full of "chaos and paradox", he challenges us to step outside our comfort zone and grow in order to reach our current audiences. In a similar fashion, educators must grow and adapt their ways of teaching in order to reach today's students. Sweet's EPIC model can be very transferable to the field of education and is explained below.

E - Experiential

"What rational was to the Gutenberg world, experience is to the Google world" (Sweet 2015, p. 44). Today's students are not engaged by lecture; they are seeking a true hands-on experience. They are looking for a guide, not a lecturer. This can be achieved by creating environments where students can truly engage with the lessons we are trying to convey. An example would be creating leadership opportunities that match their skill and knowledge level. These opportunities can scaffold up in scope and responsibility as more knowledge is gained, but it gives them a safe environment to experiment with what they have learned.

P - Participatory

"While experience can sometimes be passive, participation turns people into active agents of initiation and response" (Sweet 2015, p. 51). Students support what they help to create. Providing students with opportunities to practice what they are learning or to help drive decisions will allow them to take ownership and be more invested. Examples range from letting students vote on an issue to giving them the opportunity to sit on a campus-wide committee to giving them the opportunity to teach/facilitate a topic with which they can connect.

I - Image Rich

"One of the shifts we need to make… is to realize that the power isn't in the words – it is in the images, the stories" (Sweet 2015, p. 56). Today's students have always known a world full of images and stimulation. They have never known a world that did not include the TV or the computer. As the saying goes, "A picture tells a thousand words" and in the world of social media, imagery is what invites people to participate. Here, an example would be infusing graphics into worksheets to break up text or videos into presentations. This will allow the students to make sense of the information in a way that makes more sense to them.

C- Connected

"Invite people to connect with each other so they can better understand" (Sweet 2015, p. 59). Today's students are constantly connected – to each other and the outside world. They are used to being able to share their thoughts and opinions. Engaging students in the conversation and creating ways for them to share their ideas can help them connect to a topic and the people around them. An example would be providing opportunities for students to process new information in a smaller group. As a part of a workshop, rather than having one person talking the entire time, break it up by asking the students to form small groups and discuss the larger topic. To keep them focused, this could involve providing some probing questions or asking for an outcome. This allows them to bounce ideas off of one another, have an active role in where the conversation is going, and feel connected with those around them.

All four of Sweet's tenants are equally important in shaping a transformational learning environment, but they are nothing if you yourself cannot connect with your students. Tim Elmore (2017) posits that each generation has difficulty relating to the next and that it can be difficult to relate to younger generations when you don't truly understand them. Elmore believes that there are seven steps to leading those you don't understand, specifically the coming generations, which are outlined below.

- Give Them Slack: Allow them to express themselves in innovative ways
- Don't Freak Out: Freaking out at their seemingly odd choices shuts them off
- Affirm what you can: Find the positive elements of their identity that you can affirm and give them 100% of your attention
- Call Out What is Harmful: Help them discover which expressions and choices may be harmful
- Offer the Long View: Help them recognize the long-term implications of poor decisions
- Help Them Focus: Help them discover their best self by equipping them to focus on their unique style, talents, and strengths.
- Tell the Truth: Never sacrifice a truthful, genuine conversation in fear of not connecting

How then do we combine all of this in order to bridge the gaps between today's students and ourselves? We become aware and even more intentional. We must recognize how we are different and how we similar from those we are teaching – and we need to use both to our advantage. We must look to provide leadership opportunities that are appealing to the upcoming generations and get them involved early. We must be willing to step outside our own comfort zones and meet them where they are.

Conclusion

In his book, "Lincoln on Leadership", author Donald Phillips (1992) breaks down the leadership attributes of one of America's greatest presidents who led America through one the most troubling times in American history. He divides the book into four sections, each which prescribe those important leadership areas that we, as mentors and "images" to our students must follow if we are serious about preparing them for the maritime industry. These sections are; People, Character, Endeavor, Communication. Using some of the methods discussed above, and focusing on how we treat people, the character we embody, the goals we endeavor to reach, and the manner in which we communicate to our peers, subordinates, and supervisors, will allow us to be the "images" seen by our students regarding how to model maritime leadership.

References

CENTER FOR GENERATIONAL KINETICS., 2016. Generational Breakdown: Info about all of the Generations. Available from http://genhq.com/faq-info-about-generations/

DWECK, C. S., 2016. *Mindset*. New York City , NY: Ballantine Books.

ELMORE, T., 2015. *Generation i-Y, Secrets to Connecting with Today's Teens and Young Adults in the Digital Age*. Atlanta , GA: Poet Gardener Publishing.

ELMORE, T., 2017, May 2. How to lead a Student you just Don't Understand. Retrieved May 12, 2017, from https://gowingleaders.com/blog/lead-student-just-don't-understand

KRETA, S. J., 2015. Defining and Designing a Comprehensive Leadership Education Program using the Maritime Model of Leadership. *IAMU AGA 2015,*161-165.

PEW RESEARCH CENTER, DISCOBERY RESEARCH GROUP., n.d.. Millennials; A Portrait of Generation Next. Available from http://www.discoveryresearchgroup.com/landmark/my-generation-segmenting-characteristics-of-generation-x-y-z

PHILLIPS, D. T., 1992. *Lincoln on Leadership*. New York City , NY: Grand Central Publishing.

SWEET, L., 2015. Blood Word: Making Narraphors EPIC. In *Giving Blood: A Fresh Paradigm for Preaching*. pp. 43-63. New York City, NY: HarperCollins Publishing.

WOODEN, J., & JAMISON, S., 1997. *Wooden – A Lifetime of Observations and Reflections On and Off the Court*. Lincolnwood, IL: Contemporary Books.

INTERNATIONAL MARITIME MANAGEMENT: A DISTANCE-EDUCATION M.SC. COURSE FOR NAUTICAL OFFICERS ON BOARD SEA-GOING SHIPS

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Abstract The paper outlines the special instructional design of International Maritime Management (IMM) which allows active seafarers to combine their work on board vessels with a distance-education university degree course at Master's level (L7 according to the European Qualifications Framework, EQF). The highly flexible didactic concept of the degree course includes a series of pedagogical elements by which students can enjoy maximum transparency in their learning process. Sea times without a permanent access to the Internet do not hamper the learning progress while students are able to allocate study times in line with their professional duties on board and with family requirements. The general approach is to integrate the students' professional background into their studies in order to put theories into practice and to reflect on professional matters simultaneously. This integration means that the learners apply the theoretical knowledge they acquire throughout their studies to professional issues they are faced with in their daily work life. All modules are taught entirely in English language.

IMM has started in September 2017 after a five-year development and trialling phase. During this trialling period nearly 200 international students were enrolled as test students. The accompanying continuous monitoring process has led to substantial empirical findings of an extensive research into higher education. This research has not only contributed to a constant improvement of the didactic concept, it has also provided an insight into the learning strategies adopted by participating students.

The paper introduces the didactic concept of IMM including its integral elements of self-assessment to fathom out the students' perceived knowledge growth and open-book assessment which takes into account the professional environment of its learners. It also presents the findings of the empirical education research carried out including figures on student motivation, typical study workload of active seafarers and student retention issues.

Keywords: post-graduate distance education, combining work and study, didactics, instructional design

Introduction

When nautical officers complete their under-graduate studies of Nautical Sciences they usually start their primary profession on board seagoing ships. On average, they will continue to work at sea for a period of some five years after which they typically take on jobs in management positions on the secondary market ashore. The specific work conditions on board are characterised by long absence phases of several months. The extended sea time leads to a personal situation which causes women and men to judge their professional activities and family duties as incompatible with university studies (Caesar et al. 2015).

Around 80 percent of the world trade cargo is transported by ship (Allianz Global Corporate & Speciality SE 2016) leading to a high demand for qualified personnel capable to organise transport chains. Mobility of people and goods is a catalysing factor for a functioning economy. The world-wide transport chains require interdisciplinary solutions for international challenges. The professional area is subject to a highly dynamic development which makes an on-going learning process indispensable. The possibility of combining university studies with the target groups' work is especially attractive as post-graduate students do not have to give up their nautical career in order to obtain a higher university degree. Nautical offices can acquire practical experience during their active time as a seafarer while simultaneously pursuing an academic career to prepare themselves for a highly qualified position ashore.

In order to cater for this very special demand the Faculty of Maritime and Logistics Studies of Jade University of Applied Sciences has developed the study course of International Maritime Management (Jade HS 2017a). During a five-year development and trialling phase conceptual questions had to be answered first. Based on a target

group analysis and in contrast to existing maritime studies the course structure, the study plan and the curriculum were developed. The most important result of the first research phase is a didactic concept that takes into account the very special target student group (Nause et al. 2013). Among other topics it includes the organisation and combination of self-study periods and attendance phases. It also delivers a structure for the teaching and learning material. An exemplary implementation was carried out on a pilot module (John/Nause 2016; Nause/John 2014a). In all order to guarantee a successful implementation lecturers were assisted didactically and technically in the development of their modules. Following this trialling phase all other learning modules were produced. From the winter semester 2015 onwards all modules were offered, studied by test students and evaluated systematically (Nause et al. 2016; Jade HS 2015). The results of this evaluation were used to develop the study concept further.

For the first time in Germany the special requirements of the target student group of active nautical offices have been considered:

- Work on board seagoing ships is characterised by long and irregular phases of work and holidays. Nautical offices can be at sea for periods of up to six months. The didactic concept of the study course needs to enable learners to study the course contents flexibly and independently from their university.
- The students work on ships which are underway in different and constantly changing time zones. Consequently, the exchange of information can only be achieved through asynchronous means of communication.
- On board seagoing ships no permanent connection to the Internet is given, with the exception of emails which may be sent without attachments. The limited access to the Internet leads to the fact that students do not enjoy a continuous access to teaching and learning material nor to additional important information.

Theoretical considerations

The architecture of distance education courses has different requirements related to their didactics concept than study courses which are offered on campus. Students cannot be motivated and tutored directly by their lecturers. Consequently, a custom-tailored organisation is required which complies with the demands by the target student group with regards to an incorporated program of work and study.

At this point our didactics concept is summarised in a nutshell: The term didactics refers to the "theory and practice of teaching and learning" (Jank/Meyer 2002, p. 14 cited by Schlutz 2006, p. 81). Following the supply development model according to Schlutz (2006), question words are used to determine the programme to be planned and to figure out in how far the questions are mutually dependent (ibid, p. 78):

- For what: What utility does the programme offer?
- For whom: Which target group is addressed?
- Based on what: What are the participants' prerequisites to achieve the learning objectives and qualifications?
- What: Which contents are delivered?
- How: Which organisational forms and (main) methods are applied?
- With what, Where: Which media and learning locations are used?

The special requirements are based on the distance of students to the study location. For this reason, a blended learning concept is applied whereby the distance is inversely proportional to the share of attendance time. This includes concepts which combine classic learning methods with e-learning to create a "useful overall concept" (Sauter/Sauter 2002, p. 246). The mixed methods approach combines distance learning and attendance phases as required by the correct characteristics of the target group (Zumbach 2010). In distance education, a virtual classroom is implemented by means of a learning management system (LMS). This learning platform provides administrative and content-based functions, it helps learners and lecturers to communicate, it controls learning processes, it delivers files and electronic assessment functions and it can be used for scheduling deadlines (Rippien 2012).

Didactic Concept

In order to provide for the requirements of the target group of active nautical officers, a purpose-built pedagogical concept needs to deliver a learning framework in line with their professional situation. This applies to the whole study course but also to the individual learning modules. Given the long distances between students and the study location a combination of distance education and on-campus education has been integrated into the learning and teaching concept. Here, asynchronous distance education is combined with short attendance phases to cover specific learning topics.

In the following the didactics concept of IMM is presented. The structure of this paper follows the design of the study course concept. After an introduction of the study course structure the individual module's structure is presented.

Degree Course

IMM includes a regular part-time study duration of five semesters. The study course provides students with a M.Sc. degree of 90 credits according to the European Credit Transfer System. The study course consists of eight modules of six credits each, one module of 12 credits and a Master's thesis of 30 credits:

All modules are completed with an assessment. This assessment may comprise essays,

No.	Learning Module	Credits
IMM01	Academic Research Methods	6
IMM02	International Maritime Law	6
IMM03	Enterprise Information Management	6
IMM04	Maritime Business	6
IMM05	Green Shipping	6
IMM06	Cost & Yield Management	6
IMM07	Maritime Management Applications	2*6
IMM08	Case Studies	12
IMM09	Master-Thesis	30

Figure 1: Study plan, own illustration.

written examinations, presentations with discussions or a business game. The Master's thesis also includes a presentation to the examiners. The selection and assignment of modules and assessment elements guarantee the achievement of different competencies which reach across different modules. In line with the international character of the maritime economy the whole study course is taught in English language.

A distance education Master's degree course needs to take into account that students will carry out their professional activities simultaneously with their studies. This aspect is reflected and supported throughout the whole IMM course. Students can choose modules flexibly so that they can combine their studies with their individual situation in life and in their professional environment. It is possible to postpone or interrupt parts of their studies should the individual professional and/or family situation require this. For

example, students can study one module only per semester or they can take semesters off.

IMM uses modern technology for distance education. A central instance is the virtual lecture theatre (i.e. LMS). Students access the electronic teaching and learning material by means of this platform which also guarantees the access to additional information. The LMS also provides a communication platform on the basis of asynchronous discussion forums which are used by learners and lecturers. The learning management system is also used to provide students with mandatory self-learning quizzes which are integrated into different modules with the aim to give evidence of the learning progress. Students can take these tasks as often as they like and independently from their time zone and location. The quizzes include questions which focus on reproducing knowledge, and the students' responses are immediately assessed by the system and related back to the students.

The concept of the study course takes into account the students' professional situation with respect to the number of attendance phases at the Faculty of Maritime and Logistics Studies in Elsfleth:

- Students start their first semester with an attendance phase in Elsfleth. During this first meeting the focus lies on meeting lecturers and learners and on reducing communication barriers. The attendance phase also encourages students to create learning groups and networks. An introduction to the LMS is given, the electronic library is presented and the structure of the study course modules is introduced. Students also learn how to cope with the central requirement of self-organisation in their distance education studies.
- In the subsequent attendance phases students sit examinations, participate in an electronic business game and deliver presentations and discussions. The organisation and implementation of the presentations resembles an academic conference. Furthermore, students are prepared for the Master's thesis by means of a seminar. The seminar introduces the time frame and structure of the thesis, first questions can be discussed and support can be given with regards to the definition and thematic approach of diverse issues.

Students decide for themselves if they travel to Elsfleth once, twice or three times to take one, two or three examinations per attendance phase. The attendance phases are offered twice a year, always at the beginning of the summer and the winter semester: they take place on the weekend before 1 March and on the weekend before 20

September. This is the traditional start of the summer and winter semesters at Jade University of Applied Sciences.

Another element is the increased permissibility of professional academic education as well as the support of lifelong learning as central elements of the Bologna process (BMBF 2017). For this purpose a structured cross-crediting method has been developed (Jade HS 2017b). In IMM competencies achieved in tertiary education as well as outside an academic environment can be cross-credited as regular modules. The aim is to reduce any redundancies. This means that competencies acquired in previous studies do not have to be studied again. Potential students can ask to have their competencies cross-credited prior to beginning their university studies. The resulting shorter study time is useful for students with a limited time budget due to professional and family duties. The shorter time also facilitates the decision to take on the task of distance education studies.

Learning Modules

Following the didactics concept of IMM, all modules incorporate a homogeneous structure. The uniform module design assists students in their orientation and provides a more accessible study process of the whole study course (Nause/John 2014b).

All learning materials are available right from the start. The LMS provides course books, additional information and the open-book assessment questions. In a student-centred approach, learners acquire the theoretical knowledge themselves by means of the provided course books. These scripts are mainly didactically prepared texts (Grassl 2013; Holmberg 2005) which are made available to students in a PDF format and as e-books. The course books start off by explaining the intended learning objectives from a student's perspective. Then, the individual chapters are presented which are organised in a way that permits learners to make progress in relatively short learning phases. These short phases aim to enable students to combine their studies with their professional and private life. All chapters conclude with reflection questions so that students are encouraged to learn actively and independently. The reflection questions provide a linkage to the students' existing competencies which allows them to construct and apply knowledge (instrumental competencies). Individual application cases are raised and discussed in Internet for asynchronous communication. During these learning processes, students exchange ideas with their peers and learn from the different (professional)

backgrounds. Lecturers accompany them in their learning processes (communicative competences).

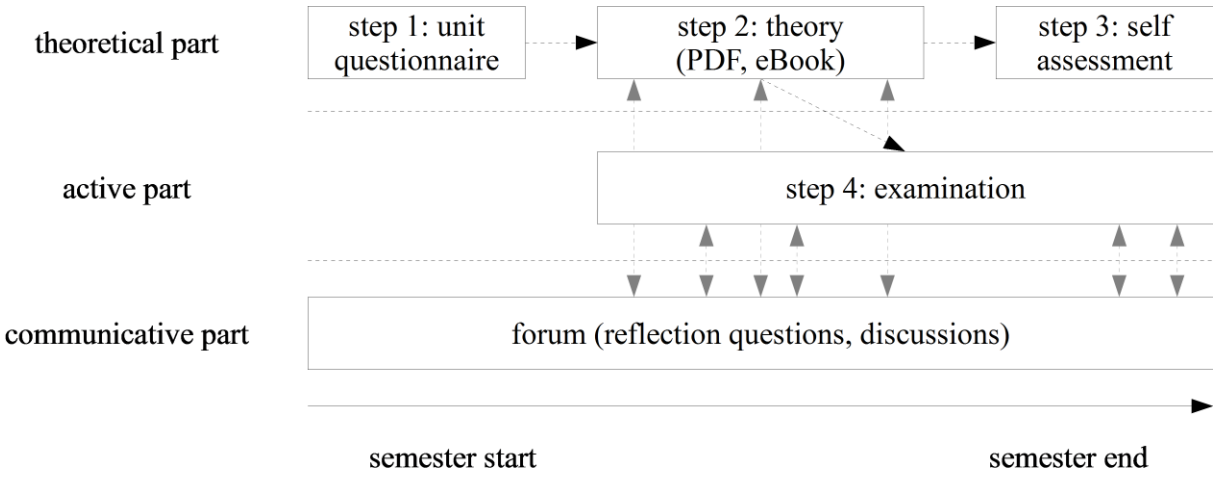

Figure 2: Learning module structure, own illustration.

Right from the start of each module, students are confronted with the module assessment, i.e. they know the general assessment questions and can use them for their individual learning curve by integrating the tasks into their professional context. By covering student-centred topics based on authentic issues from their professional environment students can link these with the theoretical constructs provided by the different modules thus acquiring the respective competences systematically. Taking into account existing knowledge and the students' professional background encourages learners to reflect on their own actions. Hence, a close relation of theoretical and practical considerations is established. This approach is complemented by realistic case studies and an electronic business game. The aim is to mitigate the inherent risk of traditional teaching whereby students firstly acquire basic knowledge and methodologies and then construct a possible application for them (Webler 2002, p. 221).

At the beginning of each module, students evaluate their knowledge by means of anonymous surveys on the respective learning objectives. Here, learners assess their individual knowledge level on a Likert scale. This approach is very reliable and it connects the new learning objectives with existing competences (Hattie 2009, p. 44f). The magnitude of the perceived learning effect can be calculated and used as one indicator for the module's "success". The survey also helps students to understand the learning objectives of the different modules and to estimate the required effort to achieve them.

Conclusion

For the first time in Germany, the study course of International Maritime Management assists active seafarers on board sea-going vessels in pursuing a career in the transport and logistics domain ashore. An individual personal development is targeted by means of a distance-education course at Master's level which combines the students work environment with the acquisition of new competences. The study programme started in September 2017 after a two-year trialling phase with nearly 200 volunteering test students. Some of the test students have successfully passed all modules while others were only interested in specific learning modules. The continuous evaluation process has shown that the course's concept is aligned with the special requirements of the target student group: *International Maritime Management can be studied by active seafarers while they work on board sea-going ships.* Nevertheless, the testing and trialling phase has also pinpointed scope for further development: Planning their studies carefully plays an even more important role for working students as anticipated: a clear need exists for communicating study progress, assessment requirements and dates and deadlines at a very early stage. Mature working students possess a high expertise of skills and competences acquired on board ship which can be integrated into their university studies. On the other hand, they have high demands as to the quality of their studies. The testing and trialling phase has been able to prove that despite the high discipline required from students by working and studying simultaneously, a custom-tailored study programme is indeed capable of providing them with the right means to make further progress in their academic and professional career.

References

Allianz Global Corporate & Specialty SE (ed.) (2016): *Safety and Shipping Review 2016.* Munich.

Bundesministerium für Bildung und Forschung (BMBF) (2017): Der Bologna-Prozess – die Europäische Studienreform. URL: https://www.bmbf.de/de/der-bologna-prozess-die-europaeische-studienreform-1038.html (Accessed on: 08 May 2017).

Caesar, L. D., Cahoon, S. & Fei, J. (2015): Exploring the range of retention issues for seafarers in global shipping: opportunities for further research. *WMU Journal of Maritime Affairs, 14*(1), pp. 141-157.

Grassl, R. (2013): Lehren an der Tastatur – Autorinnen und Autoren von Studienheften als Lehrende in der Distance Education. In: E. Cendon, R. Grassl & A. Pellert (ed.), *Vom Lehren zum Lebenslangen Lernen: Formate akademischer Weiterbildung* (pp. 117-134). Münster.

Hattie, J. (2009): *Visible learning: A synthesis of over 800 meta-analyses relating to achievement.* London & New York.

Holmberg, B. (2005): *The Evolution, Principles and Practices of Distance Education.* Oldenburg.

Jade Hochschule Wilhelmshaven/Oldenburg/Elsfleth (ed.) (2015): *Evaluationskonzept für den geplanten Weiterbildungsstudiengang „International Maritime Management" (M.Sc.).* Elsfleth.

Jade Hochschule Wilhelmshaven/Oldenburg/Elsfleth (ed.) (2017a): International Maritime Management (M.Sc. distance study). URL: jade-hs.de/imm (Accessed on: 08 May 2017).

Jade Hochschule Wilhelmshaven/Oldenburg/Elsfleth (ed.) (2017b): *Leitfaden zur Anrechnung von (außer-)hochschulisch erworbenen Kompetenzen auf den geplanten Weiterbildungsstudiengang „Maritime Management Online" (M.Sc.).* Elsfleth.

John, P & Nause, N. (2016). Academic Research Methods. Course book for the degree course in International Maritime Management, Department of Maritime and Logistics Studies, Jade University of Applied Sciences. URL: https://www.jade-hs.de/fileadmin/fb_seefahrt/downloads/Studieninteressierte/IMM/Course_Book_Academic_Research_Methods.pdf (Accessed on: 30 May 2017).

Nause, N., John, P., & Wandelt, R. (2013): Curriculares Design des weiterbildenden Fern-Masterstudiengangs „Maritime Management". *Personal- und Organisationsentwicklung in Einrichtungen von Lehre und Forschung, 8*(2+3), pp. 83-88.

Nause, N., John, P. & Klimmek, E. (2016): Lehrveranstaltungsevaluation in Weiterbildungsstudiengängen am Beispiel des geplanten Studiengangs „Maritime Management Online". *Das Hochschulwesen, 64*(5+6), pp. 163-169.

Nause, N., & John, P. (2014a): How can a didactic guideline assist lecturers in adopting a learning outcome-centred approach in distance education learning units? In E. Cendon, & A. Prill (ed.), *Handreichung Lernergebnisse Teil 2 – Anwendungsbeispiele einer outcomeorientierten Programmentwicklung* (pp. 21-36). Berlin.

Nause, N., & John, P. (2014b): How can the didactic design of learning units be improved on the basis of a survey among participating students? In E. Cendon, & L. Flacke (ed.), *Handreichung Kompetenzentwicklung und Heterogenität* (pp. 81-91). Berlin.

Rippien, H. (2012): *Bildungsdienstleistung eLearning: Didaktisches Handeln von Organisationen in der Weiterbildung.* Wiesbaden.

Sauter, A. M.; Sauter, W. (2002): *Blended Learning: effiziente Integration von E-Learning und Präsenztraining.* Neuwied.

Schlutz, E. (2006): *Bildungsdienstleistungen und Angebotsentwicklung.* Münster et al.

Webler, W. D. (2002): Modellhafter Aufbau von Studiengängen. *Das Hochschulwesen, 50*(6), pp. 216-223.

Zumbach, J. (2010): *Lernen mit neuen Medien: Instruktionspsychologische Grundlagen.* Stuttgart.

TO ENHANCE MARITIME CADETS JOB MARKET COMPATIBILITY THROUGH INTERNATIONAL COOPERATION BETWEEN MARITIME INSTITUTIONS

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Abstract Beginning during the spring term of 2009, the Massachusetts Maritime Academy (MMA) of the USA launched a student exchange program with Shanghai Maritime University (SMU) of China, and later, in 2013, extending it to the Dalian Maritime University (DMU) of China. Every spring term, about 25 cadets are selected from each institution and sent to the other campus to study and gain experiences. Almost 300 students from both sides have participated in the program and nearly all have demonstrated a strong capability to overcome the language barriers, adapt to the new environments, achieve great things, in the job market and their subsequent career development.

This paper presents an analysis of what accounts for the success of participating cadets in the exchange program, and their subsequent achievements in the job market competitiveness. Applying a case-study method, taking on questionnaires and the data collected over the course of nine years, this paper examines how the MMA-SMU exchange program helps students overcome cultural shock and gain their leadership qualities. This is especially true in comparison to the cadets who do not participate in the international program. The findings suggest that the program has been very effective in helping the participating cadets enhance their self-confidence, broaden their world visions and adapt to new environments with ease and grace. As a result, participating cadets have been continuously standing out in their job market competitiveness and career growth after graduating five years from the academy.

It becomes extremely important to study the successful experiences of the MMA-SMU exchange program, because it has been a big challenge facing maritime institutions that how to bring out the excellent qualities of cadets and enhance their competitiveness at the job market. When the participating cadets in the MMA-SMU program prove that they can survive and

perform well in two completely different cultures, they demonstrate that they have acquired the necessary and sufficient skills to be successful within any type of job they are offered. And this is exactly what potential employers are seeking of all graduating maritime cadets today.

Keywords: International programs between maritime institutions, Job Market Compatibility, Cross-cultural education, Language proficiency.

I. Introduction

Since the spring term of 2009, the Massachusetts Maritime Academy (MMA) of the USA has been engaging in a student exchange program with the Shanghai Maritime University (SMU), and later, in 2013, extending it to the Dalian Maritime University (DMU) of China. As the MMA-SMU/DMU exchange program has been conducted in two countries which differ greatly in culture, history, economic systems, social values and government structures, it imposes a huge challenge for the participating students to survive and be successful. Nevertheless, it has been well proved that MMA-SMU program provided students with strategies to move from shock to cross-cultural adaptability, which in turn, will make the students, as Hutchings, Jackson & McEllister refer to, "the new style employees to be cosmopolitan, multilingual, multifaceted and be able to operate across national borders." (Hutchings, Jackson & McEllister, 2002, p69). Almost 300 students from both sides have participated in the program and nearly all have demonstrated a strong capability to overcome the language barriers, adapt to the new environments, achieve great things in the job market and their subsequent career development.

This paper presents an empirical analysis of what accounts for the success of the exchange program, how the participating students overcome language barriers, outperform in the international programs and get their subsequent achievements in the job market. Applying a case-study methodology, drawing on the school-wide surveys and the data collected over the course of eight years, this paper examines how the setup of the MMA-SUM/DMU exchange program helps students overcome cultural shock, promotes language proficiency and fosters leadership qualities.

The paper is structured as follows: Section II identifies challenges facing the MMA-SMU/DMU Student Exchange Program. Section III presents the positive experiences of visiting MMA cadets in China and their subsequent job market success. Section IV offers a conclusion.

II. Challenges facing the MMA-SMU/DMU Student Exchange Program

Since the year 2010, the Massachusetts Maritime Academy has sent cadets over to Shanghai Maritime University every spring term and starting from 2013, to DMU. Each year, MMA accepts roughly twenty Chinese students to study at the MMA campus. The following table gives us the numbers of the participating cadets from MMA from the year of 2010 to 2016. In the meantime, SMU always sends pretty much the same number of cadets over to MMA year after year, as does DMU.

Table 1. Participating MMA cadets in the MMA-SMU exchange program 2010-2015

Year	2010	2011	2012	2013	2014	2015	2016
MMA Cadets To SMU	11	16	17	22	19	20	19
MMA cadets to DMU	N/A	N/A	N/A	5	4	5	7
Total number of cadets to China	11	16	17	27	23	25	26

Data sources: MMA registrar's office

Table 1 shows a clear rise in the numbers of participating cadets of the MMA-SMU exchange program in the last three years. And yet the MMA-SMU/DMU student exchange program does conduct in two countries which differs so much in many aspects, which imposes huge challenges for participating cadets, administrators and faculties of the institutions in both countries.

2.1. Cultural Awareness and World Vision

The Massachusetts Maritime Academy is a principal maritime educational institute in the US, with a focus on excellent ocean-centric majors like Marine Engineering and Marine Transportation. However, as a state college, the great majority of cadets enrolled are from Massachusetts and other local areas in New England, a region in the North-Eastern corner of the United States. The academy has shown, more or less, the features of homogeneity and conservativeness. Thanks to the vision and courage of President Gurnon, MMA stepped out of its comfort zone in response to the proposal of SMU in China, and set up the MMA-SMU exchange program in 2008. The exchange program was the first international exchange program at MMA. Among all American maritime institutes, MMA is still the only institution which

offers a successful international exchange program with Chinese maritime universities. The following school-wide survey of 109 cadets in 2011, show how the cadets perceived the program and how prepared they were in regards to international travel.

Table 2. World Traveling of MMA cadets

Destination of travel	Percentage of survey participants
China	3%
Asian Countries (except China)	7%
European Countries	31%
Caribbean, South & Latin American Countries	97%
Canada	78%

Table 2 indicates how extensively (or not quite) American students travelled outside the US and places they felt comfortable going to. Only a few American students had gone to Asian countries (except China), such as Israel, Jordan, India, and Japan. And three had visited China, including one American-born Vietnamese. Around three-fourths of responding cadets made trips to Canada; a country that holds similar political, economic, social and cultural systems to the USA. And yet out of the eighty-five students who had visited Canada, all of them went to English-speaking areas like Toronto, Vancouver and Ottawa, and only one third had gone French-speaking areas like Montreal and Quebec City. About 31% of the respondents toured European countries, and the highly frequented destinations were Italy, Ireland, Portugal and England. To a great extent, this is due to the fact that many of the respondents are descendant of the British, Italian, Portuguese and Irish, can still speak the language, or have family members living in Europe. One cadet explained that his grandfather lived in a village outside of Rome and he has more than 20 Italian cousins.

The statistics in Table 2, also shows that nearly all of the MMA cadets paid visits to Caribbean, South and Latin American countries, such as Mexico, Barbados, Puerto Rica, Ecuador, Panama, Costa Rica and Tortola. That is mainly because cadets at MMA are required to take sea terms, and the countries in Caribbean, South and Latin American regions are usually the planned destination when the cadets take voyages with the school training ship.

Therefore, it is well expected that the MMA exchange students would unavoidably experience some "culture shock" when they go to China and try to blend into the new environment in such a swift period of time. The term, "culture shock", was first introduced by an anthropologist and economist, Kalervo Oberg, as a disease suffered by individuals living in a new environment. According to Oberg, "culture shock resulted from the loss of well-known signs and symbols, causing individuals to experience anxiety, frustration and helplessness." (Oberg, 1960). To fully realize the stress MMA exchange cadets might face in China, the MMA-SMU program was designed in such a way which mitigates culture shock to the minimum. The effective measures include assigning one Chinese student and one American student as roommates, free selection of courses, extensive classes of language and culture, and cultural trips to enhance the understanding of the host country.

Table 3. Answers to Questionnaires (MMA)

Survey Questions/ Answers	Positive	Negative	Neutral	Year
The impact the China program would impose on MMA?	81.9% 84.5% 89.2	0.9% 0% 0%	17.4% 15.5% 10.8%	2011 2013 2016
How will the China program influence you?	33% 39% 45%	2.8% 1.5% 0%	64.2% 59.5% 55%	2011 2013 2016
Do you want to go abroad for jobs or studies?	56.0% 63.0% 67%	22.9% 15.1% 10%	21.1% 21.9% 23%	2011 2013 2016
What do you think of the Chinese students?	75.2% 78.1% 84.5%	0% 0% 0%	24.8% 21.9% 15.6%	2011 2013 2016
Do you want to be roommates of visiting Chinese Cadets?	19.3% 21.2% 27.6%	71.5% 69.4% 59.9%	9.2% 9.4% 12.5%	2011 2013 2016

Table 3 presents the 5 major questions in the survey, taken in 2011, 2013 and 2016 respectively, and the answers the participating cadets selected. The sample sizes for the school-wide survey are 109, 103 and 107 participating cadets for the three years. For each of the questions, the cadets had 3 choices, "positive", "negative" or "neutral", and gave one answer per question. They were also asked to provide further explanations to each of their choices.

In the surveys of 2011, 2013 and 2016, a great majority of MMA cadets believed that the China program would have a positive impact on MMA, and none had negative opinions about Chinese students. With the development of the exchange program, there is a slight increase in positivity for all questions. Both Tables 2 and 3 clearly state that many MMA cadets have not gone far from where they were born and raised and were still uncomfortable with the unfamiliar.

Most MMA cadets would prefer not to share a room with a visiting Chinese student. When being asked the reason, several MMA students said that they would like to have a roommate who would be closer to themselves, with similar personalities, backgrounds, and hobbies. As one student put it, "I want to room with one of my friends."

It is also worth mentioning that over the course of nine years, each group of Chinese exchange students brought qualities of diligence, a strong work ethic, and determination to succeed, when they were selected and sent to the MMA campus. Though the Chinese students would experience culture shock and language barriers, they made extraordinary efforts to blend in and excel in the classroom. One MMA professor of Marine Engineering said: "It is a pleasure to have the Chinese students in my class. They work so hard and get the best grades." With the on-going exchange program, MMA cadets have become more culturally aware and keen on international affairs.

2.2. The Unique Features of the Two Engaging Maritime Institutions

The two institutions, MMA and SMU, are quite different in their scales and their comparative advantages, though both are playing a leading role in fostering maritime professionals. The exchange Program gives a challenge to both schools, and yet provides an opportunity to bring out the potentials of each school and benefit the other.

The SMU exchange students, selected from a large pool of candidates to participate in the MMA-SMU exchange program, are a group of the elite cadets with all the fine qualities to be expected in maritime students. These young Chinese students, though adhering to traditional

Chinese value system, have been impacted more or less by the western cultures, ideology, arts and trends. One student puts it in her personal statement: "I grow up seeing American movies, TV series and shows. My most favorite ones are So You Think You Can Dance, Transformers and Heroes. And I really look forward to seeing America with my own eyes." The exposures to western cultures, such as involving in other international programs, world travels, attending international schools in China, reading western books, watching western movies, and listening to western music, help the Chinese students understand the western society and recognize its value systems.

There are two more common characteristics about the Chinese students which facilitate them blending in the new environment: being fluent in oral and written English, and coming to MMA as a group. The Chinese students are required to take English from elementary schools (some even from kindergartens). The English proficiency greatly enables the Chinese students communicating smoothly with MMA cadets and performing to their potentials in the classroom. Furthermore, different from other individual foreign cadets studying at the academy, SMU students come as a group of 20, which gives them a large cushion to minimize the cultural discomfort if they do experience any.

Therefore, when proposed for the exchange program, both MMA and SMU believe that it is in the mutual interests to launch the program which would fully utilize the potential of both schools, the excellent SMU students and high quality faculties, and educational and training facilities at MMA.

Table 4: Do you prefer American professors to foreign-born professors (MMA)

Answers	Prefer American Prof.	Prefer Foreign Prof.	No Preferences	Time of Survey
Percentage	18%	9%	73%	May 2015
Percentage	25%	4%	71%	Sep. 2015

We can see that more than 70% of the participating cadets have no preference between American-born professors and foreign-born professors. Table 4 sums up the results of two surveys conducted in May 2015 and September 2015 with 33 and 53 respondents respectively at MMA. It clearly shows that the on-going process of globalization and interactions between

countries and peoples has brought positive changes towards the cultural acceptance and mutual understandings, especially among young generations.

III. Positive Experience in China and Job Market Success for MMA Exchange Students

3.1. Positive Experience at SMU of China

Each year, the participating cadets from the academy gained very positive experiences during their stay in China. They believed the program helped them in the following three areas: developing good relations with Chinese people by experiencing the country first hand, putting them in more advantageous positions in different cultures and among different people, and meeting cadets of the same major from other countries. One student wrote in his report of the exchange program: "It is a great opportunity to meet people from other countries in similar fields of study." Another cadet said that "It allows exchange of cultures and offers a new unique experience. It also helps educate everyone in the school about the Chinese culture, not just those who get to go."

Many participating cadets from the first groups became strong advocates of the exchange program and promote the program in every possible way. The cadets present papers about the program and their own personal experiences at international and domestic maritime conferences, hold positions in the student council, serve as cadet officers of foreign exchange programs, give talks to cadets' parents, and encourage other MMA students to join the program.

The cadets from MMA have left a strong impression in China. The young men and women not only show their fine academic qualities by expressing their language proficiency, intuitive vision, and genuine curiosity and perseverance, but also their spirit and personality, through determination, cultural adaptability, flexibility, and the capability to overcome all difficulty. Here is a good example: Myra was the only female cadet going to China in the first year. On top of being the best student in the class, averaging 85.2, while the class mean was an 82, Myra joined the soccer team as the eleventh member representing MMA to play against SMU and other university teams in Shanghai. It turns out that she scored the most in the games. She was once injured badly on the field and rushed to the hospital in an ambulance. Her optimism and determination made a deep impression on her teammates, the Chinese cadets and

the doctors who treated her in the hospital. One Chinese faculty at SMU exclaimed, “Wow, fragility, your name is not American women.”

3.2. Job Market Success for the Exchange Cadets at MMA

At this point, we only have five groups of MMA cadets graduating from the academy after studying for one semester in China, and most received good job offers upon graduation. For the purpose of this paper, we will focus on the jobs the cadets entered after they were gilded with China experiences. We will look at the companies the cadets received offers from in their senior year and how much their experiences in China contributed to the jobs and later promotions. We see three things clearly from the available data collected by the Office of Career and Professional Services of the academy: companies the participating cadets now work for tend to be large, with many international elements, a decent salary offer, and they are on a steady rising track of career development.

Here we would like to look into two cases of the program participating cadets who visited SMU in the year of 2010 and see how the China experience help the cadets gain fine qualities and their success in the job market.

Myra , the first female who went to China in 2010, received a job with SpecTec upon her graduation as a regional sales manager. SpecTec is a premier provider of asset management solutions for the marine, offshore & energy, defense and yachting industries all over the world. Her responsibility is to identify and evaluate sales opportunities in the United States, Canada, and Latin America. After working at SpecTec for two and half years, Myra switched to DNV GL Group, the world’s largest ship and offshore classification society of the maritime industry, a leading technical advisor to the oil & gas industry, and a leading expert in the energy value chain, including renewables. The company has 16,000 employees across 300 sites in more than 100 countries and gains revenue of EUR 2,500 million per year. Myra works as Sales Support Manager and she loves her challenging and rewarding job.

Johnathan, who went to China in the Spring year of 2010, was offered a job as a technical coordinator by Canada Steamship Lines (CSL). CSL is a Montreal-based company which brings highly-efficient, gravity-fed, self-unloading capability to bulk shipping and transshipment markets throughout the world. Only two years out of college, Johnathon has completed project work in China for CSL International and is now based in England, working

for CSL Europe and their Technical Operations Director conducting analysis and development of fleet wide operational, financial and energy efficiency improvements. The young graduate also assists in development of a monitoring system to improve the CSL Europe safety program. As put by the front page article of the MMA website, "this young grad hopped on CSL's sturdy corporate ladder and started climbing!" Currently Johnathan works as the Manager of Strategy and New Business Development at the headquarters of CSL in Montreal of Canada.

The following graphs (from the Office of Career and Professional Services at MMA) present the salary range of MMA seniors from the years 2011 to 2016. There were 81 cadets in 2011, 93 cadets in 2012 and 108 cadets in 2013 who responded to the survey, respectively. The salaries were put into five different ranges; below $35,000, between $35,000 and $50,000, between $50,000 and $75,000, and between $75,000 and $100,000, and over $100,000. The vertical bars show the percentages of entry level salaries the responding cadets received for the year 2011, 2012 and 2013. And in the later graphs, we will show the date for the year of 2014, 2015 and 2016.

Fig. 1 Salary ranges seniors received for the year 2011 -2013

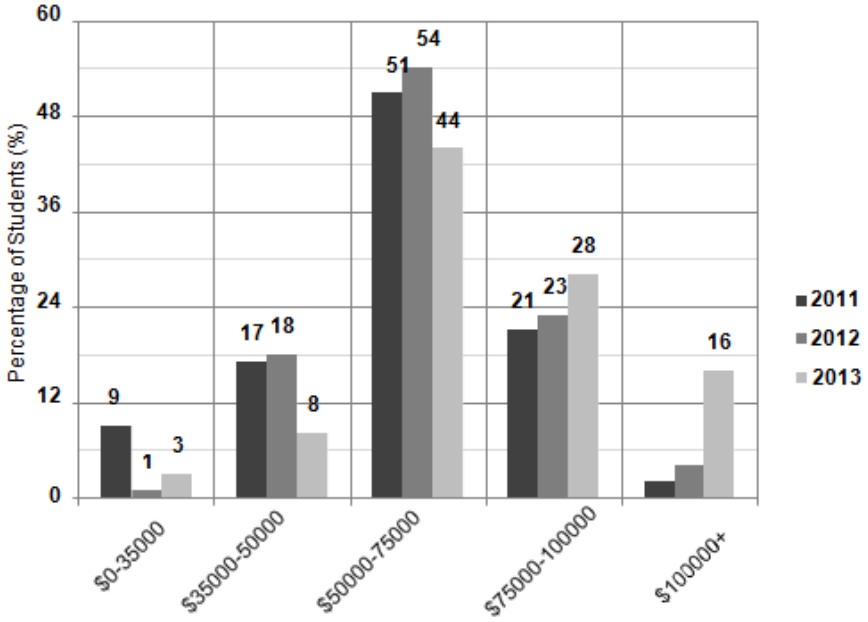


Figure 1 shows that about 50% of MMA seniors have annual salaries that range from $50,000-$75,000 for all the three years and well over 20% earn in the $75,000-$99,000 range. In 2013, 16% received an initial offer of more than $100,000. Only three female exchange

students out of the five responded to the surveys; two reported a salary range between $50,000- $75,000 and the other $35,000-$50,000.

Fig.2 Salary ranges seniors received on graduation for year 2014

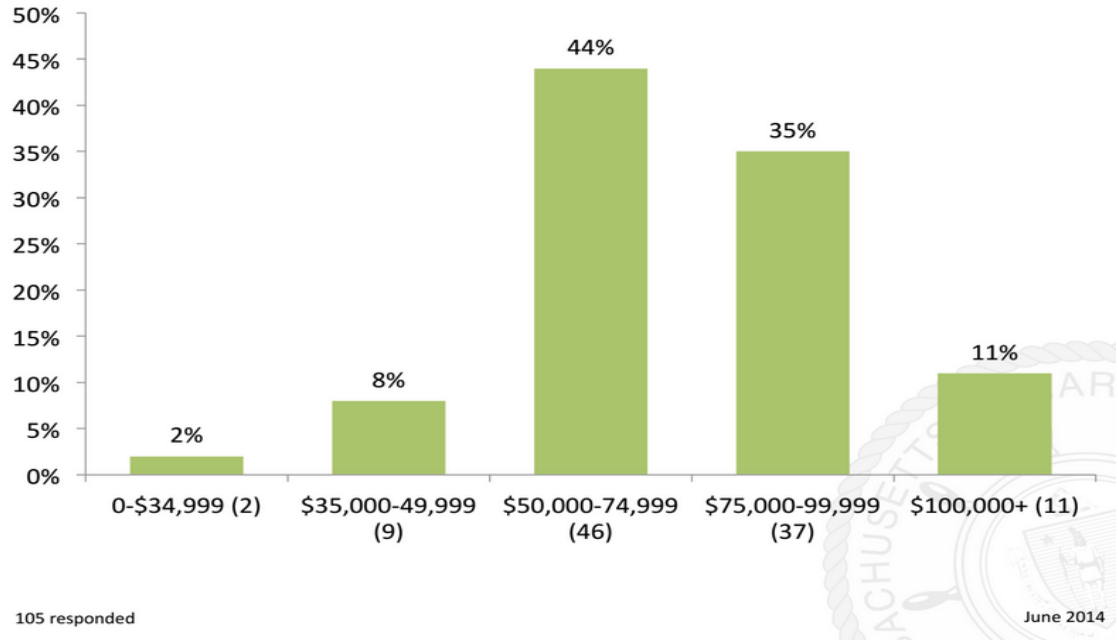


Fig.3 Salary ranges seniors received on graduation for year 2015

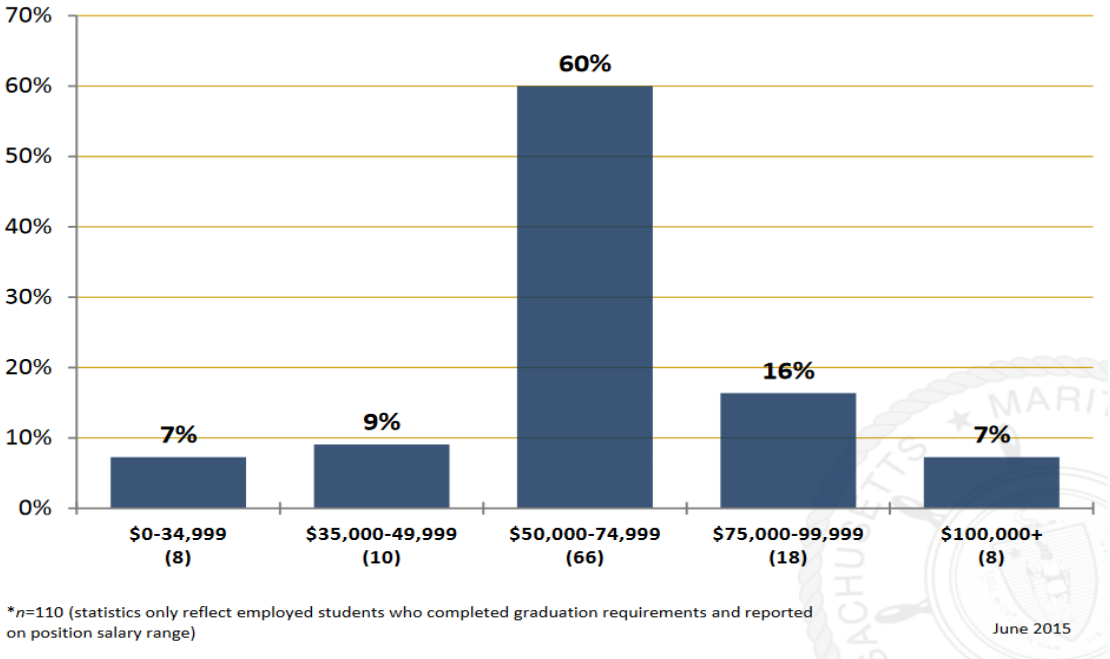
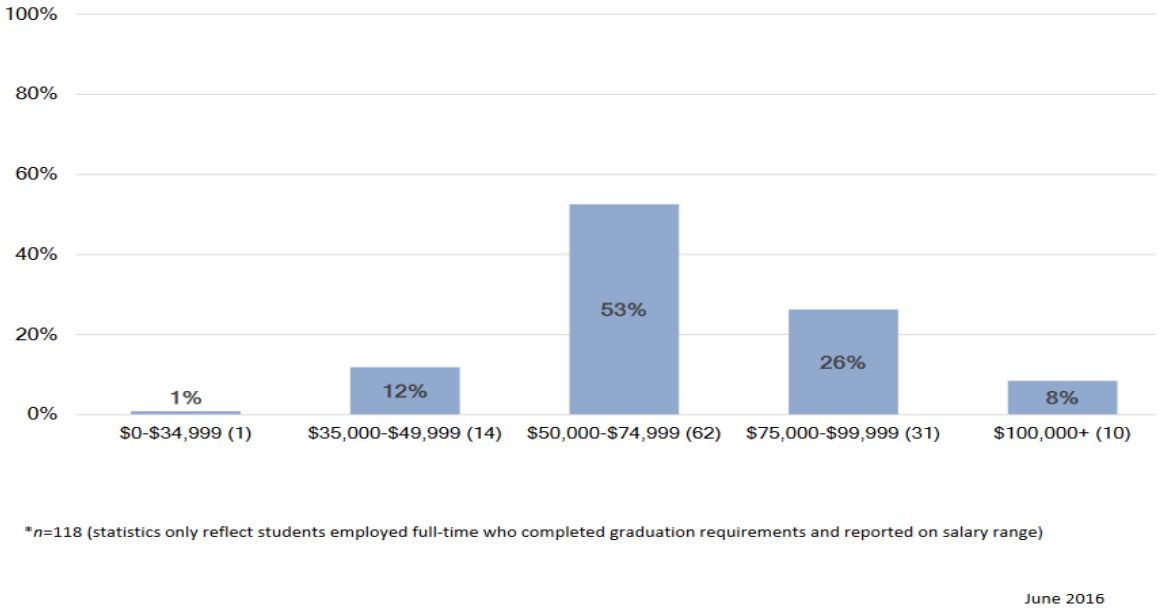


Fig.4 Salary ranges seniors received on graduation for year 2016



The three figures above, Fig. 3, 4 and 5 show that in the year 2014, 2015 and 2016, the MMA cadets received pretty much the same salary ranges with much of changes. And they also indicate that cadets of non-sea-going majors like Maritime Business and Maritime Environment constantly get salaries higher than the country's average entry level salary. The average starting salary for a 2017 college grad is just slightly under $50,000 ($49,785, to be exact), the study indicates. That's up 3% from last year. (Money , May 12th 2017 , by Brad Tuttle) .

IV. Conclusion

Looking at the available data, it is clear that the exchange students are given an edge over their peers. In regards to international experience that can easily be applied to future jobs, cadets who choose to take this opportunity find themselves much better candidates within a rapidly expanding job market. When combined with the exchange students' statistically higher grades, broader international vision, the capability to move between cultures with ease, and proficiency in language, it shows how the exchange program gives cadets the tools needed to succeed in the job market, and the development of their career.

The international cooperation between two maritime institutes, such as that in the MMA- SMU student exchange program, is very effective to help the participating cadets enhance their self-confidence, broaden their global visions and adapt to a new environment with ease and grace. The successful experiences of the MMA-SMU program are applicable not only

to the maritime universities of USA and China, but also to the institutions which are located in other culturally diverse countries. When the participating cadets prove that they can survive and perform well in two completely different cultures, they demonstrate that they have all the necessary and sufficient skills to be successful within any type of job they are offered. And thisis exactly what the potential employers are seeking of all graduating maritime cadets in these times.

References

[1] Ferraro, G. (2010). *The cultural dimension of international business*. Boston: Prentice Hall, p134.

[2] Gardiner, H. & Kosmitzki, C., "Lives across Cultures: Cross-cultural Human Development", 5th edition, Boston: Allyn & Bacon, 2010.

[3] Heidi, D., "On (Mis-)Conceptions of Culture as a Vehicle of Business Success: Singapore Chinese Investment Strategies after Failing in China", East Asia: An International Quarterly, June 1, 2007.

[4] Hutchings, K., Jackson, P., & McEllister, R. (2002). Exploiting the links between theory and practice: Developing students' cross-cultural understanding through an international study tour to China. *Higher Education Research & Development, 21*(1), 55–71.

[5] Koller, J., Asian Philosophies", 5th Edition, Prentice Hall, New Jersey, 2007.

[6] Lockwood, V. (2009). The impact of development on women: The interplay of material conditions and gender ideology. In C.B. Brettell & C.F. Sargent (Eds.), *Gender in cross-cultural perspective* (pp. 510-524). New York: Prentice Hall.

[7] Oberg, K. (1960). Culture shock: adjustment to new cultural environments. *Practical Anthropologist,* 7, 177–182.

[8] Rowntree, L., Lewis, M., Price, M., & Wyckoff, W., Diversity amid Globalization: World Religions, Environment, Development, 4th Edition, New Jersey: Pearson, 2009.

[9] Salary reports of senior graduates, (July 2011, June 2012, June 2013, June 2014, June 2015, June 2016), Office of Career and Professional Placement at Massachusetts Maritime Academy, USA

[10] Schneider, S. & Barsoux, J, (1997). Managing across cultures. Hertfordshire: Prentice Hall.

[11] SpecTech (2014). Overview. http://www.spectec.net/en. Accessed 1 Apr 2014

MARINE STRUCTURAL FAILURES: CAUSES AND ANALYSIS TOOLS

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Abstract. One of major design requirements for any marine structure (ship or offshore facility) is to have reasonably long and safe operational life cycle without any catastrophic failure. However, failures still occur causing financial losses and threating human lives, especially in modern structures with reduced weight but increased load carrying capacity. Engineering practice distinguishes usually one or few causes of failure: excessive force and/or temperature induced elastic deformation, yielding, fatigue, corrosion, creep, etc. Therefore, as a first step, it is important to identify potential threats that can affect integrity of marine structures. In order to understand the causes of failures, structure's load response, failure process, possible consequences and methods to cope with and prevent failures, it is important to educate marine engineers about such problems. Probably the most suitable way of transferring knowledge would be learning from actual examples from engineering practice.

Research on this topic includes: identifying potential threats affecting marine structural integrity, analyzing various cases of failures using experimental and numerical approach, assessing structural critical points that could serve as a root of failure, formation of a database comprised of elaborated case studies that can be used in the education worldwide, disseminating results and promoting open access to the database. This paper serves as a progress report of the first part of the ongoing IAMU research project for 2017 where the

causes of typical failures in marine structures are determined and critical review of previously conducted researches on similar topics is outlined. Further, results of experimental and numerical failure analysis of typical failures in maritime structures are presented along with directions for future use and database forming.

Keywords: failure analysis, marine structures, education database, case studies

1. Introduction

In order to limit the occurrence of fatalities, environmental and economic damage marine structures are to be designed, built and operated in such manner that the probabilities of overall structural rigid body stability and failures of parts and/or complete structure are reduced to minimum. Extensive study of catastrophic accidents serves as a knowledge base source for future design procedures that will make marine structures safer and longer lasting.

Fatigue is regarded as a critical limit state that has to be taken into account during the design phase of a marine structure. It has become customary to perform an optimal fatigue design analysis as an integral part of design calculations. Nowadays, the theoretical basis for such an analysis is largely based on data and procedures developed from experimental and empirical research. As fatigue damage (cracks) phenomena imply nonlinear material damage in microscopic scale as well as continuous separation of the material, continuum mechanics principles and fundamentals are basically violated. Therefore, various fatigue assessment methods were developed for marine structures details.

Studies and analysis of marine structures failures had shown that a significant percentage of failures were a consequence of inadequate design due to lack of operational considerations, incomplete structural elements evaluations and incorrect use of calculation methods.

During the design phase of a specific marine structure, a level of structural safety is chosen by defining individual structural elements, used materials and functional requirements based on the expected lifetime of the structure, the ramifications of eventual failures (higher safety factors) and the costs of failures. An important factor that has to be taken into account is the time dependency of the strength and loads. The strength of a structure decreases with time and strongly depends on inspection and maintenance procedures, while the load itself is very variable through the lifetime of the structure [1].

2. Structural failure causes

The strength of a structure represents a limit state of loading conditions above which the

structure loses ability to achieve its specified required function. As long as the actual strength of the structure is kept higher than the actual loading demands, a given marine structure can be deemed safe. Otherwise, structural failures will occur.

Structural failure can be defined as loss of the load-carrying capacity of a component or member within a structure or of the structure itself (including global failure modes like capsizing, sinking, positioning system failures etc.). The failure can result in catastrophic damage (i.e. complete loss of the structure itself) or partial structure damage when the structure can be repaired or recovered. Global failures can more often result in fatal casualties while smaller and localized structural damage may result in pollution and recoverable structural damage.

Structural failure is initiated when the material in a structure is stressed to its strength limit, thus causing fracture or excessive deformations. The structural integrity of a marine structure depends on load conditions, the strength of the structure itself, manufacturing and materials quality level, severity of service conditions, design quality as well as various human elements that have effects during exploitation of the structure.

There are two distinctive groups of failure causes. The first group is comprised of unforeseeable external or environmental effects which exert additional loading on the structure resulting in over-load. Such effects are extreme weather (overloads), accidental loads (collisions, explosions, fire, etc.) and operational errors. The second group comprises causes for failures that occur either during the design and construction phase (dimensioning errors, poor construction workmanship, material imperfections) or due to phenomena growing in time (fatigue), both resulting in reduced actual strength in respect to the design value. All of the listed causes can partially or completely be a result of human factor.

3. Failure analysis tools

The analysis methods can be grouped into methods that use nominal stresses (typical for standard codes) acting to a structure or part of a structure and then compare the stress amplitude to nominal S-N curves. This approach is appropriate for structures that are standardized and therefore well backed up with statistical experimental data that can be used as initial assumptions for fatigue analysis. The alternative is the evaluation of local stresses influence to fatigue (notch stress factors, N-SIF).

The latest trend in failure analysis development is the unification of analysis methods and procedures [3], [4], [5] in order to obtain a comprehensive procedure of structural failure analysis that would cover main failure modes and enable a safer and more efficient design,

manufacture and maintenance processes.

3.1.Experimental tools

Nondestructive testing and examination (NDT, NDE), as well as structural health monitoring (SHM), of structures play a significant role in fracture analysis and control procedures. Any method used must not alter, change or modify the failed condition but must survey the failure in a nondestructive mode so as to not impact, change or further degrade the failure zone. This kind of examination provides input values for fracture analysis which yields results that define inspection and maintenance intervals for the structure and represent input values for life prediction estimates. Structures are inspected at the beginning of their service life in order to document initial flaws which determine the starting point of the structure fatigue life prediction. The most commonly used procedures for marine structures are optical microscopy, scanning electron microscopy (SEM), GDS and acoustic emission (AE) testing.

Optical microscopy is a common and most widely used NDT analysis method which enables rapid location and identification of most external material defects. This technique is often used in conjunction with micro-sectioning to broaden the application. One of the main disadvantages is the narrow depth-of-field, especially at higher magnifications.

Scanning electron microscopy is an extension of optical microscopy in failure analysis. The use of electrons instead of a light source provides much higher magnification (up to 100,000x) and much better depth of field, unique imaging, and the opportunity to perform elemental analysis and phase identification. The examined item is placed in a vacuum enclosure and exposed with a finely focused electron beam. The main advantage of this method is minimal specimen preparation activity due to the fact that the thickness of the specimen does not pose any influence to the analysis, ultra-high resolution and 3D resulting appearance of the test object. Various analysis of marine structures and equipment have been conducted using SEM [6], [7], [8], [9].

Structural supporting members emit sounds prior to their collapse i.e. failure. This fact has been the basis of the development of scientific methods of monitoring and analysis of these sounds with the goal to detect and locate faults in mechanically loaded structures and components. AE provides comprehensive information on the origin of a discontinuity (flaw) in a stressed component and also provides information about the development of flaws in structures under dynamic loading. Discontinuities in stressed components release energy which travels in the form of high-frequency stress waves. Ultrasonic sensors (20 kHz – 1 MHz) receive these waves or oscillations and turn them in electronical signals which are in

turn processed on a computer yielding data about the source location, intensity frequency spectrum and other parameters that are of interest for the analysis. This method is passive, i.e. no active source of energy is applied in order to create observable effects as in other NDT methods (ultrasonic, radiography etc.). Three sources of acoustic emissions are recognized, namely primary, secondary and noise. The primary sources have the greatest structural significance and originate in permanent defects in the material that manifest as local stresses, either on microstructural or macrostructural level. The amount of acoustic emission energy released, and the amplitude of the resulting wave, depends on the size and the speed of the source event. The main advantages of AE compared to other NDT methods that AE can be used in all stages of testing, lesser geometry sensitivity, the method is stress related, less intrusive method, it can be used for global monitoring, the scanning is remote and it gives a real-time evaluation [10]. The disadvantages are the sensitivity to signal attenuation in the structure, less repeatability do to the uniqueness of emissions for a specific stress/loading conditions and external noise influence on accuracy.

3.2.Analytical tools

Although various analytical models have been proposed by a number of authors no comprehensive model exists. Analytical methods have been developed for prediction of progressive structural failures of marine structures [11]. The finite element modeling approach for prediction of the development of failures is accurate, but can be time consuming. Analytical procedures, based on spectral fatigue analysis, beam theory, fracture mechanics and structural factors, can provide solutions in considerably less time when needed.

The goal is to define approaches for computing the fracture driving force in structural components that contain cracks. The most appropriate analytical methodology for a given situation depends on geometry, loading, and material properties. The decisive choice factor is the character of stress. If the structure behavior is predominantly elastic, linear elastic fracture mechanics can yield acceptable results. On the other hand, when significant yielding precedes fracture, elastic-plastic methods such as referent stress approach (RSA) and failure assessment diagram (FAD) need to be used. Since a purely linear elastic fracture analysis can yield invalid and inaccurate results [12], the safest approach is to adopt an analysis that spans the entire range from linear elastic to fully plastic behavior. One of the methodology that can be applied is the failure assessment diagram (FAD) approach.

The FAD approach has first been developed from the strip-yield model and it uses two parameters which are linearly dependent to the applied load. This method can be applied to

analyze and model brittle fracture (from linear elastic to ductile overload), welded components fatigue behavior or ductile tearing. The stress intensity factors are defined on the basis of the structure collapse stress and the geometry dependence of the strip-yield model is eliminated [13], [14]. The result is a curve that represents a set of points of predicted failure points, hence the name failure assessment diagram. The failure assessment diagram is basically an alternative method for graphically representing the fracture driving force.

Depending on the type of the equation used to model the effective stress intensity factors the FAD approach can be sub-divided into the strip-yield based FAD (described above and also known as the R6 approach), J-based FAD [15], [16], [17] and approximated FAD. The J-based FAD includes the effects of hardening of the material, while the simplified approximations of the FAD curve are used to reduce the calculation times of the analysis. When stress-strain data are not available for the material of interest generic FAD expressions may be used [138], [139] that assume that the FAD is independent of both geometry and material properties. The simplified curves proved adequate for most practical applications due to the fact that design stresses are usually below yield point. Fracture analysis in fully plastic regime require an elastic-plastic J analysis.

3.3.Numerical tools

The effective application of numerical methods in fracture mechanics and fatigue analysis begun with the development of computer science in the second half of the 20^{th} century. Various methods were used (finite difference method, collocation methods, Fourier-transformations) but the finite elements method (FEM) has been established as a standard due to its universality and efficiency. FEM enables complicated crack configuration analysis under complex loads and non-linear material behavior.

Recent years have brought a significant development and increase in accessibility of commercial computational software and hardware for finite element analysis applications, marine structures included. This enables more advanced and detailed fatigue and fracture analysis even for more complex large scale structures.

Extended FEM (X-FEM) is the most recent finite element method developed and is used mainly for fracture mechanics applications. Based on the finite element method and fracture mechanics theory, X-FEM can be applied to solve complicated discontinuity issues including fracture, interface, and damage problems with great potential for use in multi-scale computation and multi-phase coupling problem. The method has been introduced in 1999. [18], and since then further developed by various authors. The basic idea of the method is to

reduce the re-meshing around the crack to a minimum. The improvements enabled the crack to be represented in the FE model independently from the mesh itself [19]. Further development has enabled modeling of arbitrary discontinuities by [20], [21]. Other researchers have extended this method for three-dimensional applications 22], [23], [24], [25]. The solution for the problem of modeling curved cracks was developed by forming higher order elements [26]. Improved XFEM methods are continuously being developed by various researchers as the method has been proven as very valuable.

4. Discussion

Safety of sea navigation requires that ship structure systems have to be free from excessive stress and vibration levels (which can result in fatigue damage). Two main types of marine systems can be distinguished: a ship hull (with a superstructure and a main engine body) and a power transmission system (a crankshaft, a shaft line, a propeller). The operation of ships occurs often in extremely bad weather conditions. Marine structures are operating in more aggressive conditions than land-based constructions and even aerospace structures. Proper assessment of the ship technical condition in the critical environmental conditions is crucial from the perspective of safety of maritime navigation. Limitation of maritime disasters is of great economic importance and, more importantly, will reduce the negative environmental impact and human injuries and life losses.

Especially the propulsion system of the ship should be subject to important assessment, because like in aviation, inoperative propulsion results in a very high probability of disaster in a storm weather conditions.

International law states that each sea going ship has to fulfill regulations of one of the classification institutions. More important, classification society’s rules are based on wide knowledge collected over hundreds of years. Classification society's rules are based on simplified, empirical equations, but not all problems can be solved by empirical rules or even differential equations. Most problems with ship failure mechanisms have to be analyzed by applying numerical calculations procedures and afterwards verified by tests and measurements.

The Finite Element Method (FEM) is one of the best available approaches to the numerical analysis of continuum. It is currently the most popular technique, and numerous commercial software packages are now available for its implementation. All classification societies admit alternatives to their calculation methods, especially FEM. These, more detailed, analyses are usually more expensive but optimization is possible. The FEM consists of modelling the

physical structure by a discrete mathematical model.

5. Conclusion

Engineers and scientists, when researching, designing or manufacturing devices and systems have to model complex natural and technical phenomena. It is important to model such phenomena with physical models and then convert them into simple mathematical models. Model or idealization of technical issues will be easier to calculate, test and predict the working conditions of the equipment. In order to do so, engineers and scientists must be able to describe and analyze objects, and devices to predict their behavior to see if they are consistent with the behaviors that the engineers, scientists desire. A mathematical model that describes a system in a form that uses appropriate mathematical and language concepts to facilitate the process of solving technical and natural science problems. A model may help to explain a system and to study the effects of different components, and to make predictions about behavior.

All engineers should be knowledgeable with numerical methods. There are engineers specialized in numerical analyses but also designers can have ability to supports their drafts by calculations. Strengths vibrations and fatigue analyses are a special part of numerical calculations. But also, engineers working with machine exploitation should have knowledge about numerical calculations. Usually they received several documents with applied procedures as well as with numerical analyses with practical conclusions (e.g. barred speed range for marine propulsion system caused by torsional vibration). They should have a basic knowledge about modern analyses and failure mechanisms.

The engineer should remember that all presented analysis methods are only a modelling method of abundant real life - real physical behavior. Each model has got limitations. For instance, if we use linear strain-stress theory for modelling vibrations of the machine placed on rubber pads in hot temperature (strong nonlinear material) we get proper results from numerical point of view but these results are completely wrong from practical point of view. Basic knowledge about failure mechanisms is crucial for modern engineers.

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References

[1] Shama M.A. AU. Marine Structural Safety and Economy. Mar Struct Insp Maintenance Monit Symp 1991;1:1–8.

[2] Gutiérrez-Solana F, Cicero S. FITNET FFS procedure: A unified European procedure for structural integrity assessment. Eng Fail Anal 2009;16:559–77.

[3] Cui W, Wang F, Huang X. A unified fatigue life prediction method for marine structures. Mar Struct 2011;24:153–81.

[4] Choung J. Comparative studies of fracture models for marine structural steels. Ocean Eng 2009;36:1164–74.

[5] Vukelic G. Failure study of a cracked speed boat steering wheel. Case Stud Eng Fail Anal 2015;4:76–82.

[6] Peng C, Zhu W, Liu Z, Wei X. Perforated mechanism of a water line outlet tee pipe for an oil well drilling rig. Case Stud Eng Fail Anal 2015;4:39–49.

[7] Ilman MN, Kusmono. Analysis of internal corrosion in subsea oil pipeline. Case Stud Eng Fail Anal 2014;2:1–8.

[8] Harris W, Birkitt K. Analysis of the failure of an offshore compressor crankshaft. Case Stud Eng Fail Anal 2016;7:50–5.

[9] Charles J. Hellier. Handbook of Nondestructive Evaluation. 2nd ed. McGraw-Hill Education; 2013.

[10] Bardetsky A, Lee A. Analytical prediction of progressive structural failure of a damaged ship for rapid response damage assessment. Proc. ASME 2014 33rd Int. Conf. Ocean. Offshore Arct. Eng., 2016, p. 1–9.

[11] Anderson TL. Fracture Mechanics: Fundamentals and Applications. 3rd ed. CRC Press; 2005.

[12] Dowling AR, Townley CHA. The effect of defects on structural failure: A two-criteria approach. Int J Press Vessel Pip 1975;3:77–107.

[13] Milne I, Ainsworth R., Dowling A., Stewart A. Assessment of the integrity of structures containing defects. Int J Press Vessel Pip 1988;32:3–104.

[14] Bloom JM. Prediction of ductile tearing using a proposed strain hardening failure assessment diagram. Int J Fract 1980;16:R73–7.

[15] Bloom JM. Corrections: “Prediction of Ductile Tearing Using A Proposed Strain Hardening Failure Assessment Diagram,” by J. M. Bloom. Int J Fract 1980;16:R163–7.

[16] Milne I, Ainsworth R., Dowling A., Stewart A. Background to and validation of CEGB report R/H/R6—Revision 3. Int J Press Vessel Pip 1988;32:105–96..

[17] FITNET. SINTAP procedure n.d.:231.

[18] Belytschko T, Black T. Elastic crack growth in finite elements with minimal remeshing. Int J Numer Methods Eng 1999;45:601–20.

[19] Moës N, Dolbow J, Belytschko T. A finite element method for crack growth without remeshing. Int J Numer Methods Eng 1999;46:131–50.

[20] Dolbow J. An Extended Finite Element Method with Discontinuous Enrichment for Applied Mechanics. 2011.

[21] Dolbow J, Moës N, Belytschko T. Discontinuous enrichment in finite elements with a partition of unity method. Finite Elem Anal Des 2000;36:235–60.

[22] Sukumar N, Moës N, Moran B, Belytschko T. Extended finite element method for three-dimensional crack modelling. Int J Numer Methods Eng 2000;48:1549–70.

[23] Daux C, Moës N, Dolbow J, Sukumar N, Belytschko T. Arbitrary branched and intersecting cracks with the extended finite element method. Int J Numer Methods Eng 2000;48:1741–60.

[24] Marines-Garcia I, Paris P, Tada H, Bathias C. Fatigue crack growth from small to long cracks in VHCF with surface initiations. Int J Fatigue 2007;29:2072–8.

[25] Liu YB, Li YD, Li SX, Yang ZG, Chen SM, Hui WJ, et al. Prediction of the S–N curves of high-strength steels in the very high cycle fatigue regime. Int J Fatigue 2010;32:1351–7.

[26] Sonsino C. Fatigue testing under variable amplitude loading. Int J Fatigue 2007;29:1080–9.

THE CONCEPT OF TRACKING AND MONITORING SYSTEM FOR SENSITIVE CARGOES IN THE INTERMODAL TRANSPORTATION

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Abstract. The paper proposes a novel concept of the system that can be used for tracking and monitoring whereabouts and condition of sensitive cargoes in the intermodal transportation. The main aim of the proposed system is tracking and monitoring of several selected parameters of the container cargoes from the moment of placing them in a container and afterwards during the whole voyage, until container unloading in the destination place. Thus, the proposed system can be classified as a door-to-door type of solution. The aim of the suggested system is also to assure a rich functionality for monitoring sensitive cargoes for all stakeholders in the supply logistic chain through designing user friendly and wide analytical interface. As a base for further design steps a review of the selected existing systems for tracking and monitoring sensitive cargoes in the sea transportation is included in the paper. Next, technical and functional assumptions for the novel proposed system are described.

Keywords: sea transport, sensitive cargo, tracking and monitoring systems

1. Introduction

Transport and logistics is a vital part not only of the global economy. From the European perspective it leverages export of European goods and increases their competitiveness. This is especially true for maritime transport which allows to reach global economy with products made in European countries.

Maritime transport plays particularly important role in Polish, German and other EU countries economies. European countries including Poland and Germany have long and successful history of shipbuilding and shipping. However during the last two decades shipbuilding activities have diminished due to the competition of the Far East shipyards. According to several renowned economists presently we are facing a turning point where the existing experience and resources should be redirected towards more advanced products and items. Such an innovative approach could assure a stable growth of the European maritime economy. The proposed project belongs to an very innovative IT and automation sector combining it with a strong shipping background and therefore using the available know-how in a novel domain. The project is seen as a tool for creating added value for its stakeholders and positively influencing the maritime economy.

Transport of condition-sensitive cargoes is gaining an importance due to the technology advances and growing global demand for condition-sensitive products as well as a constant growth of the average transportation distance. Furthermore, what can be observed recently, the additional factor for closer tracking and monitoring is the growing value of the transported products. Development of wealth in Far East countries (especially in China) resulted in a necessity of maintaining strict transport conditions for upmarket, high-value products (e.g. gourmet food, wines, haut-couture products etc.) [5], [6], [7].

Long distance transport of sensitive cargo is usually carried-out using the refrigerated containers (reefer containers) of standard sizes (20', 40' or 45'). These containers allow for maintaining the required degree of condition standards (usually meeting restrictions on temperature but for some cases assuring also other parameters such as humidity inside a container). Furthermore modern containers allow for a local monitoring of the cargo conditions (conditions inside container) and in certain cases local monitoring parameters can be accessible through a parent system (located usually in a container terminal or on a container ship). Parent systems use the existing infrastructure (in a terminal or on a vessel) to provide access to the most important parameters of the cargo condition inside a container. Obtained data can be compared with known standards and in case cargo parameters deviate from the required ones an alert information is generated. Some systems offer external access to the condition monitoring functionality e.g. for cargo owner [8].

There are several systems for tracking and monitoring cargoes, including sensitive cargoes, but no one is ready to provide monitoring functions from the moment of loading the cargo into a container and afterwards during the whole voyage, until container is unloaded in the destination place. Constant access to the monitored parameters throughout all phases of

the transportation chain is currently not available for the maritime transportation stakeholders. The objective of the paper is to present a concept of the system for tracking and monitoring sensitive cargoes in the sea transportation addressing the above issue. The idea of the system based on integration of functionality and some technical solutions (including communication protocols) from the existing systems for monitoring cargoes in the transportation thus creating a complex solution (system) of the door-to-door type.

The paper is organized as follows. In Section 2 the state-of-the-art in research and development of tracking and monitoring systems for sensitive cargoes in the sea transportation is included. Section 3 presents concept and assumptions of the proposed system, with overview on the research and development process which has to be carried out to design and implement the suggested system. Finally, the last section concludes the paper with final remarks.

2. State of the art in research and development

Reefer containers monitoring and tracking systems do not constitute an extremely competitive market. There are only few vendors offering monitoring systems but their solutions cover only part of the logistics chain (container terminal and/or vessel). Some of the leading solutions are briefly reviewed below.

GRASP 3.0 system [1] offered by US company RTE Inc. is a comprehensive tool for monitoring and control of conditions inside the reefer container. It includes both software and hardware solutions. Hardware includes both - dedicated solutions designed to be attached to a reefer container and, alternatively, some modifications of the third party hardware of selected brands. Software is developed as a desktop application (i.e. requires installation on the user terminal) and therefore does not offer cloud flexibility. Main features of the system are summarized below:

- Recording precise connecting and disconnecting times in order to reduce likelihood of container being not powered,
- Electronic storage of information (claim reports),
- Alarm functionality,
- Remote control of selected parameters.

ReeferConnect system [2] is offered by another US company ORBCOMM. System combines dispersed hardware (installed on a container) with on-demand software which is tailored for the purpose of the user. With this approach user interfaces are built in a case-by-

case method. Therefore there is no general interface available as a cloud solution. Main features of the systems are following:

- Tracking and monitoring of each container in a system,
- Providing status of the vital reefer container parameters,
- Alarm messages in case of exceeding set boundaries of selected parameters
- Integration with existing reefer container systems.

REEFCON 6 developed by the global company Emerson is an advanced monitoring and control system for reefer containers in a container terminal and on board containership [3]. System does not provide functionality for monitoring containers during their road or rail transportation leg. However for the vessel and terminal transport phases system provides specialized graphical interfaces. System focuses on the whole terminal or vessel rather than on each separate container. Main features of REEFCON include:

- Monitoring container conditions during storage in terminal and transportation on board,
- Real-time status and alarm functionality,
- Conditions reporting on request,
- Data centralization with use of the Global Monitoring Server.

Reefer Container Monitoring System [4] provided by German Intershalt has been designed with the goal of monitoring the reefer containers onboard a container vessel. System uses data transmission through the power cable or allows semi-automatic data logging with use of handheld terminal in case of containers not equipped with modem.

Concluding the review Section one should note the following:

- The reviewed systems offer different functionalities and capabilities. However, some of their functions are common to all of them.
- The reviewed systems are based on different ICT technologies.
- There are no data available on their dependability and reliability.
- None of the discussed system can offer the door-to-door service.

3. Conceptual assumptions and requirements for the proposed system

3.1 General assumptions

Main reason for proposing a new approach for tracking and monitoring sensitive cargoes is the need to respond to challenges from increasing volume of cargoes transported by the sea, increasing number of the specialized sensitive cargo containers used, increasing

value of the transported cargoes and a growing demand for a door-to-door services assuring better effectiveness of the transportation chain. The proposed solution therefore fits well into the current trends in offering global, innovative, dependable and value-generating solutions to the intermodal transportation systems.

The main design assumption for the proposed system is its ability of tracking and monitoring the selected parameters of the container cargoes from the moment they are loaded inside a container and afterwards during all the transportation phases including land, water and sea lags, until a cargo transported in a container is unloaded in the destination place. Hence, the proposed system would offer the door-to-door service capabilities.

Another important assumption is that the system, including its communication protocols, should be open allowing for a speedy and flexible adaptation of the dataset required to be monitored during transportation depending on the requirements of the sensitive cargo and/or its carrier or owner. Consequently, a flexible sharing of different kinds of the measured and monitored parameter values, which the transportation process stakeholders would like to record, should be offered. To implement such a system, a new and innovative set of the controllable sensors allowing for typical parameters monitoring through discrete reading, as well as monitoring of the required spectrum of such parameters over the whole container space is needed. Results of such measurements registered over the whole container space, will form an input for spectrum analysis allowing for a complete evaluation of conditions in which cargo is transported. Subsequently, evaluation results should trigger eventual alarm functions.

To realize such system it is also needed to design, develop and implement a new telemetric solution allowing for transmission of the measurements from inside a container during all transportation legs (including storage and waiting for loading/unloading in container and logistics terminals). Communication and data transmission subsystems should be flexible allowing for changing the tele-transmission medium through the ground GPRS as well as through the satellite telecommunication systems. One of the required system functionalities should be also ability to integrate through specially designed interface with the parent container terminal systems as well as with the ship infrastructure systems.

As it has been mentioned, the system should be based on a dedicated telemetric and analytical solutions. From the ICT technology point of view the proposed system should use a cloud processing tools and techniques which will increase accessibility to system functions for all potential users. The graphical user interface should be an important part of the system designed to allow for customization and personalization with respect to category of users and

their particular expectations. Flexible access to system functions should be guaranteed through modular structure of the software component.

In addition, it should be considered to implement the analytical module allowing for the predictive processing and identification of the short-term and long-term changes of the observed parameter values. This should extend functionality of the system allowing for evaluating eventual physical and economic consequences which might be critical from the point of view of quality and value of the transported sensitive cargoes. Such solution could aid decision-making processes of the logistic chain stakeholders. From the research point of view, an open question remains methodology of induction based on spectral analysis applied to spectral data collected under the above described assumptions.

General structure and components of the proposed system are shown in Fig. 1.

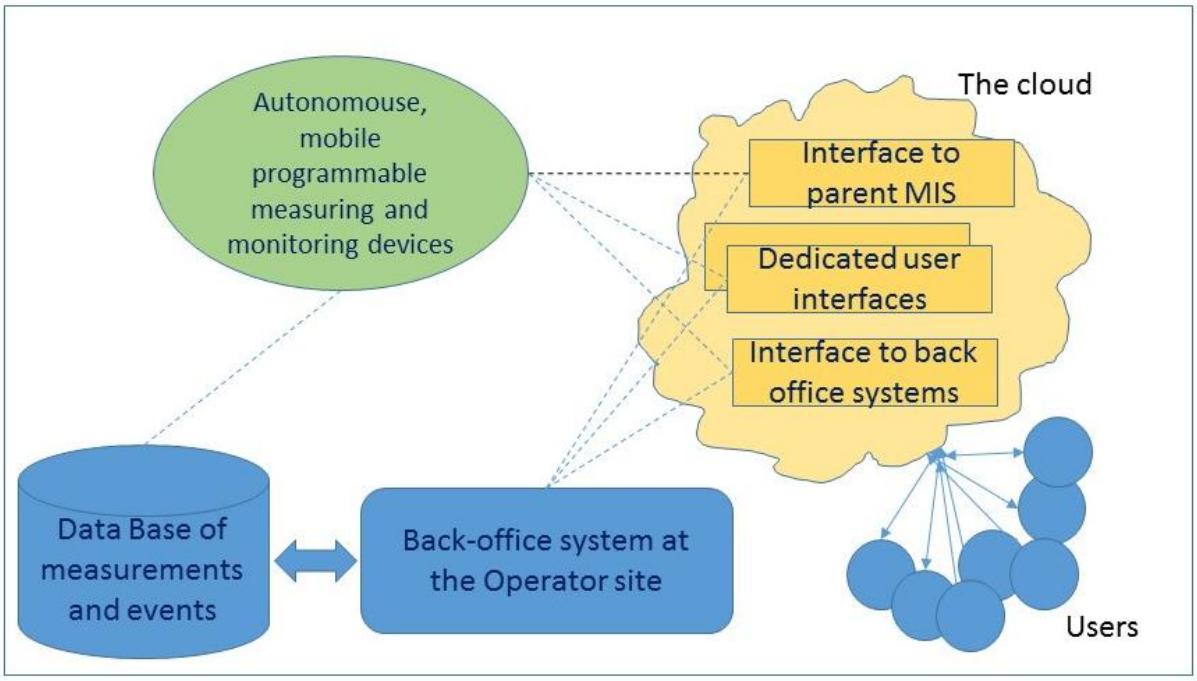

Fig. 1. General structure and components of the proposed system

Thanks to the module functionality the system will be flexible and provide, through dedicated interfaces, different services to different users. Overall impact of the system on logistic chain effectiveness should be positive. Services such as micropayments and subscriptions will make the access easy and affordable. Increased dependability of the main service, that is multimodal transportation of sensitive cargoes achieved through monitoring and tracking, could decrease uncertainty on the part of shippers and insurers leading to decrease of the insurance costs. Eventual alarms raised by the system will allow for timely

reactions due to the real-time property of the system information flow. In case of alarms there subscription systems. The system will aid managing sensitive cargoes transportation chain through on-line real-time monitoring and assurance of meeting standards and requirements. Decreasing risks of damage to cargoes should be considered as an important factor for reducing probability of environmental pollution as a result of improper cargo handling.

3.2 Research and development challenges

The paper reports on idea of the R&D project presently at its early phase. To develop and implement the proposed system a number of research and development tasks need to be carried-out. In particular, the following milestones have to be reached:

- Designing AMTM (autonomous mobile tracking and monitoring) devices through finding new technological solutions and validating functionality of emerging solutions as well as assessing their properties with respect to the expected application area, which is transportation of the sensitive cargoes,
- Proposing adequate telematics solutions including standards, sensors and respective protocols,
- Designing robust and flexible sensors for both continuous and discrete recordings,
- Finding adequate telemetric solutions,
- Proposing and validating new specialized methods and tools for spectral data analysis, and spectral data processing,
- Proposing and validating tools and techniques for knowledge extraction from the recorded data which will be a typical “Big Data” problem.
- Solving system analysis task for making possible integration of the system with the parent stakeholder MIS (management information systems

There are also engineering tasks that require skilful application of the existing technologies. Among them one should mention the following:

- Designing communication subsystem,
- Designing a power supply solutions for system components, including sensors and mobile devices,
- Integrating all components into a working system,
- Proposing adequate system configuration,
- Designing databases structure and functionality with consideration of user needs,
- Designing the required interfaces assuring ease and low costs of access,

- Designing and validating set of the system users roles including tools for providing functionality “on demand”,
- Designing cloud computing part considering availability, costs and ease of access.

4. Concluding remarks

The review of currently available solutions shows that in the field of tracking and monitoring sensitive cargoes transported in containers there are no door-to-door services available on the market. The proposed system aims at providing a novel alternative for all of the chain stakeholders providing for monitoring of the sensitive cargo conditions over all intermodal transportation legs.

Probably such a capability could be achieved through improving the existing solutions by adding a new telematics mechanisms to the parent systems and increasing they functionality. Such an approach would be equally costly as developing a new system and will probably not assure the required universality and flexibility. The proposed system aims at creating an innovative system based on newest ICT technologies. Its implementation will create added value for shipping and intermodal transportation chains community through better utilisation of the transportation infrastructure, reduced damages to the sensitive cargoes and reduced probability of damages to environment.

Potential system users include logistic chain stakeholders such us ship owners and transportation companies, container terminal operators, transit operators, cargo owners, cargo senders and receivers, and insurance companies. Currently, there are no systems of the proposed or similar functionality offered on the market, so the proposed system would be considered as an extension of the existing solutions with a wide range benefits.

Finally, the authors would like to stress that the concept of the system is a part of the early stage of the research and development project, aiming at offering the emerging product on the market by one of project partners.

References

1. GRASP 3.0 – Reefer Monitoring System, http://rtelectronics.com/remote-reefer-monitoring/ (Accessed June 31, 2017).
2. Remote Container Management - ORBCOMM: ReeferConnect, https://www.orbcomm.com/PDF/datasheet/ReeferConnect.pdf (Accessed June 31, 2017).
3. Emerson Transportation Solutions: REFCON 6, http://www.emersonclimate.com/en-us/products/Container_Monitoring/Pages/refcon.aspx (Accessed June 31, 2017).

4. Interschalt maritime systems: INTERSCHALT, http://www.interschalt.com/ (Accessed June 31, 2017).
5. Freight transport statistics, Statistics Explained, EUROSTAT, http://ec.europa.eu/eurostat/statistics-explained/index.php/Freight_transport_statistics#Further_Eurostat_information (Accessed June 31, 2017)
6. Energy, transport and environment indicators, STATISTICAL BOOKS, EUROSTAT, 2016 edition, http://ec.europa.eu/eurostat/documents/3217494/7731525/KS-DK-16-001-EN-N.pdf/cc2b4de7-146c-4254-9521-dcbd6e6fafa6 (Accessed June 31, 2017).
7. Joseph E. Stiglitz, The Chinese Century, GEOPOLITICS, 2014, https://www.vanityfair.com/news/2015/01/china-worlds-largest-economy (Accessed June 31, 2017).
8. Freight Transportation Modal Shares: Scenarios for a Low-Carbon Future, CAMBRIDGE SYSTEMATICS, 2013, http://www.nrel.gov/docs/fy13osti/55636.pdf (Accessed March, 2017).

RESEARCH ON TECHNIQUES OF HIERARCHICAL - HETEROGENEOUS NETWORKING AND OPTIMIZATION OF RESOURCE SCHEDULING IN THE SEA AREA

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Abstract: The realization of a unified and efficient marine communication network is not only about how to develop a communication system, but also how to manage them, that is, how to set up an efficient marine communication network. Marine hierarchical-heterogeneous network is a multi-level integrated marine communication network, with shore-based, ship-based, star-based, space-based, underwater sound/light base station access, transmission and information aggregation capability. The access control, heterogeneous networking and resource optimization scheduling technology is facing enormous challenges, according to different priorities and types of services. Considering the complexity of the heterogeneous network as a cross-network with multi-user and multi-service, it is necessary to apply the delay tolerance network technology, cooperative technology, TD-LTE and software definition network technology into the network architecture design. The vision is exploiting DTN technology based ship-borne Internet, and the space-sea cooperative DTN data transmission scheduling mechanism; exploring the underwater acoustic/optical communication network switching scheduling mechanism; and then software definition heterogeneous network implementation is proposed, especially its optimal target network selection scheme. The project is meant as a petri

dish to provide valuable theoretical guidance and technical support of planning and performance evaluation for future marine hierarchical-heterogeneous network.

Keywords: Hierarchical-Heterogeneous Network; Resource Scheduling; Marine Communication; Delay Tolerant Network

1. Introduction

At present, marine communication system mainly includes maritime wireless communication, marine satellite communication and shore-based mobile communication system, which together constitute a basic realization of the marine full coverage of the communication network. The system can guarantee the daily communication of coastal, offshore and ocean-going ships-coasts, ships and ships; in the fields of ocean transportation, oil and gas exploration and exploitation, marine environmental monitoring, marine fishery, mariculture and marine science and other fields, accurate, timely and secure communication infrastructure. In general, marine communication technology is still at a lower level of application stage, which only basically meets the maritime activities of the conventional communication needs. Although there are some ships on the river which based on the public network GPRS/CDMA/3G construction of the maritime communications system, but it can’t achieve a wide range of remote network coverage. At the same time, because the conventional communication system of marine communication network is not compatible with each other, the communication bandwidth is different. There is a blind spot in the coverage area, lack of flexible configuration, efficient and unified management mechanism. Conventional marine communication network is becoming increasingly difficult to meet growing ocean activities demand, as constraints of marine development and exploration to the development of a major bottleneck. In particular, the International Maritime Organization has also proposed the development of electronic navigation E-Navigation strategy [1] to meet the future of marine business expansion, user needs, marine environmental protection and other development needs. Therefore, we must fully investigate the development of marine communications, understand the world's advanced marine communication technology, explore the development of suitable marine communication network architecture, and ultimately build a high-speed, high reliability,

full coverage, easy management, flexibility, low cost of the new ocean communication network [2].

At the same time, marine communication network resource management mechanism is another challenge that can't be ignored in marine communication. The realization of a unified and efficient marine communication network is not only about how to develop a communication system, but also how to manage them, that is, how to set up an efficient marine communication network. The research on the optimal allocation of resources of marine wideband communication system is still at the initial stage, and the related references are few. In [3], the Nautical Ad-hoc Network (NAC) is proposed for three scenes of harbor, seaside and ocean. Singapore-related scholars combined with Japan NICT research institutions with the start of the WiMAX-based Mesh network distributed adaptive slot allocation [4] and routing research work. However, research has focused on routing protocols, connectivity, and maritime channel modeling. Lin et al. analyzed the performance of maritime DTN network based on WiMAX technology, simulated the navigation data of Singapore Strait, and compared the performance of different routing protocol algorithms. The results show that the DTN routing protocol has a better probability of packet transmission in the maritime environment [5]. The paper [6] proposed a transmission performance analysis based on the theoretical model of the ship's encounter probability. The paper [7] is based on the existing AIS system, mobile data, predict ship-ship encounter model. However, ship-ship communications are within the scope of their respective communications. In our previous research process, Delay-Tolerant Networking (DTN) [8], WiMAX technology, and green communication technology were applied to the implementation of sea wideband networks. The storage-carrying-forwarding method was used to support intermittent connectivity, large and high bit error rate of maritime communication environment, and around the sea wideband data transmission in the optimal allocation of resources and scheduling issues to start a certain research work [9-11]. In addition to the above discussion of the marine communication network management methods, there are other literature, such as the literature [12-13] researchers also put forward their own management methods, the practical application should be based on different needs to adopt appropriate integration the internet. At present, the fifth generation terrestrial mobile communication technology (5G) is under trial operation, and 5G will be an important part of the future

information infrastructure. It can be used to solve the expansion of marine communication coverage and improve system capacity and other problems. Therefore, although there is already a variety of unique integrated network, but the development of more efficient integrated marine communication network, the study of the corresponding efficient marine communication network resource management mechanism is still one of the future research focuses.

2. System model

The hierarchical-heterogeneous network is a multi-level integrated marine communication heterogeneous network. Through the comprehensive utilization of shore base stations, satellites, island reefs, sea floating platforms, unmanned ships, stratospheric airships and other relay nodes, at the same time, depending on the maritime communication priority (distress, emergency, safety, regular), different types of services (different types of traffic, voice, data communication, multimedia services, etc.), different communication initiators (ship, shore) and network access (shore-based close-up access, offshore distance access, offshore mobile platform access) access control, heterogeneous networking and resource optimization scheduling technology is facing great challenges. This project takes full account of the complexity of the multi-level heterogeneous network in the sea as a cross-network and multi-user and multi-service giant system. The application of delay tolerant network DTN technology, collaboration technology, TD-LTE and software definition network (Software Defined Network, SDN) technology, to explore the multi-level heterogeneous network and resource optimization scheduling key technology research. The hierarchical-heterogeneous network has the capability of wide area coverage, real-time acquisition, safely control, accessed and on-demand service. Its flexible multi-access scheme and resource scheduling scheme can be used for marine hydrological meteorology and resources Exploration, disaster reduction, ship data transmission and other applications to provide network-based information services, especially on the maritime burst application mode of resources to support the flexible scheduling research to optimize the system business access control and network service performance. The smooth implementation of this project will become a human understanding of the ocean, the use of ocean information stations, and will also open up the future of information technology in the field of one of the important research.

Vessels network which is an intelligent transportation system on the sea, belongs to a new generation of maritime network. It is one of the most important supplement and extension of land vehicle networking, i.e. VANET [14]. In this paper, we build up this Space/Air/Sea integrated network, which is a multi-layer heterogeneous network, has shore-based, space-based and air-based access ability. This heterogeneous network could provide network access, data transportation and information gathering functions at the same time. The system model is shown in Fig. 1.

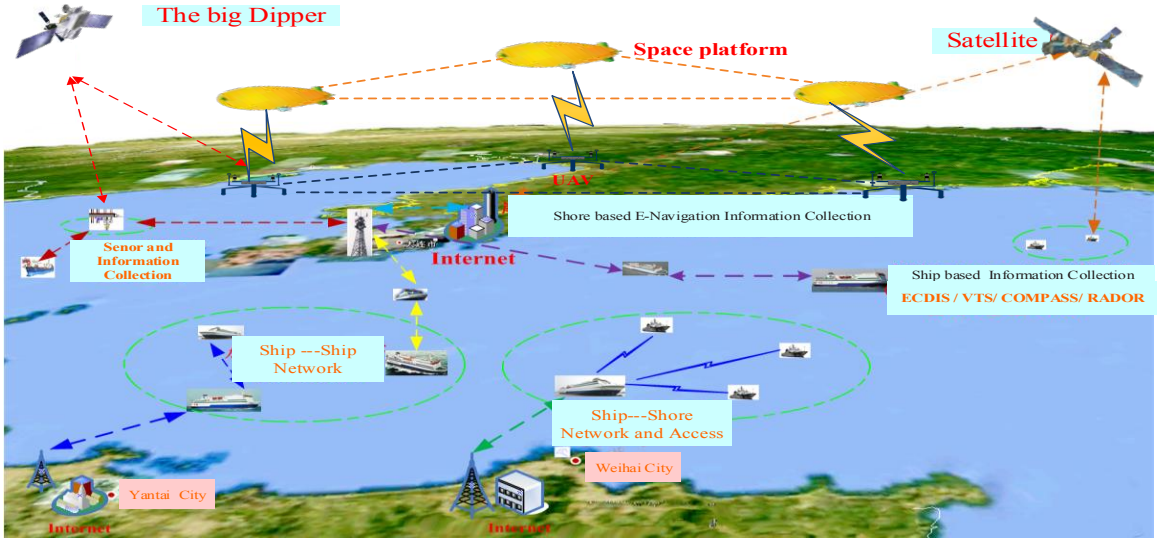

Fig.1 System model

3. Key Scientific Issues of Space/Air/Sea Integrated Network

The specificity of this study lies in the analysis of future demand and application pattern of intelligent ship communication. According to the coexistence of broadband data and narrowband data, the cost of shore base station construction is high, the distance of sea communication is far, the connectivity of the network node is sparse, And the high bit error rate, and constructs the multi-level heterogeneous network with the infrastructure such as communication satellite, air platform, ground base station, underwater sound/optical communication and so on. Considering the hierarchical-heterogeneous networks according to the specific structure can be divided into multiple levels, so in a wide range of multi-dimensional data transmission network heterogeneous characteristics. According to the different ship communication needs, maritime communication priority and application mode,

the interactive data scheduling and resource allocation mechanism are studied, and the resource utilization efficiency of each information platform is effectively improved.

- **Research on Data Transmission Scheduling Mechanism of Ship-borne Internet Based on DTN Technology**

Considering the ship mobility and network topology time-varying, especially due to the particularity of the maritime communication environment, so that the layout of the base station will have a discontinuous problem in time, but the existing classical scheduling mathematical algorithms are mostly based on continuous time characteristics, Which gave the ship-borne Internet DTN data transmission scheduling issues posed a serious challenge. Therefore, the design of a variety of ship-borne interconnection, seamless, and efficient ship-borne interconnect delay tolerance of network data transmission scheduling problems to be solved key scientific issues.

In order to solve the discontinuity problem of DTN network in time domain, we consider the time-capacity mapping method to convert based on time-capacity domain scheduling problem.

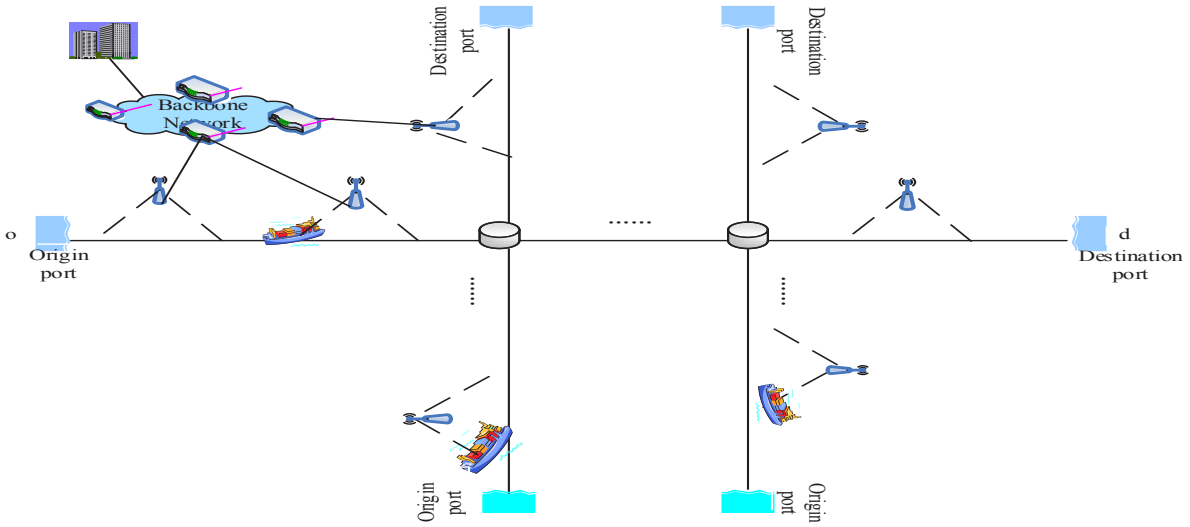

Fig.2 The Model of Ship-borne Internet Based on DTN Technology

Define $T_h^i(T_h^o)$ for the time at which the ship enters (leaves) the h shore base, respectively. $[T_h^o, T_{h+1}^i]$ is the time at which the ship is outside the coverage of two adjacent base stations, the ship can't transmit information via the base station in this time slot, and $A_{h,k}$

is the capacity of the k frame within the h shore coverage. The time-capacity mapping function is $f(t):[T_I,T_o]\rightarrow[0,1,\mathrm{L}\ \sum_{h=1}^{H}\sum_{k=1}^{K}A_{h,k}]$

$$f(t)=\begin{cases}\sum_{m=1}^{(t-T_{h_t}^i)/T_F}A_{h_t,m}+\sum_{l=1}^{h_t-1}\sum_{m=1}^{K_l}A_{l,m}, \text{if } h_t\geq 1 \text{ and } T_{h_t}^i\leq t\leq T_{h_t}^o \\ \sum_{l=1}^{h_t}\sum_{m=1}^{K_l}A_{l,m}, \qquad \text{otherwise}\end{cases}$$

$h_t=\arg\max_h\{T_h^i\leq t\}$, if $T_{h_t}^i\leq t\leq T_{h_t}^o$, otherwise $h_t=0$.

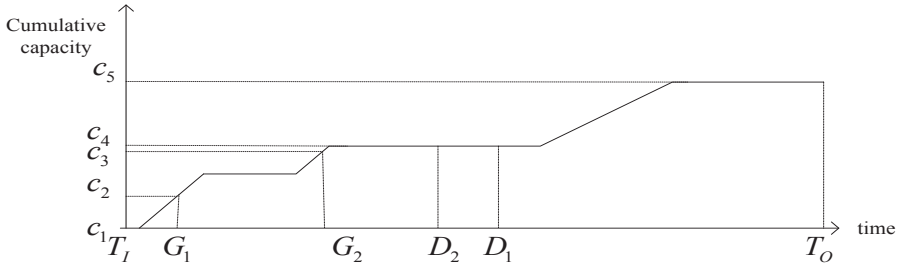

Fig.3 Time-Capacity Mapping

- **Research on Dispatching Mechanism of Underwater Acoustic / Optical Communication Network Switching**

Underwater acoustic/optical communication networks have different transmission characteristics and conditions of use. In this paper, the user in the underwater communication network is used to study the allocation mechanism of the acoustic/optical communication network resources to realize the optimization of the underwater data transmission. The subject first performs underwater acoustic/optical communication network modeling. In consideration of the total amount of transmission data of the underwater network user, the total amount of the received data of the underwater data transmission base station and the overall performance of the underwater data transmission to study how to use optical communication resources. This study can reduce the drawbacks of using high-latency and low-rate when the large amount of data is transmitted using the underwater acoustic transmission, so as to realize the optimal switching scheduling of the underwater data transmission mechanism.

- **Hierarchical - Heterogeneous Software Definition Network Realization and Optimal Target Network Selection Mechanism**

Techniques of hierarchical-heterogeneous networks can cope with the complex environment and tasks of future maritime communications environments. Considering that the network consists of ground access stations, airborne unmanned aerial vehicles, airships,

shore-based, underwater communications equipment and other access and control equipment, the network topology is changing, and a variety of information exchange frequently, direct and effective control. This project constructs the multi-level heterogeneous network of aggregated SDN based on fog calculation, which can play the advantages of unified management of network information and local information quickly [15]. It is very suitable for emergency treatment of marine environment, especially sea emergencies. And make full use of the software to define the advantages of SDN control plane and data plane separation, and effectively solve the network switching decision, and finally build a seamless, transparent, efficient, unified multi-level heterogeneous network selection mechanism. The SDN model is shown in Fig. 4.

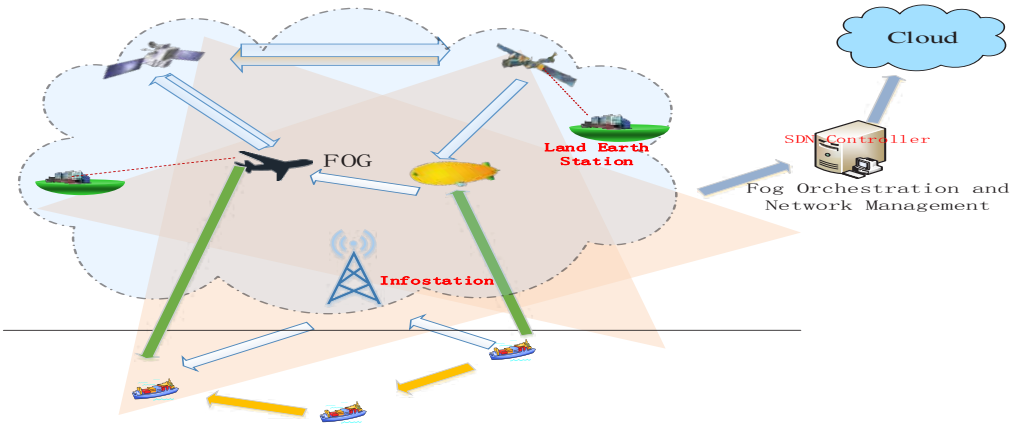

Fig.4 SDN-based Space/Air/Sea Integrated Network Architecture Leveraging Fog Computing.

4. Conclusion

In this paper, we propose a novel heterogeneous network. Marine hierarchical-heterogeneous network is a multi-level integrated marine communication network, with shore-based, ship-based, star-based, space-based, underwater sound/light base station access, transmission and information aggregation capability. SDN-based Space/Air/ Sea integrated network architecture leveraging fog computing. Targeting the dedicated communication on the sea, we design the unique network structure, as well as the component accordingly. And the working procedures are listed to show how this network works and it concerns. The project is meant as a petri dish to provide valuable theoretical guidance and technical support of planning and performance evaluation for future marine hierarchical-heterogeneous network.

In future work, we will take into account the maritime communications network security issues, while strengthening the scientific research in this area. Considering the above issues, combined with some of the problems of the new architecture of maritime communications, IMO legislative work will also be the focus of our work.

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References

[1] IALA Recommendation e-NAV-140, The e-Navigation Architecture the initial Shore-basedPerspective Edition 1.0, Dec. 2009.

[2] Xia M H, Zhu Y M, Chen E H, et al. The Present Situation and Challenges of Marine Communication, SCIENCE CHINA Information Sciences, doi:10.1360/N112013-00016, 2017.3.

[3] Kim Y B, Kim J H, Wang Y P, et al. Application scenarios of nautical ad-hoc network for maritime communications. IEEE Biloxi Marine Technology for Our Future: Global and Local Challenges, 2009: 1-4.

[4] J. Jurianto, S.K.Hazra, S.H`. To, W.M.L. Tan, J.S. Patmasuntaram, and M. Fujise, “Path loss measurements in sea port for WiMAX”, in Proc. WCNC, 2007: 1871-1876.

[5] Lin, Hao-Min etc. al., “Performance study on delay tolerant networks in maritime communication environments”, in Proc. IEEE OCEANS, 2010: 1-6.

[6] Qin, Shuang etc. al., “Performance modeling of data transmission in maritime delay-tolerantnetworks”, in Proc. IEEE WCNC, 2013:1109-1114.

[7] Kolios, Panayiotis and Lambrinos, Lambros, “Optimising file delivery in a maritime environment through inter-vessel connectivity predictions”, in Proc. IEEE WIMOB, 2012:777-783.

[8] Burleig S, Hooke A, Torgerson L, et al. Delay-tolerant networking: an approach to interplanetary Internet. IEEE Communication Magazine, 2003, 41(6): 128-136.

[9] Yang T T, Shen X M. Maritime wideband communication networks: video transmission scheduling. Springer Briefs in Electrical and Computer Engineering, 2014.

[10] Yang T T, Liang H, Cheng N, et al. Efficient scheduling for video transmission in maritime wireless communication network”, IEEE Transactions on Vehicular Technology. 2015, 64(8):4215-4229.

[11] Yang T T, Zheng Z M, Liang H, et al. Green energy and content aware data transmission in maritime wireless communication network. IEEE Transactions on Intelligent Transportation System. 2015, 16(2): 751-762.

[12] Laarhuis J. Distributed maritime surveillance system: WO, EP 2355451 A1. 2011.

[13] Kidston D, Labbe I. A service oriented framework for policy-based management of maritime mobile networks. IEEE MILCOM2006, 2006: 1-7.

[14] V. Friderikos, K, Papadaki, M. Doler, A. Gkelias and H.Agvhami, “Linked Waters”, IEEE Comms. Engineer, pp.24-27, April 2005.

[15] H. Zhang, W. Quan, H.-C. Chao, and C. Qiao, “Smart identifier network: A collaborative architecture for the future internet,” pp. 46–51, May 2016.

TRADITIONAL NAVIGATION IN E-NAVIGATION CONTEXT

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Abstract

This paper is based on research and analysis of 5 incident cases from the period 2013-2016 published by European Maritime Safety Agency (EMSA) that clearly marks the safety risks due to the improper use of sophisticated electronic navigational tools - AIS, ECDIS, Integrated Bridge Systems, Automatic Radar Plotting Aids on board commercial ships, as well as, discusses issues of potential risks involved with complacency and over reliance on Electronic Chart Display and Information System (ECDIS) and advises that seafarers should put more efforts to undergo the necessary traditional navigational training. There is a growing tendency for seafarer competence to be measured by administrative and electronic expertise, but this can mask poor performance when basic seamanship is required. Seafarers should continue to be trained in a variety of traditional and proven navigational techniques, hold a paper chart "back up" portfolio, and run table top exercises to maintain their familiarity with paper charts and proper position fixing routines. An over reliance on ECDIS can cause these traditional skills to fade and potentially lead to incidents. The industry should make sufficient navigational training widely available. Human errors are generally caused by technologies, environments, and organizations which are incompatible in some way with optimal human performance. The human has been expected to adapt to the system but this does not work. Instead, what needs to be done is to adapt the system to the human.

Keywords: e-Navigation, Traditional navigation, Maritime education and Training, Safety.

Introduction

We are moving into a new era with the arrival of true "e-Navigation", the first manifestation of which is the electronic chart. And as with every other advance in navigation since the arrival of

radar, the benefits of the new bring with them cautions which must be considered if we wouldn't like to witness a number of "ECDIS assisted" incidents. Nowadays there is a growing tendency for measuring seafarer competence by administrative and electronic expertise, but this can mask poor performance when basic seamanship is required. Routine situations can turn into emergencies very rapidly.

Safe navigation in e-Navigation concept

According to IMO definition, scope and need of e-Navigation (IMO, MSC 85/26/Add.1, 2011) are:

1. ***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. ***E-navigation is intended to meet present and future user needs through harmonization of marine navigation systems and supporting shore services.***
3. ***There is a clear and compelling need to equip shipboard users and those ashore responsible for the safety of shipping with modern, proven tools that are optimized for good decision making in order to make maritime navigation and communications more reliable and user friendly. The overall goal is to improve safety of navigation and to reduce errors.***

The 2010 amendments to the STCW Convention (IMO, STCW/CONF.2/34, Resolution 2, 2010) have introduced inter alia enhanced Bridge Resource Management training for all officers in charge of a navigational watch (OOW), and stricter minimum rest hour requirements. This was a direct response to the recognition by regulators and accident investigators of the importance of the human element in ship safety. New equipment and technology underlines the need for familiarization with ship specific arrangements. ECDIS is a particular example and caution against over reliance on the system should be paid off. In addition to contributing to maritime safety the efficient and well planned sea passages are necessary for the economic health of the shipping industry. Together with new environmental requirements, including rules to reduce air emissions, there are additional pressures to ensure effective passage planning and efficient execution.

Case analysis

Guided by the above principles and requirements for safe navigation, we selected and investigated 5 incident cases (European Maritime Casualty Information Platform, 2017) published by EMSA on EMCIP (European Maritime Casualty Information Platform) during the period 2013-2016 that in our opinion, reveals and clearly marks the safety risks due to the improper use of ECDIS equipment and potential risks involved with complacency and over reliance on sophisticated electronic aids to navigation.

The inception of e-Navigation concept took place way back in the year 2006, when the International Maritime Organization (IMO) decided to include a well-defined strategy (IMO, MSC 85/26/Add.1, 2011) to integrate new and existing navigational tools for enhancing handling and safety of ships at the sea. The main aim of the e-Navigation concept is to develop a system which can properly organize all the ship's data at one place in order to help improving navigational safety of the ships. Human error during ship navigation has been recognized as one of the prime reasons for maritime accidents. Though the number of accidents at sea has reduced lately, a lot needs to be done in order to reduce navigational errors as a result of human negligence. The matter of concern is that in spite of highly advanced equipment systems used in modern ships, accidents related to navigation continues to occur.

Incident No. 1 (MAIB, United Kingdom, REPORT No. 24/2014, 2014)

At 04:34 on 18 September 2013, the Malta registered chemical tanker, "Ovit", ran aground on the Varne Bank in the Dover Strait while on passage from Rotterdam, Netherlands, to Brindisi, Italy. The vessel, which was carrying a cargo of vegetable oil, remained aground for just under 3 hours; there were no injuries and damage to the vessel was superficial. There was no pollution. M/t "Ovit" refloated on the rising tide and subsequently berthed in Dover. "Ovit" primary means of navigation was ECDIS. The officer of the watch was following a route shown on the ECDIS display; the route passed directly over the Varne Bank.

Navigation safety issues directly contributing to the accident:

1. The passage plan, which was prepared by an inexperienced and unsupervised junior officer, passed directly over the Varne Bank and was unsafe.
2. The passage plan was not properly checked for navigational hazards using the ECDIS check-route function and it was not checked by the master.

3. When taking over the watch, the OOW did not check the ship's intended track relative to any dangers to navigation that would be encountered on his watch.
4. The OOW monitored the vessel's position solely against the intended track. Consequently, his situational awareness was poor.
5. Although the lights from the cardinal buoys marking the Varne Bank were seen by the lookout, they were not reported.
6. The passage through the Dover Strait was treated in exactly the same way as a passage in open water. Moreover, the master demonstrated an astounding level of complacency when his vessel was apparently drifting in the Dover Strait without propulsion.
7. The deck officers were unable to safely navigate using the vessel's ECDIS. The route was not properly checked, inappropriate depth and cross track error settings were used, and the scale of Electronic Nautical Chart (ENC) in use was unsuitable for the area.
8. The ECDIS audible alarm was inoperative. Although the crew was aware of this defect, it had not been reported.
9. ECDIS training undertaken by the ship's master and deck officers had not provide them with the level of knowledge necessary to operate the system effectively.
10. The safety management system (SMS) bridge procedures provided on board "Ovit" by Ayder Tankers Ltd. were comprehensive and included extensive guidance on the conduct of navigation using ECDIS. However, it is evident that the master and deck officers did not implement the ship manager's policies for safe navigation and bridge watchkeeping.
11. The on board management of "Ovit" was dysfunctional and the master provided insufficient leadership for a safety culture to be developed and instilled on his bridge.
12. The serious shortcomings with the navigation on board "Ovit" highlighted in this investigation had not been identified during the vessel's recent audits and inspections. There is a strong case to develop and provide tools for auditors and inspectors to check the use and performance of ECDIS.

Incident No.2 (HBMCI, Greece, REPORT No. 04/2014, 2016)

On 21 September 2014 Ro-Ro Passenger "Europalink" was enroute to Ancona, Italy having departed from the port of Igoumenitsa, Greece with 693 passengers, 70 crew members and loaded with 366 vehicles. At about 02:20 she was running at approximately 24 knots keeping a course of

360° while helm was in autopilot mode. Actual weather conditions were reported to be good with moderate sea and variable winds 2-3 (Beaufort scale) and good visibility. At 02:33, while under turn to port by continuously setting the autopilot, she hit on the rocky shoal reef South of Peristerai Islet, located 0.6 nm off the Northeast coast of the island of Corfu, Greece. No injuries to crew or passengers were reported and no pollution occurred. During the marine accident the 2nd Officer was on duty, however the Master being also on the bridge was in charge of the con.

"Europalink" primary means of navigation were standard paper Nautical Charts of British Admiralty while Electronic Navigational Charts were also provided through approved ECDIS system, installed as a component of her centralized Navigation Control System. Based on the above the navigating Officer could either monitor "Europalink" passage from the paper charts by entering fixes or continuously check and control her followed courses electronically through ECDIS and Radar, fitted in the main navigation console. Her passage plan was plotted on the voyage paper charts as well as in ECDIS, allowing the Officer on the watch to electronically monitor her track and execute course progress.

Navigation safety issues directly contributing to the accident:

1. "Europalink" navigational team performance was poor failing to effectively utilize state of the art navigational aids available.
2. "Europalink" SMS - "Voyage Planning form" was not incorporating in full the requirements foreseen in IMO Resolution A.893 (21) (IMO, *Resolution A.893 (21), Para. 2.1.7.6*, February 2000)[6] that is volume of traffic in "appraisal planning phase".
3. The execution phase of "Europalink" voyage plan was not effectively performed under the respective section of IMO Resolution A.893 (21) and as a result passage planning was ineffectively being monitored. .
4. The voyage plan speed limit for the Peristerai passage segment was disregarded by both Master and the OOW.
5. The Master was focused in "Europalink" trading operational demands (itinerary) at the cost of her navigational safety.
6. COLREGS safe speed rule was disregarded by the Master.
7. The Master's situational awareness had been notably lessened under complacency and overconfident status. Bridge Resource Management provisions were not practiced by the Master and the OOW

8. The OOW situational awareness had been notably lessen failing to perform a safe turn based on the information sourced from the navigational aids and the external environment.

Incident No.3 (MAIB, United Kingdom, REPORT No. 27/2016, 2016**)**

At 16:58 on 29 August 2015, the Cyprus registered cargo ship "Daroja" and the St. Kitts and Nevis registered oil bunker barge "Erin Wood" collided 4 nautical miles south-east of Peterhead, Scotland. Minor damage was caused to "Daroja" but damage to "Erin Wood" included breaches of the hull, resulting in flooding of the vessel and pollution from leaking fuel cargo.

At the time of the accident, both vessels were manned by watchkeepers not keeping a lookout and therefore unaware of the risk of collision. On board "Daroja", the Chief Officer, who was the OOW, missed opportunities to detect "Erin Wood" by visual, radar and automatic identification system means.

Navigation safety issues directly contributing to the accident:

1. "Daroja" and "Erin Wood" collided because a proper lookout was not being kept on either vessel.
2. On board "Daroja", the Chief Officer, who was the OOW, missed multiple opportunities to detect "Erin Wood"; this happened because he had become complacent about his watchkeeping duties and allowed himself to become distracted.
3. Complacency and poor watchkeeping practices were systemic on board "Daroja". This was largely due to the repetitive nature of its trading route and a lack of mentorship and direction from the vessel's Master.
4. Although "Erin Wood" skipper was aware of the presence of another vessel, he did not effectively assess the situation and assumed a larger vessel would keep clear.
5. Lone watchkeeping was a normal practice in both vessels and the risks associated with this had not been properly assessed.

Incident No.4 (DMAIB, Denmark**,** 2015**)**

On 10 July 2014, the Danish fishing vessel "Inger Marie" and the Maltese general cargo ship "RIG" collided approximately 11 nautical miles north-east of the Island of Læsø, Denmark. "Inger Marie" foundered shortly after the collision and the skipper, who was the only crew member on board, perished. The collision happened in good weather conditions and with little traffic in the area. Circumstances suggest that neither the skipper on "Inger Marie" nor the OOW on "RIG" were

aware of the other ship's presence and the risk of collision until moments before the collision. The OOW on "RIG" tried to avoid the collision by turning to starboard, but the maneuver was too late. It is uncertain whether the skipper on "Inger Marie" realized the risk of collision before the impact. On "RIG", the OOW officer was not actively using the radar and did not plot the vessels in the area nor visually observe "Inger Marie" approaching, because he did not move around on the bridge and/or was preoccupied and therefore did not see "Inger Marie" approaching in a blind sector.

Navigation safety issues directly contributing to the accident:

1. A conjunction of circumstances led to the collision that was overall caused by a lack of effective look-out on both ships. On "Inger Marie", the look-out was not effective probably due to work practices while the vessel was underway. On "RIG", the lack of effective look-out was probably caused by the favorable weather conditions that gave a good overview of the situation and minimized the use of the radar. Once the presence of "Inger Marie" was acknowledged on "RIG", it was too late to avoid the collision.

Incident No.5 (MAIB, United Kingdom, REPORT No. 12/2016, 2016**)**

At 13:28 on 11 May 2015, the Bahamas registered passenger vessel "Hamburg" grounded on charted rocks near the New Rocks buoy in the Sound of Mull, Scotland. The accident caused considerable raking damage to the hull and rendered the port propeller, shaft and rudder unserviceable. There were no injuries and the vessel continued on its passage to Tobermory. The investigation found that, having been unable to enter Tobermory Bay on arrival, the passage plan was neither re-evaluated nor amended. Combined with poor bridge team management and navigational practices, this resulted in the vessel running into danger and grounding. Despite the loud noise and vibration resulting from the grounding, the bridge team did not initiate the post-grounding checklist, no musters were held and neither the vessel's managers nor any shore authorities were notified of the accident. Upon arrival at Tobermory Bay, the Master made an ill-considered and poorly executed attempt at anchoring just within the bay's entrance instead of the planned position in the south of the bay. This had to be aborted to avoid a second grounding when "Hamburg" dragged its anchor. The passenger vessel was then taken back out to the open sea with unknown damage to its structure, before diverting to Belfast where a dive survey revealed the extent of the damage. The vessel was withdrawn from service for 3 months for repairs.

Navigation safety issues directly contributing to the accident:

1. "Hamburg" grounded on the charted New Rocks shoal because the bridge team did not recognize that their vessel was approaching the New Rocks buoy from an unsafe direction.
2. The master did not demand a high standard of navigational practices from his officers which resulted in weak practices amongst the bridge team.
3. The OOW placed "Hamburg" in an untenable traffic situation where the passenger vessel was giving way to all other vessels regardless of the requirements of the COLREGS.
4. There is significant evidence that insufficient attention was being paid to the conduct of navigation on "Hamburg".
5. It was foreseeable that the OOW would use the ECDIS instead of the paper chart for navigation, but no mechanisms were in place to ensure it was used effectively.
6. "Hamburg" bridge team failed to apply Bridge Team Management tools (BTM) effectively, either before or after the grounding, despite the requirements of the Safety Management System and the master and navigator having received BTM training.

A detailed analysis of the above cases, regardless of the different types of vessels and situations shows and highlights:

1. ***Serious accidents with casualties and significant property damage continues to happened despite the high level of automation and latest generation electronics on the bridge.***
2. ***Unsatisfactory and dangerous actions performed by the Officers on watch and/or Masters of ships in the cases examined are caused by complacency, inefficient Bridge Team Management and non-compliance with international safety regulations.***
3. ***Poor performance when basic seamanship and common sense is required, inadequate actions and misleading communications stands out in all cases.***
4. ***Human errors (regardless the reason - fatigue, poor passage planning, non-compliance, etc.) continue to create the foundation of marine accidents.***

Conclusion

50% of the casualties for the period 2011-2015 were of a navigational nature, such as contacts, groundings/stranding or collisions, according the 2016 EMSA data (EMSA, 2017, p.8) . Human

erroneous action represented 63% of accidental events and 67% of accidental events were linked to shipboard operations as a contributing factor, making the prevention of human error of paramount importance if we wish to reduce the number and severity of maritime accidents.

Crew size and training decisions directly affect crew workload and their capabilities to perform safely and effectively. A strict hierarchical command structure can inhibit effective teamwork, whereas free, interactive communications can enhance it. Company policies with respect to meeting schedules and working safely will directly influence the degree of risk-taking behavior and operational safety. While human errors are all too often blamed on "inattention" or "mistakes" on the part of the OOW or Masters, more often than not they are symptomatic of deeper and more complicated problems in the total maritime system. Human errors are generally caused by technologies, environments, and organizations which are incompatible in some way with optimal human performance. These incompatible factors "set up" the human operator to make mistakes.

So what to be done in order to solve this problem?

Traditionally international and local authorities, ship-owners and operators have tried either to persuade or threaten seafarers into not making errors, as though proper motivation could somehow overcome inborn human limitations. ***In other words, the human has been expected to adapt to the system but this does not work. Instead, what needs to be done is to adapt the system to the human*** (DR. ANITA M. ROTHBLUM, 2002, p.13).

In the light of the abovestated it is necessary, as per our humble opinion, to ask ourselves what is the role of the Maritime universities for the needed changes in the safe navigation process. The fundamental responsibility of the maritime education is to create and build well-trained and motivated maritime professionals. By focusing efforts on the transfer of knowledge, traditional skills and proven experience in the context of the safety navigation culture for the future officers, the Maritime universities can contribute greatly to the safety of navigation and therefore resulting outcome will be a significant reduction of marine accidents. High standard traditional seamanship training and new technologies should be blended in the 21st century marine education in order to form qualified and respected marine and naval officers.

References

INTERNATIONAL MARITIME ORGANIZATION, MSC 85/26/Add.1, "*Strategy for the development and implementation of e-Navigation"*, 25th of July 2011.

INTERNATIONAL MARITIME ORGANIZATION, STCW/CONF.2/34, *Resolution 2 - The Manila Amendments to* the *Seafarers' Training, Certification and Watchkeeping (STCW) Code*, Text adopted by the Conference, 03rd of August.2010

EUROPEAN MARITIME CASUALTY INFORMATION PLATFORM,
Web resource: https://emcipportal.jrc.ec.europa.eu [online], Accessed 25th of May 2017

MARINE ACCIDENT INVESTIGATION BRANCH, United Kingdom, REPORT No. 24/2014 named *"Report on the investigation of the grounding of m/t Ovit in the Dover Strait on 18 September 2013"*, Date of issue: September 2014.

HELLENIC BUREAU FOR MARITIME CASUALTIES INVESTIGATION, Greece, REPORT No. 04/2014 named *"Impact of RoPax Europalink on Peristerai Islet shoal reef*", Date of issue: 2016.

INTERNATIONAL MARITIME ORGANIZATION, *Resolution A.893 (21), Para. 2.1.7.6*, February 2000

MARINE ACCIDENT INVESTIGATION BRANCH, UNITED KINGDOM, REPORT No. 27/2016 named *"Report on the investigation of the collision between the general cargo ship Daroja and the oil bunker barge Erin Wood 4 nautical miles south-east of Peterhead, Scotland on 29 August 2015"*, Date of issue: December 2016.

THE DANISH MARITIME ACCIDENT INVESTIGATION BOARD, Denmark, REPORT named *"2015 RIG and INGER MARIE Collision on 10 July 2014"*, Date of issue: 3 March 2015.

MARINE ACCIDENT INVESTIGATION BRANCH, United Kingdom, REPORT No. 12/2016 named *"Report on the investigation of the grounding of the cruise ship Hamburg in the Sound of Mull, Scotland 11 May 2015"*, Date of issue: June 2016

EUROPEAN MARITIME SAFETY AGENCY, "*Annual overview of Marine casualties and incidents 2016"*, Date of issue: January 2017

DR. ANITA M. ROTHBLUM, 2nd International workshop on human factors in offshore operations (HFW2002), *"Human factors in incidents investigation and analysis report"*, 2002, U.S. Coast guard Research & Development Center, Groton, CT 06340 [online resource, available at http://www.dtic.mil/dtic/tr/fulltext/u2/a458863.pdf] Accessed 23th of May 2017.

21ST CENTURY CELESTIAL NAVIGATION SYSTEMS

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Abstract

Celestial navigation is the art and science of navigating by the stars, sun, moon, and planets, and it is one of the oldest of human arts. With the rise of electronic means of finding location, especially with the increasingly popular Global Positioning System (GPS), knowledge of celestial navigation has experienced a precipitous decline. Celestial navigation involves reducing celestial measurements taken with a sextant to lines of position on a chart using calculators or computer programs… But there is another approach - Celestial navigation enters powerfully 21st century as a highly sophisticated technology. Unfortunately, since much of the new hardware has been developed for space and aircraft systems, many of the technological advances have been invisible to those outside the aero-space engineering community. Authors of this paper believes that much of the work that has gone into star trackers for space applications can be brought down to Earth to serve in new generation sea navigation systems - in particular, combining automated star trackers with inertial navigation systems (INS) seems to be a synergistic match - they have complementary characteristics. Although such astro-inertial systems are now in limited operational use with good success, the automated star trackers they contain are based on outdated technology. New star tracker systems, currently used in space and aircraft applications, would provide a cheaper, more reliable navigation system. With reduced costs and enhanced reliability, such systems may be practical on many platforms not previously considered, including commercial and naval ships. Currently modern bridge navigation systems rely almost entirely on GPS, it is important that this dependence does not become a single-point-failure risk for safe navigation. Independent alternatives to GPS are needed and are required. Application of available technology can ensure that celestial navigation has as much of a role to play in the future as it has in the past in helping to provide safe passage for ships worldwide.

Keywords: Celestial navigation, Inertial navigation systems, Star-trackers

Introduction

Celestial navigation was the primary means for navigating ships for centuries. The rapid development of technology has brought about significant changes in marine navigation and the equipment used to ensure the safety of navigation relegating celestial navigation to a backup role at best. The great success and widespread use of GPS have resulted in the termination of some of the other older means of electronic navigation systems. Celestial navigation is often overlooked as an alternative to GPS because of the drawbacks of its traditional practice of sextant, almanacs, and manual sight plan and reduction procedures involving laborious mathematical equations (Pappalardi, F. "et al", 2001, pp. 1452–1459)

Commercial GPS units are quickly inundating both civilian and military vessels plying the world's waterways and can be found in an increasingly wide variety of places. Commercial GPS units can now be found within satellite systems, navigations systems, data links, unmanned vehicles, ordnance, and optical sighting systems. As a result, the dependency on commercial GPS technology is also proliferating, increasing the possibility of Electromagnetic Interference (EMI) or damage to these units. In May 2000, United States Naval Sea Systems Command (NAVSEA) launched an investigation into GPS susceptibility to EMI damages after receiving United States Navy (USN) message traffic indicating a United States Naval Ship (USNS) had experienced commercial GPS damage during a routine boarding operation training exercise (Williams, S. 2006, pp. 26-35).

The electronic navigation equipment now used on all ships includes items such as receivers of satellite navigating systems GPS, GLONASS, RADARs, systems of Automatic Radar Plotting (ARPA), and Automatic Identification System equipment (AIS). Electronic Chart Display and Information System (ECDIS) is one direction for use on vessels. ECDIS is a computer system which satisfies the special requirements that allows navigators to use an electronic nautical chart instead of plotting on paper charts. Such status ECDIS is determined by rule V/19 of the convention of International Maritime Organization (IMO) on Safety of Life at Sea (SOLAS-74/88). According to this rule, all ships should have: nautical charts and nautical publications to plan and display the ship's route for intended voyage and to plan and monitor positions throughout the voyage an

Electronic Chart Display and Information System (ECDIS) can be accepted as meeting the chart carriage requirements of this subparagraph; back-up arrangements to meet the functional requirements of this subparagraph is partly or fully fulfilled by electronic means. The corresponding complete set of sea nautical charts it can be used as duplicating means for ECDIS (IMO,SOLAS, 2012). Many commercial shipping companies have had great success with real-time navigation situational awareness equipment.

Vulnerability and disruptions in GPS Service

Table 1-0. GPS Dependencies in Maritime Transportation

System or Application	Functional Purpose			User Community					Operating Environment				Operating Platform		
	Positioning	Navigation	Timing	Federal	State	Local	Private	Commercial	Space	Air	Surface	Subsurface	Vessel	Infrastructure	System
Automatic Identification Systems (AIS)	X		X	X	X	X	X	X			X		X		X
Draft Information System (DIS)	X	X		X				X			X		X		X
Electronic Chart Display and Information System (ECDIS)	X	X	X	X	X	X	X	X			X		X		X
Emergency Position Indicating Radio Beacon (EPIRB)	X			X	X	X	X	X	X	X	X		X		
Global Maritime Distress and Safety System (GMDSS)	X		X	X	X	X	X	X			X		X		X
GPS Location Services for Cargo Terminal Equipment	X	X			X	X		X			X		X	X	X
Hydrographic survey systems	X			X	X	X	X	X			X		X	X	X
NOAA Vessel Monitoring System	X		X	X				X			X		X		X
Positioning Aids to Navigation (ATONs)	X			X	X	X	X	X			X			X	X
Tidal measurements	X			X	X	X	X	X			X			X	X
USACE River Information Services (RIS)	X	X		X	X	X	X	X			X		X	X	X
USACE Vessel Monitoring System	X		X	X	X	X		X			X		X	X	X
USCG Vessel Traffic Services	X	X		X				X			X		X	X	X
Voyage Data Recorders (VDR)	X		X	X				X			x		X		
Virtual and Synthetic Aids to Navigation	X			X	X	X	X	X			X			X	X

The maritime shipping community was one of the first to fully embrace GPS for positioning and navigation. Today, GPS receivers represent one of the core components of any vessel's suite of navigation and communications equipment (Eric Wallischeck, 2016, pp 17-21).

GPS disruptions can be described by a number of bivariate characteristics, which are described in Table 1-1:

Table 1-1: Characteristics of GPS Disruptions

Characteristic	Example
Unintentional vs. Intentional	Is the disruption caused by a piece of space debris that disabled a GPS satellite or is it due to an intentional act by a disgruntled employee or terrorist?
Predictable vs. Unpredictable	Was the disruption due to an anticipated increase in solar flare activity or the sudden activation of a jamming device?
Environmental vs. Manmade	Is the disruption due to increased solar weather activity or due to an improperly configured radio transmitter operating in an adjacent frequency band?
Crude vs. Sophisticated	Is the disruption caused by a $50 GPS jammer purchased on-line, or by a hacker precisely manipulating a GPS signal to deceive shipping or highway traffic?
Local vs. Widespread	Is the disruption a targeted spoofing attack against a single cargo terminal, or does it cover a large geographic area (e.g., due to a significant solar weather phenomenon)?

Table 1-2 maps the five general categories of GPS disruptions against the characteristics described above.

Table 1-2: GPS Disruptions vs. Characteristics

	Spectrum Encroachment	Solar Weather	GPS Infrastructure	Jamming	Spoofing
Unintentional or Intentional	UNINTENTIONAL				
			INTENTIONAL		
Predictable or Unpredictable	PREDICTABLE				
	UNPREDICTABLE				
Environmental or Manmade		ENVIRONMENTAL			
	MANMADE		MANMADE		
Crude or Sophisticated	CRUDE				
			SOPHISTICATED		
Local or Widespread	LOCAL		LOCAL		
	WIDESPREAD				

GPS has operational characteristics and vulnerabilities (see above) that may render it unusable or unreliable under certain conditions. Much work is being devoted to developing strategies for GPS outages. IMO required "all ships irrespective of size to have a receiver for a global navigation satellite system or a terrestrial radionavigation system, or other means, suitable for use at all times throughout the intended voyage to establish and update the ship's position by automatic means" (IMO, SOLAS, 2012).

Prudent navigation practice requires both a primary and a secondary means of navigation, with the secondary independent of the primary. Celestial navigation remains one of the few independent alternatives to GPS. The question what to do if GPS is not available is still unanswered firmly. Some kind of alternative to GPS is needed to provide redundancy for navigation systems. Inertial navigation systems are being viewed as the answer. However, there is a complication. These systems are really only a very accurate form of dead reckoning, and they require periodic alignment to some sort of external reference system. That external system could be GPS, of course, but such a mode of operation does not provide a secondary means of navigation that is "independent of the primary."

Celestial navigation as GPS alternative

Celestial navigation is often overlooked as an alternative to GPS (Chris Gregerson et al, 2000) because of the drawbacks of its traditional practice. However, celestial navigation can encompass any method that utilizes observations of astronomical bodies — bodies with known positions in a standard celestial reference frame to determine the position of a platform in a standard terrestrial reference frame. The various methods for performing celestial navigation can be grouped into three general categories:

- ***Traditional, manual methods*** require use of a handheld sextant, coupled with manual sight planning and reduction procedures (i.e., printed almanacs and forms);
- ***Traditional, computer based methods*** also require use of the sextant, but sight planning and reduction are performed using software;
- ***Fully auto- mated methods*** use some type of automatic electronic sextant or star tracker to make observations, which are then fed to software that performs the sight reduction.
  Star tracker data can also be sent directly to inertial navigation systems and incorporated into the INS solution.

It is usually stated that a fix obtained by traditional means (i.e. through use of a sextant) is accurate to about 1-2 nautical miles. This is because altitude observations of stars made with handheld marine sextants ("sights") are accurate to about 1-2 arcminutes (0,017-0,033 degrees). Most methods of sight reduction — both manual and computer-based, take advantage of the low accuracy of the observations by incorporating approximations and non-rigorous assumptions as a means to simplify the computations.

Replacing the handheld sextant with an automated observing device — an electronic star tracker, for example — offers the possibility for greatly improving the quality of the observations. This is not a new idea. When GPS and INS is still not ripe, Celestial Navigation System (CNS) was spread to aeronautics by US (B-52, B-1B, B-2A, C-141A, SR-71, F22 et al.) and Soviet Union (TU-16, TU-95, TU-160 et al.) (AnGuo, Wang. 2007, pp.2347–2353) . Then the star tracker (i.e. track one star or planet or angle between it) (Noack, Thomas Luther, 1963). has been used to determine the attitude of the spacecraft in help orient the Apollo spacecraft enroute to and from the Moon. Now the advanced star sensor (i.e. sense many star simultaneous) is developed for the application of optical CCD technique (AST-201 Star Tracker System Specifications, 1998).

Over the years, star trackers have been used with great success on many spacecraft, missiles, and high-flying aircraft. The problem is that the known star trackers in operational use are based on old technologies and are very expensive. Without a doubt, these old technologies limit the effectiveness of the systems and are responsible for their high cost, but star trackers based on newer, off-the-shelf technologies show promise for a wider range of applications at significantly lower cost, and may provide an effective navigation alternative in situations where GPS is denied or unavailable.

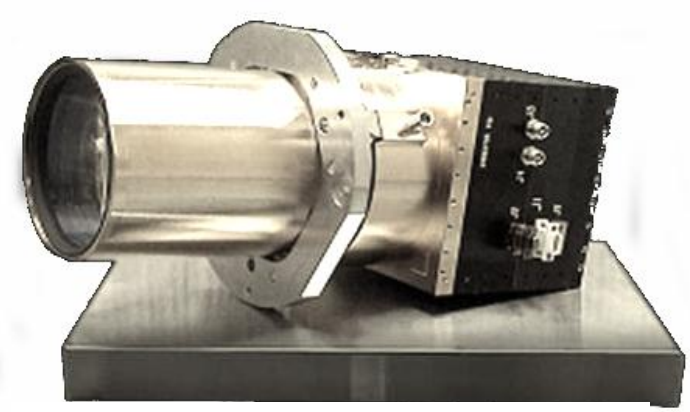
Automated Celestial Technology

Since the early days of the space age, automated celestial observing systems have been used on missiles, satellites, and planetary exploration spacecraft as an aid to navigation. Strategic missile systems such as Polaris, Poseidon, Trident, and MX have used compact star trackers in the powered phase of flight to determine the absolute orientation of the vehicle for the inertial guidance system. The more modern of these units achieve sub-arc second (< 0.000277778 degrees) angular precision. The Space Shuttle has several star trackers mounted in its nose. Automated star trackers have become off-the-shelf items for attitude determination for a large number of Earth-orbiting satellites; Compared to the old technology, the new star trackers are simpler, smaller, draw less

power, and are more reliable. With higher quantum efficiency detectors, many more stars (thousands rather than tens) can be observed, providing a substantially higher data rate. Potentially, these star trackers are also significantly cheaper, although currently the small number of units produced and the requirements of space hardware qualification have kept costs artificially high.

Would such an automated star tracker systems be practical for marine navigation?

Particular attention should be paid to the following two systems: Lockheed's ***AST-201(Autonomous Star Tracker) system*** developed in 1998 (AST-201 Star Tracker System Specifications, 1998) and Rockwell Collins ***CIPP (Celestial-Inertial Precision Pointing) System*** developed in 2015 (Celestial-Inertial Precision Pointing System Specifications, 2015).



AST-201(Autonomous Star Tracker) system

The AST-201 using what amounts to a standard camera lens with a charge coupled device (CCD) array in its focal plane, this unit can detect stars down to visual magnitude 7 (fainter than the human eye can see). The unit is designed to be mounted on a rotating satellite and has no moving parts. The star tracker has an 8.8 field and its electronics subsystem contains its own star catalog and star pattern recognition software. The unit operates as a "black box" that receives stellar photons as input and provides a continuous stream of digitized orientation angles as output. The orientation accuracy is several arc seconds about axes parallel to the focal plane. The unit is approximately 15 x 15 x 30 cm, including the lens shade, weighs about 4 kg, and is, of course, space qualified. The calculated MTBF is over 700,000 hours.

CIPP (Celestial-Inertial Precision Pointing) System

CIPP System is state-of-the-art high-performance sensor fusion unit for navigation. The system consists of

two cameras, which convey the position of the sun or the stars to calculate orientation, working in conjunction with inertial sensors called micro-electromechanical systems (MEMS). The MEMS provide acceleration and angular-rate signals, like those used to enable a smartphone to know which way it's being tilted. Running on a dedicated processor, system software blends the information gathered by the cameras and the MEMS to give a best estimate of roll, pitch and heading angles continuously, sending out information 40 or 50 times per second. Using celestial object determination and inertial sensing, the device continuously calculates all three angles very accurately. Unit is 6.6 x 4.8 x 1.5 cm, weighs less than 100 g and is capable of pointing accuracies within a tenth of a degree. Peak power during celestial determination: < 2 W and standby power < 0.3 W! System can easily incorporate additional sensors such as a magnetometer (i.e. digital magnetic compass) into the solution.

Star tracker technology for space systems has continued to evolve. We believe that the latest technology in star trackers, exemplified by the above described systems, provides an opportunity for the development of small, lightweight, inexpensive, reliable celestial systems that can be coupled to existing INS systems for commercial and naval ships. A not unreasonable expectation for this technology is the acquisition of large numbers of star positions, day or night, providing an accuracy of better than one arc second (less than 30 meters).

Conclusion

The combination of automated star trackers and inertial navigation systems (INS) is a synergistic match. Considered as stand-alone systems, inertial and celestial navigation have complementary characteristics. After initialization, INS is self-contained and has no coupling to an external reference system; celestial provides a direct link to the most fundamental inertial reference system available. INS units require initial alignment using positioning data from another source; celestial is completely autonomous. INS accuracy degrades with time from initial alignment; celestial fix accuracy is not time dependent. INS units are oblivious to the weather; celestial is sensitive to cloud conditions. Yet, despite their differences, both INS and celestial are passive, jam-proof, and in operational use are not dependent on shore or space components.

As nowadays ships navigation rely increasingly on GPS, it is important that this dependence does not become a single-point-failure risk for safety of navigation. Independent alternatives to GPS are needed: The state-of-the-art star trackers designed for space applications can be profitably applied to ships navigation when used in combination with inertial navigation systems. Existing astro-

inertial systems, built with older technology, have demonstrated accuracy and reliability on a limited number of platforms. New technology offers the possibility of significantly increased accuracy, reliability, data rate and lower cost. With imaginative application of the latest technology, celestial navigation has as much of a role to play in the future as it has in the past in helping to provide safe passage for ships worldwide.

References

PAPPALARDI, F., S.J. DUNHAM, M.E. LEBLANG, T.E. JONES, J. BANGERT AND G. KAPLAN. 2001. Alternatives to GPS. *Proc. MTS/IEEE Conference and Exhibition OCEANS. Vol. 3,* pp. 1452–1459.[online resource: http://ieeexplore.ieee.org/document/968047] Accessed April 2017.

WILLIAMS, S. 2006. RADAR'd GPS Vulnerable to High-Power Microwaves. *GPS World*, April 2006, pp. 26-35.

INTERNATIONAL MARITIME ORGANIZATION. 2012. *International Convention for the Safety of Life at Sea (SOLAS). Ch V, Regulation 19.*

ERIC WALLISCHECK ,"GPS Dependencies in the Transportation Sector", August 2016*, U.S. Department of Transportation ,Office of the Assistant Secretary for Research and Technology, John A Volpe National Transportation Systems Center,* pp 17-21.

INTERNATIONAL MARITIME ORGANIZATION, 2012, *International Convention for the Safety of Life at Sea, 1974 (SOLAS) ,CHAPTER V Regulation 19 , Para. 2.1.6.*

CHRIS GREGERSON, JOHN BANGERT AND FRED PAPPALARDI, 2000, "Celestial augmentation of Inertial Navigation Systems: A robust Navigation alternative", *U.S. Naval Observatory, Washington, DC (USNO) SPAWAR System Center, San Diego, CA (SPAWARSYSCEN SD)*.

ANGUO, WANG. 2007. "Modern Celestial Navigation and the Key Techniques." *Acta Electronica Sinica* 35(12), pp.2347–2353

NOACK, THOMAS LUTHER, "An optimized celestial-inertial navigation system " (1963). *Retrospective Theses and Dissertations*. Paper 2943

"AST-201 STAR TRACKER SYSTEM SPECIFICATIONS, 1998, REV. D" LMMS-F426359-D, Lockheed Martin Missiles & Space Advanced Technology Center [online web resource:http://www.lockheedmartin.com/content/dam/lockheed/data/space/documents/ATC/ATC_Brochure.pdf], accessed April 2017.

CELESTIAL-INERTIAL PRECISION POINTING SYSTEM SPECIFICATIONS, 2015, Rockwell Collins Corp., [online resource: https://www.rockwellcollins.com/Products_and_Services/A_Z/C/Celestial_Inertial_Precision_Pointing_System.aspx], accessed April 2017.

ARTIFICIAL NEURAL NETWORK CONTROLLER FOR AUTOMATIC SHIP BERTHING USING HEAD-UP COORDINATE SYSTEM

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Abstract: The Artificial Neural Network (ANN) model has been known as one of the most effective theories for automatic ship berthing, as it has learning ability and mimics the actions of the human brain when performing the stages of ship berthing. However, existing ANN controllers can only bring a ship into a berth in a certain port, where the inputs of the ANN are the same as those of the teaching data. This means that those ANN controllers must be retrained when the ship arrives to a new port, which is time-consuming and costly. In this research, by using the head-up coordinate system, which includes the relative bearing and distance from the ship to the berth, a novel ANN controller is proposed to automatically control the ship into the berth in different ports without retraining the ANN structure. Numerical simulations were performed to verify the effectiveness of the proposed controller. First, teaching data were created in the original port to train the neural network; then, the controller was tested for automatic berthing in other ports, where the initial conditions of the inputs in the head-up coordinate system were similar to those of the teaching data in the original port. The results showed that the proposed controller has good performance for ship berthing in ports.

Keywords: Automatic ship berthing; ANN controller; Head-up coordinate system; Low speed; Relative bearing.

1. Introduction

Because a neural network has learning ability and mimics the actions of the human brain when performing the stages of ship berthing, many researchers have used this theory for automatic ship berthing. The first study on berthing control using a neural network as the main controller was conducted by Yamato et al. (1990) [2]. In that work, the inputs of the ANN controller included the ship position, ship heading, ship velocities, and beam distances. Although this suggestion obtained excellent results, this approach was replaced by an expert system proposed

by Yamato (1992) [3]. Zhang et al. (1997) [10] suggested a multivariable neural controller for ship berthing with inputs that included the ship state, desired states, and the control signal at previous steps and with parameters that could be adapted by an online training process. Later, Im and Hasegawa (2001, 2002) [5] proposed a neural network with parallel structure in a hidden layer to obtain better results than a centralized network. Subsequently, Im (2007, 2009) [6] applied a selective ANN controller for ship berthing considering that the ship starts from any point around the berthing area. On the other hand, Nguyen (2007) [4] proposed two ANN controllers using an adaptive interaction learning technique and a predetermined berthing route to control the ship heading and ship speed simultaneously. Recently, the auxiliary devices used to support ship maneuvering, such as the side thruster and tugboat, have been incorporated in automatic berthing by Tran and Im (2012) [9]. In that research, the bow thruster and stern tugboat were added simultaneously into the ANN controllers as new outputs. With four outputs consisting of the rudder angle, propeller, bow thruster, and stern tugboat, the ship was controlled to the first goal area by the rudder angle and propeller, as in previous studies; then, the ship was guided to the final goal area by the bow thruster and stern tugboat. In addition, nonlinear programming methods and virtual windows have been suggested by Ahmed and Hasegawa (2013) [1] to create consistent teaching data for training the network, and the ANN controller was later verified for ship berthing with no disturbance cases. In the case of gusty winds, the PD controller was used to keep the ship on an imaginary line after the course changing process was performed by the ANN controller. As summarized above, the neural controllers that have been proposed by previous studies only control a ship into a berth of a certain port, and the ANN inputs are the same as those of teaching data created in advance. When arriving at new ports, either these ANN controllers must be retrained by other teaching data or the ship must install different controllers for each port. This requires time-consuming, expensive, and computationally complex control systems. In this research, by using the head-up coordinate system, which includes the relative bearing and distance from the ship to the berth, a novel ANN controller is proposed to control a ship into a berth in different ports without retraining the ANN structure. Numerical simulations were performed to verify the effectiveness of the proposed controller. The results showed that the proposed controller has good performance for ship berthing in ports.

2. Mathematical Model of Ship Maneuvering

In this research, the Maneuvering Modeling Group (MMG) model was applied to represent the ship motion, in which the hydrodynamic forces and moments acting on the ship were divided into modular components such as the hull, rudder, and propeller.

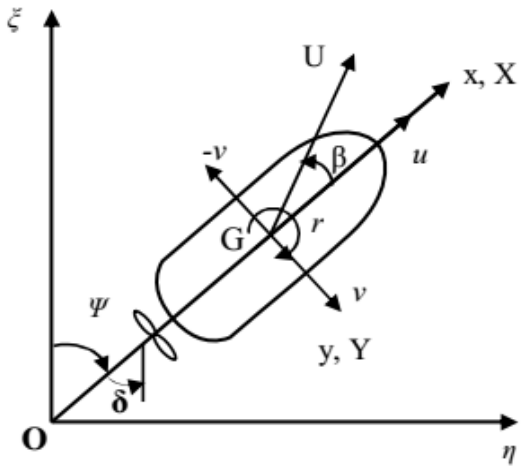

Fig. 1 Coordinate system for ship dynamic motion

According to MMG model, the maneuvering equation of the ship is expressed in the following form:

$$\begin{aligned}(m+m_x)\dot{u}-(m+m_y)vr &= X_H+X_P+X_R\\ (m+m_y)\dot{v}+(m+m_x)ur &= Y_H+Y_P+Y_R\\ (I_{zz}+J_{zz})\dot{r} &= N_H+N_R\end{aligned} \tag{1}$$

The subscripts *H, P,* and *R* represent the hull, propeller, and rudder components, respectively. The hydrodynamic forces and moments acting on the ship are expressed by by Kijima et al. (1990).

In this study, the training ship SAE NURI of Mokpo National Maritime University was adopted as the model ship whose parameters were used to predict the hydrodynamic coefficients. The ship's principle particular is shown in Table 1.

Table 1 Principle particular of the ship

Type	Training ship
Length overall	103[m]
Length between perpendicular	94[m]
Breadth	15.6[m]
Draft	5.4[m]
Thruster (Bow)	49000[N]
Transverse projected area	183.3[m^2]
Lateral projected area	1053.7[m^2]

3. ANN controller for automatic ship berthing using head-up coordinate system

3.1. Head-up coordinate system

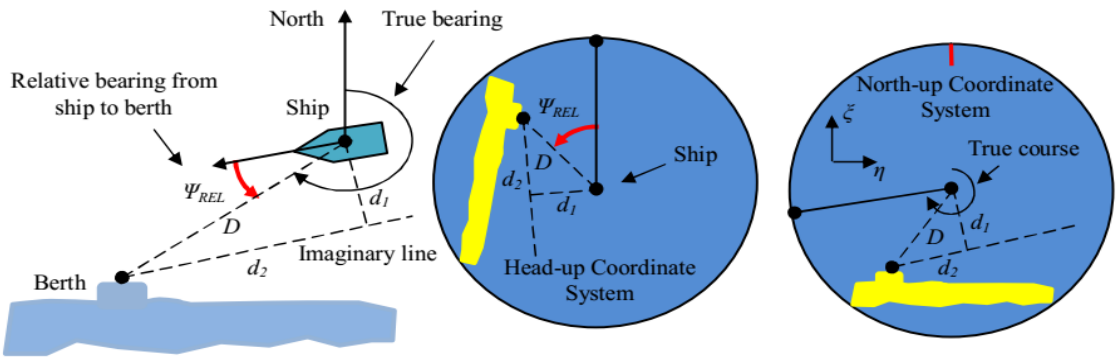

Fig. 2 Relative bearing from ship to the berth in head-up coordinate system

The inputs used in previous controllers were the parameters in the North-up coordinate system, namely, the geographical coordinates (η, ξ) and ship heading (Ψ). In this research, two new parameters expressed in the head-up coordinate system, the relative bearing (Ψ_{REL}) and the distance from the ship to the berth (D), were introduced to obtain suitable actions for the rudder (δ_{ord}) and propeller (rps) by the proposed ANN controller, as shown in Fig. 2. The combination of these parameters with the distance to the imaginary line (d_1) and the remaining distance to the berth (d_2) created four parameters (Ψ_{REL}, D, d_1, d_2) for the proposed controller.

3.2. Formula for data converter

In every case, the ship dynamics data (u, v, r) are originally kept, the data converter is used to convert the ship states (η, ξ, Ψ, d_1, d_2) in the North-up coordinate system into inputs for the proposed ANN controller, such as (Ψ_{REL}, D, d_1, d_2), in the head-up coordinate system. The detailed formula for the data converter is expressed as in Eq. (2).

$$
\begin{aligned}
&D = \sqrt{\left(\xi_{ship} - \xi_{berth}\right)^2 + \left(\eta_{ship} - \eta_{berth}\right)^2} \\
&BA = kD \ \ (k > 1) \\
&\lambda = \cos^{-1}\left(\frac{\overrightarrow{BS}\overrightarrow{BA}}{|\overrightarrow{BS}||\overrightarrow{BA}|}\right) \\
&d_1 = D\sin(\lambda) \\
&d_2 = D\cos(\lambda) \\
&\psi_{REL} = \angle\left(Heading\ line, \overrightarrow{SB}\right)
\end{aligned} \tag{2}
$$

where the relative bearing to the berth ψ_{REL} is the directional angle (in degrees) from the heading line of the ship to a straight line drawn from the observation position on the ship $S\left(\eta_{ship}, \xi_{ship}\right)$ to the berth $B(\eta_{berth}, \xi_{berth})$, and λ is the angle between the vector $\overrightarrow{BS}$ and the vector $\overrightarrow{BA}$.

3.3. Concept and control flow of automatic ship berthing for different ports based on ANN

In previous studies, the inputs of the teaching data consisted of the ship velocities (u_1, v_1, r_1), the ship heading (Ψ_1), and the geographical coordinates of the ship in the port area (η_1, ξ_1). The neural network has no ability to calculate well when the initial inputs of the network are entirely different from those considered in the teaching data. Because the geographical coordinates of the ship (η_1, ξ_1) in the original port are always different from those (η_2, ξ_2) in other ports, these ANN controllers cannot be applied to other ports. In this research, the ship maneuvering process used to create the teaching data was performed similarly to previous studies, but the ship states, including the relative bearing (Ψ_{REL}) and distance from the ship to the berth (D, d_1, d_2), were used as the main key for the proposed ANN controller. By using a data converter, the geographical coordinates of the ship at the port (η, ξ) and the ship heading (Ψ) are cancelled out from the teaching data. This means that the teaching data for the proposed ANN that were created in the original port consist of the inputs (Ψ_{REL1}, D_1, $d_{1(1)}$, $d_{2(1)}$, u_1, v_1, r_1) and outputs such as the rudder angle (δ_{ord}) and propeller speed (rps). In other ports, where the initial states (Ψ_{REL2}, D_2, $d_{1(2)}$, $d_{2(2)}$, u_2, v_2, r_2) of the ship are the same as those (Ψ_{REL1}, D_1, $d_{1(1)}$, $d_{2(1)}$, u_1, v_1, r_1) used in the teaching data created in the original port, the proposed ANN controller will control the ship automatically into the berth, as illustrated in Fig. 3.

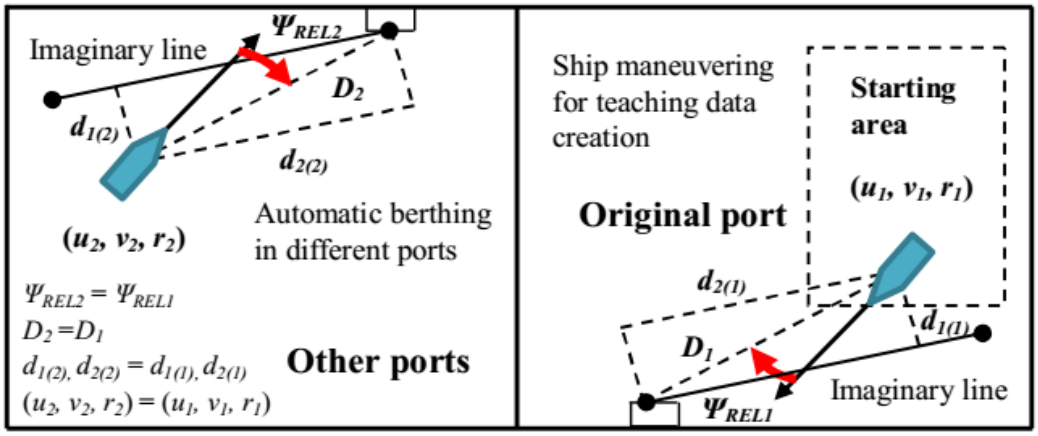

Fig. 3 Automatic ship berthing in different terminals and different ports

3.4. ANN controller using head-up coordinate system

In previous research on automatic ship berthing control using neural networks, such as Yamato et al. (1990), Yamato (1992), Im and Hasegawa (2001, 2002), Im (2007, 2009), Tran and Im (2012), and Ahmed and Hasegawa (2013), the neural network was used as the main controller and was designed based on the direct learning method of teaching data. In this research, we used the same approach to design the proposed ANN controller, as shown in Fig.9. In this study, a neural network of multi-layer perception was applied to the proposed ANN controller, which had seven inputs, the relative bearing (Ψ_{REL}), distance from the ship to the berth (D), beam distances (d_1, d_2), surge velocity (u), sway velocity (v), and yaw rate (r), and two outputs, the command rudder angle (δ_{ord}) and propeller speed (rps). The structure of the controller is shown in Fig. 4.

The back-propagation technique, in which the weights and bias of the network move along the negative direction of the gradient of the performance function, was employed to train the ANN structure. The objective of network training is to minimize the error between the outputs of the network and the outputs of the teaching data. After training the neural network, the control law $[\delta_{ord(t+1)}, rps_{(t+1)}]^T$ determined by the proposed ANN controller was derived as:

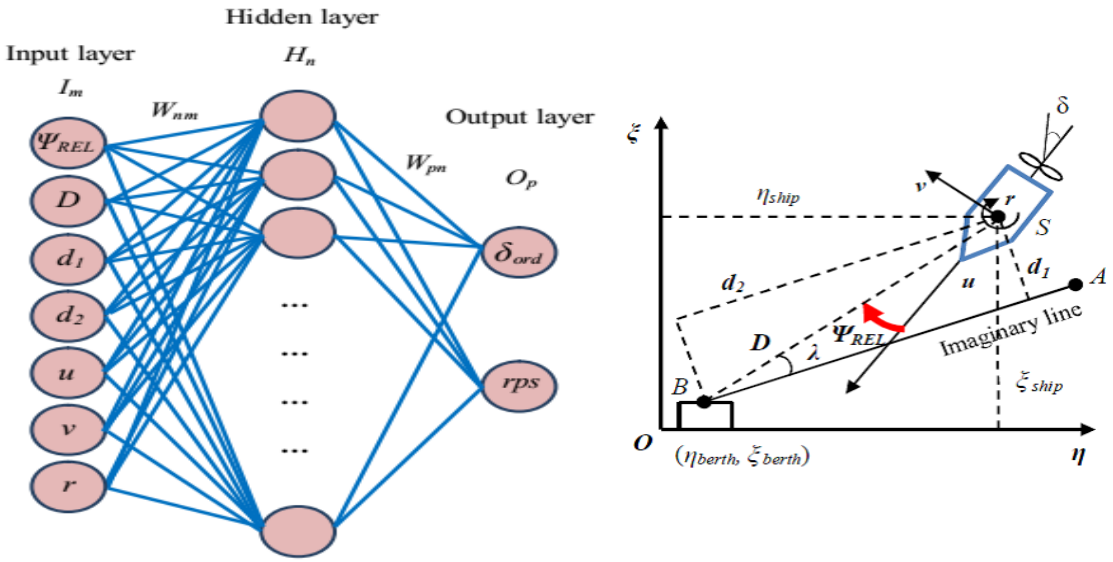

Fig. 4 The structure of neural network controller

$$\left[\delta_{ord(t+1)}, rps_{(t+1)}\right]^T =$$

$$f_2\left(\sum_{n=1}^{n} W_{pn} f_1\left(\sum_{m=1}^{m} W_{nm}\left[\psi_{REL(t)}, D_t, d_{1(t)}, d_{2(t)}, u_{1(t)}, v_{1(t)}, r_{1(t)}\right]^T + b_n\right) + b_p\right) \quad (3)$$

The training process of the neural network began by selecting the number of nodes in the hidden layer. This procedure must ensure that the learning error converges to zero in the shortest time. The structure of the hidden layer in the ANN controller was chosen to consist of 25 nodes. The trained ANN controller guarantees that the outputs of the network always follow up the outputs of the teaching data. This means that the ANN controller adjusts the rudder angle and propeller speed to control the ship into berth as a human brain when the initial states of the ship in the port are identical or similar to the inputs of the teaching data.

4. Numerical simulations and results

This section describes numerical simulations performed to verify the effectiveness of the proposed controller for different ports. The ship was controlled automatically into a berth in two different ports: the first one was the original port, where the teaching data were created, and the second one had different geometrical coordinates inform the original port.

4.1. Numerical simulation results for original port

This section describes the ship berthing simulation in the original port, which was performed to validate the learning ability of the neural network controller. Generally, the proposed ANN

controller is believed to be a very useful tool when faced with a situation that mimics that of a trained one. As shown in Fig. 5, the ability of controlled ship to stop near the wharf and reach the berthing point was good. In particular, the stopping ability was good, as it was possible to reach the wharf within 0.2 m/s in all cases. Furthermore, the final heading angles were in the range 250–270 deg.

In Fig. 5, the initial conditions of the ship at the starting time are the same as those in the teaching data. The results show that the proposed controller performs successful actions for controlling the ship into the berth in this area.

In Fig. 6, the simulations are performed for the original port, where the initial conditions of the ship are different from those in the teaching data. The results show that the interpolation ability of the proposed controller is good for initial states that are not included in the teaching data.

4.2. Numerical simulation results for other port

This part describes the simulations performed for the second port, where the geographical coordinates of the ship and the ship heading at the starting time were entirely different from those of the original port. The non-dimensional coordinates of this port were between -20 and -4 in the horizontal range and from 22 to 35 in the vertical range, and the berth position was (-10, 33.5). In Fig. 7, the initial states of the ship in this port are (-17.1, 25.4, 64, 1.5, 0, 0, 0, 0.75), (-18.6, 26.5, 34, 1.5, 0, 0, 0, 0.75), (-15, 25.5, 14.1, 1.5, 0, 0, 0, 0.75), and (-18.6, 29.4, 74, 1.5, 0, 0, 0, 0.75). The time history of the rudder angle and revolution speed shown in Fig. 7 was appropriately calculated by the controller to bring the ship into the berth.

Although the initial ship position and the ship heading in this port were different from those in the teaching data, the results show that the numerical simulations were successful. Particularly, the initial conditions of the ship in Fig. 7 are different from those in Fig.6. Therefore, the proposed controller can be applied to the second port, as well as other ports, where the initial conditions of the ship, such as the relative bearing and distance to the berth, are different from the teaching data in the original port.

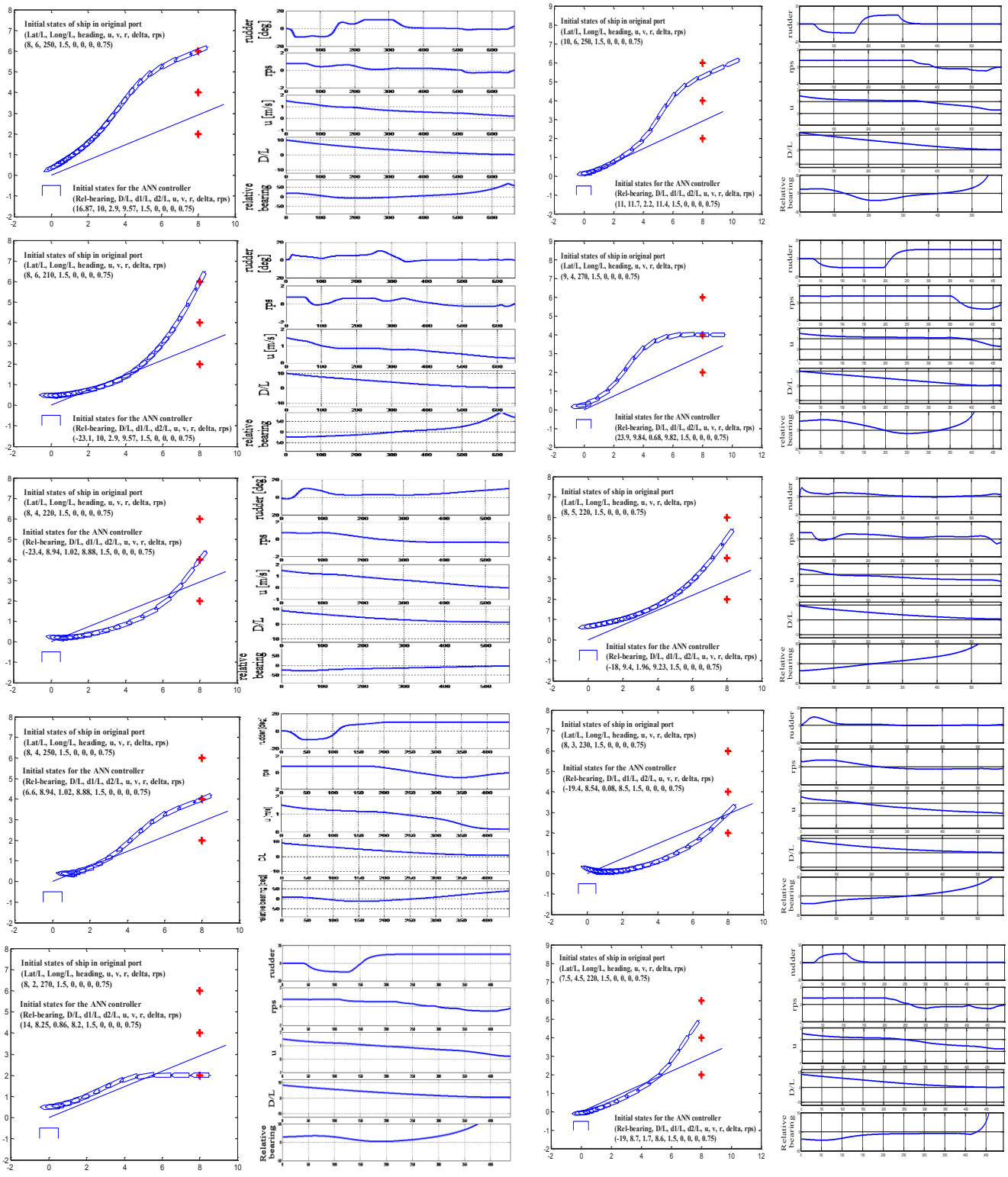

Fig 5. Simulation results in original port having same initial conditions with teaching data

Fig 6. Simulation results in original port having initial conditions different with teaching data

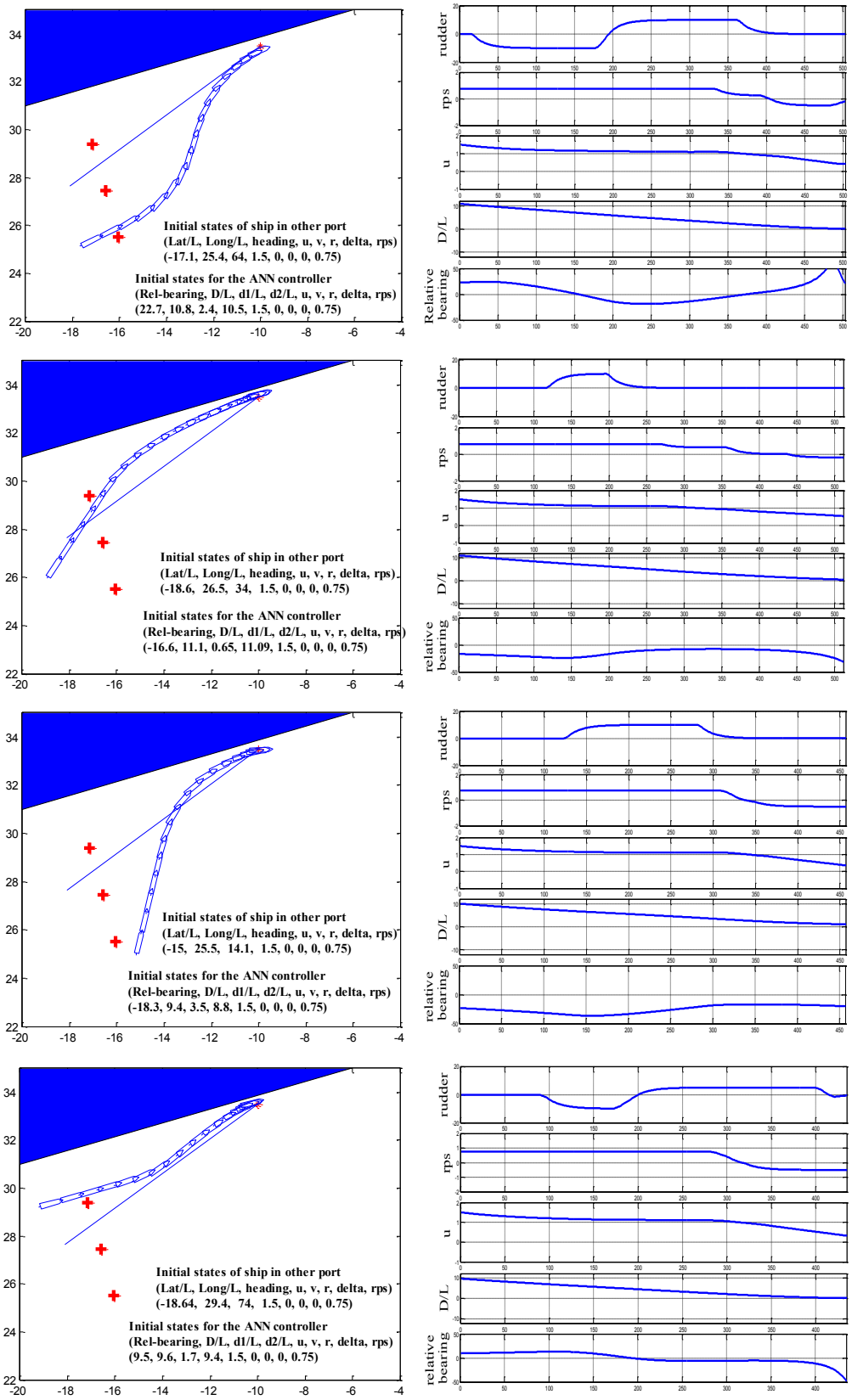

Fig. 7 Simulation results in other port having different initial conditions with teaching data

The simulation results verify that the proposed ANN controller can automatically control the ship into the berth in the original port and different ports or multi-terminals adaptively and without retraining the ANN structure. By using new inputs for the neural network, the contribution of this research is to propose the new neural controller for automatic ship berthing. The advantage of the proposed controller in comparison with previous ones is the omission of the retraining stage when applying the controller to multi-ports and multi-terminals. Therefore, this controller is more time- and cost-effective than previous ones.

5. Conclusions

In this paper, a novel research on the automatic ship berthing problem is proposed. The conclusions of this research can be summarized as follows.

- The head-up coordinate system is proposed to express the new inputs for the ANN controller. In previous research, the North-up coordinate system was usually employed to represent parameters such as the ship position and ship heading. A data converter was used to convert parameters expressed in the North-up coordinate system to the head-up coordinate system in this research.
- The relative bearing and distance from the ship to the berth were used as key inputs in the proposed ANN controller. These parameters were used as main factors in the head-up coordinate system to allow the ANN controller to adapt to different ports without retraining.
- The ANN controller was trained by teaching data created in an original port. Subsequently, the ship could be controlled automatically in different ports and multi-terminals without retraining the controller.
- Numerical simulations were performed for two ports to verify the effectiveness of the proposed controller.

For further work, It may be interesting to see the behaviour of the proposed controller in simulator studies. The manoeuvres ordered by controller could be assessed on energy saving aspect for different ports at different conditions.

Although the proposed automatic ship berthing system has some advantages, it still has some limitations. For example, the ship is only controlled into the berth from one approaching direction and the relative bearing must be within 180 deg. In the future, additional suggestions for the ANN controller will be presented to overcome the above drawbacks.

References

[1] Ahmed, Y. A. and Hasegawa, K, Automatic Ship Berthing using Artificial Neural Network Trained by Consistent Teaching Data using Non-Linear Programming Method. *Journal of Engineering Applications of Artificial Intelligence*, 2013, Vol. 26, issue 10, pp.2287-2304.

[2] H. Yamato, et al., Automatic Berthing by the Neural Controller, *Proc. Of Ninth Ship Control Systems Symposium*, 2003, Vol. 3, pp.3.183-201.

[3] H. Yamato, et al., Automatic Berthing Using Expert System, *Proc. Of Workshop on Artificial Intelligence Control and Advanced Technology in Marine Automation* (CAMS'92), 1992, pp. 173-183.

[4] Nguyen, P.H., et al, Automatic berthing control of ship using adaptive neural network. In: *International Symposium on Electrical & Electronics Engineering*. HCM City, Vietnam, 2007. Pp.23-30.

[5] Im, N.K., Hasegawa, K., A study on automatic ship berthing using parallel neural controller. *Journal of Kansai Society of Naval Architects of Japan*, 2002, 236 (September), pp.65–70.

[6] Im, N.K., et al., An application of ANN to automatic ship berthing using selective controller. *Journal on Marine Navigation and safety of Sea Transportation*, 2007, vol.1, pp.101–105.

[7] Im, N.K., All Direction Approach Automatic Ship Berthing Controller Using ANN. *Journal of Control, Automation and System Engineering*, 2009, vol.13, pp.123-129.

[8] Kijima, K., et al., On the maneuvering performance of a ship with the parameter of loading condition. *Journal of the Society of Naval Architects of Japan*, 1990, Vol 168(2), pp.141-148.

[9] Tran, V.L and Im, N.K., A study on automatic berthing with assistance of auxiliary devices. *International journal of Naval Architect and Ocean Engineering*, 2012, Vol 4, issue 3, pp. 199-210.

[10] Y. Zhang, et al., Neural Network Approaches to a Class of Ship Control Problems (Part I, II), P.A. Wilson, eds., *Eleventh Ship Control Systems Symposium*,1997, Vol. 1, pp. 115-150.

THE PROPOSED NEW FRAMEWORK FOR THE PRIVATE MARITIME SECURITY COMPANY OF MALAYSIA

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Abstract. The cases of sea robberies involving commercial vessels in the waters of Malaysia is not serious and the number is dropping. However, shipowners can engage the service of security guards on board their vessels as the last security net. Ministry of Home Affair Malaysia has developed the current framework of Private Maritime Security Company of Malaysia. The framework was developed mainly based on the requirement of local regulations. However, the existing framework may not compatible with the coastal and flag state requirements, therefore an improved framework is needed. To improve the existing framework, literature related to the private maritime security company is reviewed. The relevant guidelines from International Maritime Organization and International Standardization Organization were then incorporated into the existing framework.

Keywords: Maritime, security, private

1. Background

Private maritime security company (PMSC) is a type of company that provides security service and consultancy to private vessels, commercial ship, and offshore terminal and structures whether at sea or marine ports. PMSC is setup because of the security issue about a terrorist attack at US in 2001 and increase in 2003 during the aftermath of the gulf war. PMSC was introduced by International Maritime Organization. The example of PMSC are Solace Global Limited of UK, Sea Guard Security of US and Sea Guardian of Greece. Among the services provided by those companies are armed vessel security in high risk area, vessel's security audits and crew training. The PMSC services are deemed necessary as an

additional security layer to the existing maritime security forces and serves as the last security net to ship owners from the attack from pirates, robbers and terrorist. The PMSC service has proven in failing many pirate attempt to hijack commercial ships at the waters of Somalia [1]. The Straits of Malacca had been listed as a war risk zone by the Lloyd's Joint War Committee in June 2005 due to considerable number of sea robberies cases [2]. However, it was removed from the list about a year later due to significant improvement on the security in the area and the significant reduction of robbery cases [3]. The sea robbery cases in Malaysian waters, Straits of Malacca and Straits of Singapore in 2014 are shown in Table 1. There are a total 15 cases of sea robberies occurred in 2014, which comprise of 5 cases without loss of properties and injuries, 1 case with loss of properties, 1 case with one death and loss of properties, and 8 cases of petroleum products siphoned that resulted 115,634 metric tons cargo loss together with additional loss of other properties. The sea robbery cases in the same areas in 2015 are shown in Table 2. There are a total 31 cases of sea robberies occurred in 2015. The 31 cases comprise of 10 cases without loss of properties and injuries, 12 cases with loss of properties, and 7 cases of petroleum products siphoned with about 16,798 metric tons loss of cargo (not included MT Phubai Pattra 1) with ship's and crew's properties stole.

Table 1: Sea Robbery in the Malaysian waters, Straits of Malacca and Straits of Singapore in 2014 (Source: [4]–[19])

No.	Date	Vessel Name/ Type	Flag	Cargo/ Belonging Lost
1	6 Mar 2014 at 0515 hrs	Sea Voyager / Oil tanker	Marshall Islands	No loss of property
2	6 Mar 2014 at 0540 hrs	Orpheas / Tanker	Liberia	Some engine spares were stolen
3	10 Mar 2014 at 0150 hrs	Cape Veni / Bulk carrier	Cyprus	No loss of property
4	On 17 Apr 14 at or about 2010 hrs	MT Sri Phangnga/ Tanker		About 450,000 litres (400 MT) of MGO was siphoned; crew's personal belongings were stolen, communication equipment destroyed, ship's name and company logo painted over.
5	22 Apr 2014 at 0100 hrs	MT Naniwa Maru No. 1 / Oil tanker	Saint Kitts and Nevis	2,500 metric tons of Marine Diesel Oil was siphoned. Three crews abducted by the robbers, together with their personal belongings and travel documents.
6	28 May 2014 at 0625 hrs	Ore Vitoria / Bulk carrier	Liberia	No loss of property
7	28 May 2014 at 1042 hrs	Kien San 8 / Barge	Malaysia	No loss of property
8	29 May 2014 at 0353 hrs	Eastern Star / Bulk carrier	Vietnam	No loss of property
9	0200 hrs (local time) on 28 May	Orapin 4 / Product tanker	Thailand	Ship's communication equipment was damaged. 3,700 metric tons of ADF was siphoned. Ship's

	2014			name repainted to RAPI.
10	14 Jun 2014 at about 2030 hrs	Ai Maru / Product tanker	Honduras	Ship's communication equipment was damaged; 620 metric tonne of the MGO was siphoned; crew personal belongings were stolen.
11	4 Jul 2014 at or about 1938 hrs	Moresby 9/Tanker	Honduras	2118 metric tons of MGO was siphoned. Ship's navigation equipment, communication equipment, steering system and anchor windless damaged. Crew's personal belongings stolen.
12	7 Jun 2014 2345 hrs	MT Budi Mesra Dua/ Tanker	Malaysia	100,000 metric tons of diesel was siphoned, crew valuables were robbed and communication equipment damaged.
13	28 Aug 2014 at or about 2040 hrs	V.L.14 / Oil product tanker	Thailand	1,296 tons of lube oil was siphoned, and crew's personal belongings were stolen.
14	Last known location (off Pulau Anambas) on 3 Oct 2014	Sunrise 689/ Oil product tanker	Vietnam	The 5,000 tons gas oil was siphoned. The communication equipment was damaged and two crews were slightly injured.
15	On 7 Dec 2014 at or about 0530 hrs (local time)	VP Asphalt 2 / Tanker	Vietnam	Crew personal belongings was stolen and one crew killed.

Table 2: Sea Robbery and Piracy in the Malaysian waters, Straits of Malacca and Straits of Singapore from January to November 2015 (Source: [20]–[40])

No.	Date	Vessel Name/Type	Flag	Cargo/Belonging Lost
1	13 Feb 2015 1955 hrs	MT Lapin	Thailand	Siphoned 5 tons of diesel oil and 2000 tons of bunker oil.
2	20 Feb 2015 2130 hrs	MT Phubai Pattra 1	Thailand	Part of gasoline cargo of unknown quantity was siphoned. Crew's and ship's valuable were stolen.
3	21 March 2015 at 0100 hrs	Capetan Giorgis/bulk carrier	Marshall Island	Nothing was missing onboard and the crew was safe.
4	21 March 2015 at 0545 hrs	MSC Vancover/ container ship	Luxembourg	The perpetrators had robbed the 2nd engineer's gold chain and watch.
5	2 May 2015 at 2130 hrs (local time)	Ocean Energy/ Product tanker	Singapore	2023 MT of gas oil was discharged to a barge. Ship's Iridium phone, crew's cash and mobile phones were stolen.
6	15 May 2015 at 0600 hrs	Oriental Glory/ Product tanker	Malaysia	Siphoned off 2,500 MT of ship fuel/oil
7	04 June 2015 0015 hrs	Orkim Victory/Tanker	Malaysia	770 MT of Automotive Diesel Oil was siphoned, personal belonging stolen, communication equipment destroyed.
8	11 Jun 2015	Orkim Harmony / Product tanker	Malaysia	Vessel with 6,000 metric tonnes of ULG 95 (petrol) recovered.
9	17 Jun 2015 at 0221 hrs	Densa Shark / bulk carrier	Brazil	Nothing was missing.
10	17 Jun 2015 at 0503 hrs	Clipper Posh / LNG tanker	Norway	Nothing was missing.
11	17 Jun 2015 at 0525 hrs	Pro Triumph / tanker	Panama	Chief Engineer and 1st Engineer were tied, and some generator spares parts were stolen.
12	25 July 2015 at 0200 hrs	Rutland/Bulk Carrier	Singapore	Ship's parts and crew belonging were stolen.
13	26 July 2015 at 0540 hrs	Setagawa/ Tanker	Panama	No loss of property.
14	27 Jul 2015 0110 hrs	Matrah/ Tanker	Panama	Petty Theft.
15	30 Jul 2015	Ludolf Oldendorff/	Portugal	Petty Theft.

	0300 hrs	Tanker		
16	31 Jul 2015 0150 hrs	Gallia Graeca/ Bulk carrier	Cyprus	Petty Theft.
17	15 Aug 2015 at 2000 hrs	MT Joaquim/Tanker	Singapore	3500 tonnes of marine gas oil cargo siphoned; communication equipment damaged; and two crews injured.
18	21 Aug 2015 at 0230 hrs	Advantage Summer / Tanker	Marshall Island	No loss of property.
19	21 Aug 2015 at 0340 hrs	Navig8 Stealth SV / Tanker	Marshall Island	No loss of property.
20	21 Aug 2015 at 0430 hrs	Maersk Lebu / Container ship	Hong Kong	No loss of property.
21	21 Aug 2015 at 2329 hrs	Peace Bright /Bulk carrier	Panama	No loss of property.
22	22 Aug 2015 at 0525 hrs	Atout /Container ship	Liberia	No loss of property.
23	22 Aug 2015 at 0535 hrs	Elbtank Denmark / Tanker	Liberia	Crew's personal belonging were stolen.
24	9 Oct 2015 0526 hrs	Arabella/ Bulk carrier	Malta	Ship's parts were stolen.
25	15 Oct 2015 0350 hrs	Lucina Providence/ LPG tanker	Panama	Ship's parts were stolen.
26	15 Oct 2015 0541 hrs	Almi Spirit/ Tanker	Liberia	Ship's parts were stolen.
27	16 Oct 2015 0300 hrs	Diamond Star/ General cargo ship	Panama	Ship's parts were stolen.
28	16 Oct 2015 0500 hrs	Al Khaznah/ LNG tanker	Liberia	Ship's parts were stolen.
29	22 Oct 2015 0326 hrs	Alameda/ Bulk carrier	Malta	No loss of property.
30	22 Oct 2015 0555 hrs	Merlin/ Bulk carrier	Marshall Island	Ship's parts were stolen.
31	20 Nov 2015 1113 hrs	Salvigilant & Poe Giant 1/ Tug boat & barge	Singapore	No loss of property.

Based on the statistic shown in Table 1 and Table 2, there is a good reason for the shipping companies of Malaysia and the foreign flag ship sailing in Malaysian waters to engage the PMSC service as an additional security net. Until December 2015, Ministry of Home Affair Malaysia (MOHA) had given license to two companies as the PMSC service provider in Malaysia. However, the standard used by MOHA for the operation of PMSC in Malaysia waters may not compatible with the international shipping practice or even the local shipping practice. Therefore, the objective of this study is to identify the existing framework for PMSC of Malaysia and to propose the improved framework based on international guideline and standard.

2. Methodology

The first step of the methodology is to determine the existing framework of PMSC of Malaysia. The first step is executed by interviewing the officer-in-charge in the MOHA. The second step is to determine the existing international guideline and standard. The second step is conducted by reviewing the relevant literature. The third step is to propose the new framework by incorporating and adapting the international guidelines and standard into the existing framework.

3. Result and Discussion

3.1 The Existing Framework for PMSC of Malaysia

The existing framework for PMSC in Malaysia is shown in Figure 1.

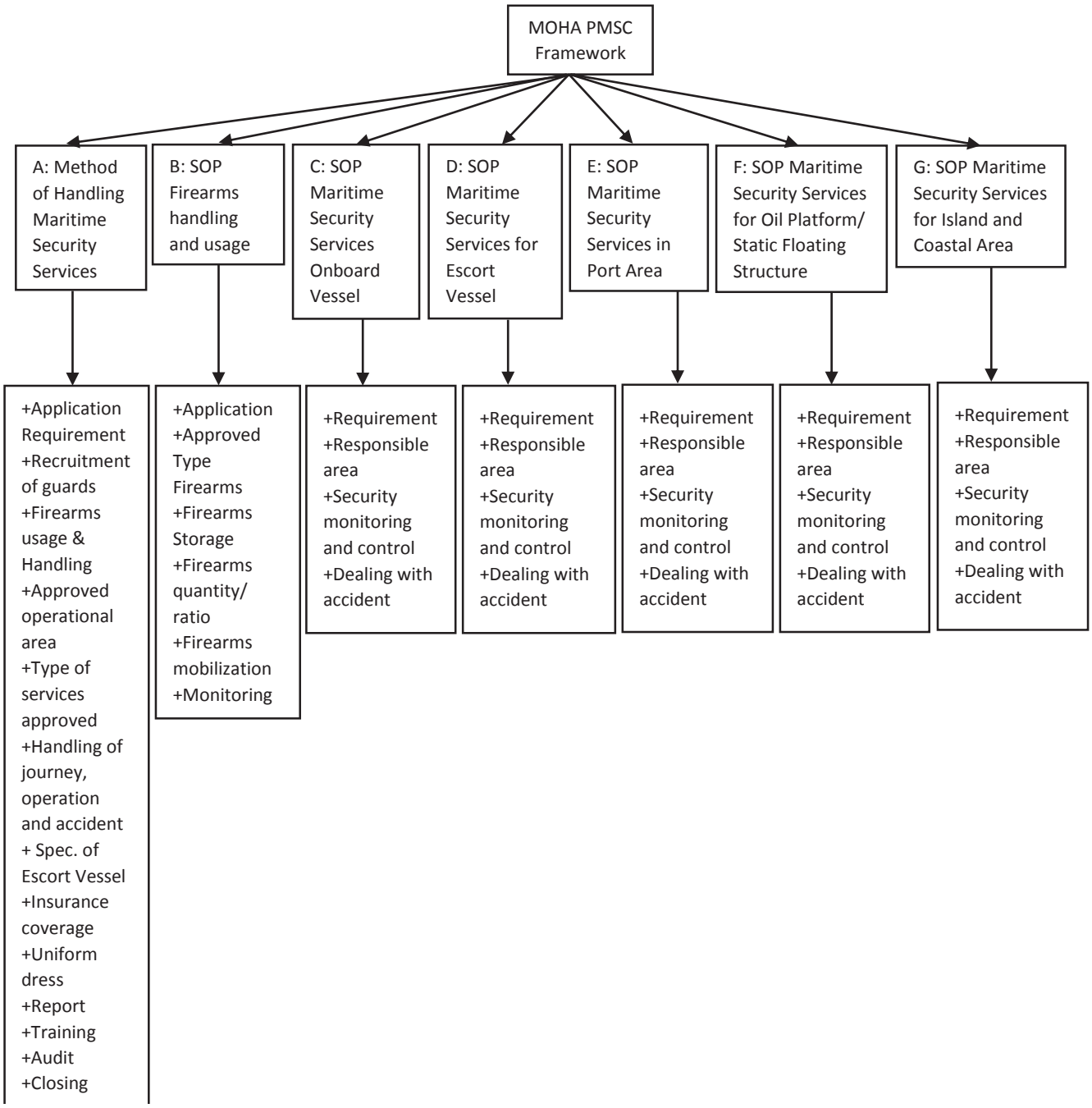

Figure 1: The existing MOHA PMSC framework of Malaysia

The framework in Figure 1 is developed based on the document given by MOHA. The PMSC are required to comply with seven standard operational procedures (SOP) that covers the requirement to setup the PMSC and all relevant operations.

3.2 International Guideline and Standard related to PMSC

Table 1 shows that relevant guidelines for PMSC that can be incorporated into the existing MOHA framework. The sources of the guidelines are, IMO, International Standardization Organization (ISO), Switzerland Federal Department of Foreign Affair (FDFA), and Geneva Academy of International Humanitarian Law and Human Rights (GAIHLHR). There are four direct references for PMSC by IMO, which address different parties, namely the port and coastal state, the flag state and the service provider. However, these literatures serve as guidelines for the relevant party to follow.

Table 1: Relevant International Guideline for PMSC (Source: [41]–[48]

Source & Year	**Literature**
IMO 2005	Convention on Facilitation of International Maritime Traffic (FAL), 1965 incorporated 2005 amendment.
FDFA 2009	The Montreux Document on Pertinent International Legal Obligations and Good Practices for States Related to Operations of Private Military and Security Companies During Armed Conflict.
IMO 2011	MSC-FAL.1/Circ.2. Questionnaire on information on port and coastal state requirements related to privately contracted armed security personnel on board ships.
IMO 2012	MSC.1/Circ.1405/Rev.2 Revised Interim Guidance to Shipowners, Ship Operators and Shipmasters on the use of Privately Contracted Armed Security Personnel on Board Ships in the High Risk Area (25 May 2012).
IMO 2012	MSC.1/Circ.1406/Rev.3 Revised Interim Recommendations for Flag States regarding the use of Privately Contracted Armed Security Personnel on board ships in the High Risk Area (25 May 2012).
IMO 2012	MSC.1/Circ.1443 Interim Guidance to Private Maritime Security Companies Providing Privately Contracted Armed Security Personnel on Board Ships in the High Risk Area (25 May 2012).
IMO 2012	MSC.1/Circ.1408/Rev.1 Revised Interim Recommendations for Port and Coastal States Regarding The Use of Privately Contracted Armed Security Personnel On Board Ships in the High Risk Area
GAIHLHR	The International Code of Conduct for Private Security Service Providers.

2013	
IMO 2015	MSC.1Circ./1406-Rev.3 Revised Interim Recommendations for Flag States regarding the use of Privately Contracted Armed Security Personnel on board ships in the High Risk Area.
ISO 2015	ISO 28007-1:2015 Guidelines for Private Maritime Security Companies (PMSC) providing privately contracted armed security personnel (PCASP) on board ships.

3.3 The Propose Improvement of Framework of PMSC of Malaysia

The propose new framework of PMSC of Malaysia is shown in Figure 2.

In order to improve the existing MOHA PMSC framework, the requirement of the existing international guidance should be incorporated into the existing framework. By doing this, the detail SOP for each operation would develop according to the relevant guidance. This would improve the existing MOHA SOP by internationalising the existing SOP and filling the areas that previously not covered. Therefore, the guidance from IMO, namely Revised Interim Recommendations for Port and Coastal States Regarding the Use of Privately Contracted Armed Security Personnel on Board Ships (PCASP) in the High Risk Area, Revised Interim Recommendations for Flag States regarding the use of Privately Contracted Armed Security Personnel on board ships in the High Risk Area, and Interim Guidance to Private Maritime Security Companies Providing Privately Contracted Armed Security Personnel on Board Ships in the High Risk Area are incorporated to the existing MOHA framework, namely the Method of Handling Maritime Security Services, SOP Firearms handling and usage, SOP Maritime Security Services Onboard Vessel, and SOP Maritime Security Services for Escort Vessel. In addition, the ISO Guideline for PMSC providing PCASP on board ships is incorporated to Method of Handling Maritime Security Services, SOP Firearms handling and usage, SOP Maritime Security Services Onboard Vessel, and SOP Maritime Security Services in Port Area.

The guideline developed by ISO can be used as the guideline to develop the Standard Operational Procedure for the PMSC operation in Malaysia and also serves as the standard to be audited by authority such as MOHA. The Montreux Document on Pertinent International Legal Obligations and Good Practices for States Related to Operations of Private Military and Security Companies During Armed Conflict and The International Code of Conduct for Private Security Service Providers are currently not suitable to be incorporated into the existing MOHA PMSC framework because the documents are tailored for services provided

in the armed conflict area, which there is no such conflict happening in the waters of Malaysia currently and the near future.

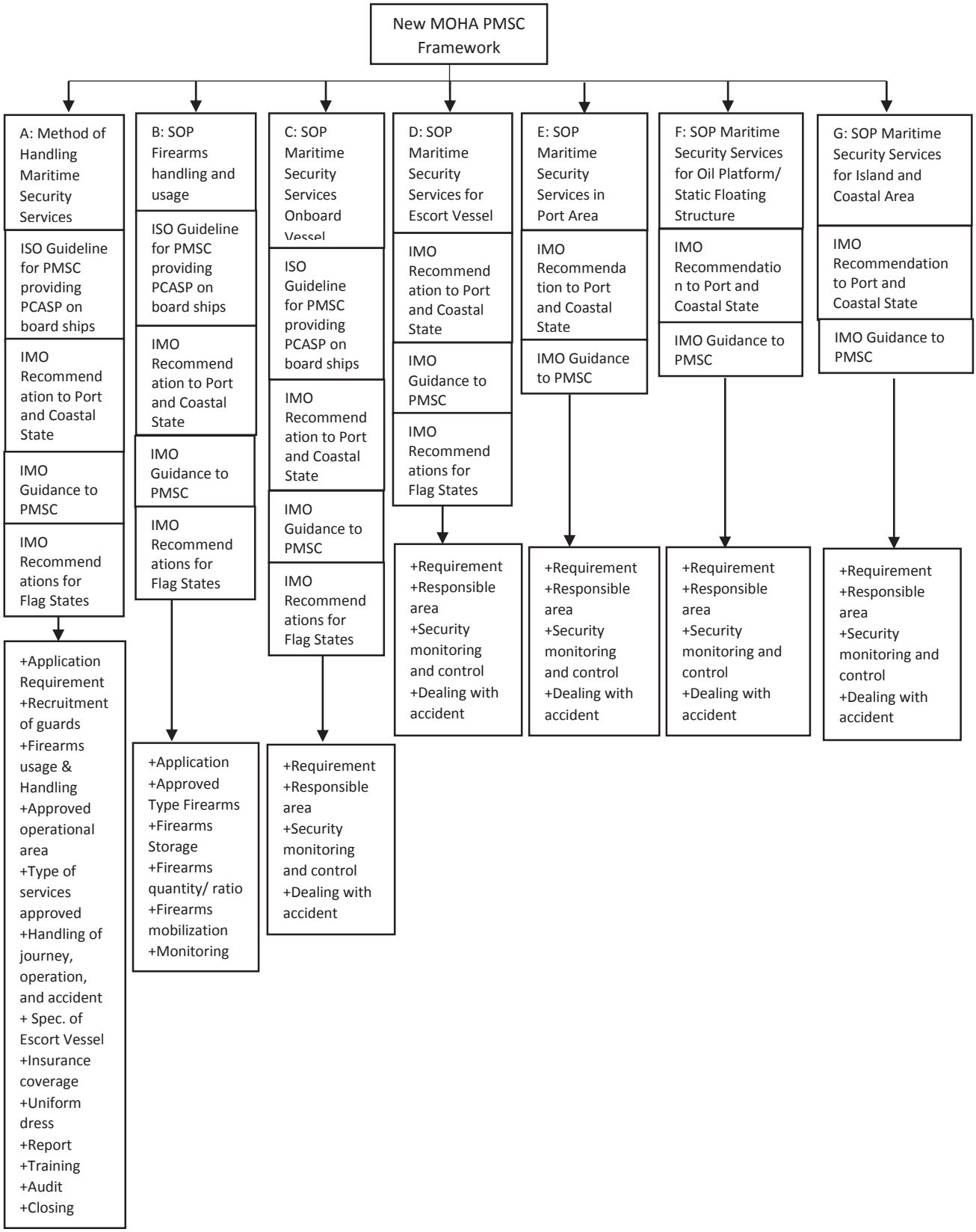

Figure 2: The proposed new MOHA PMSC framework of Malaysia

Therefore, for this time being, the guidance developed by IMO and ISO are more suitable to be applied and incorporated into the existing MOHA framework.

4. Conclusion

The existing MOHA framework of PMSC of Malaysia is developed mainly based on local regulation and therefore may conflict with the flag state of the vessel. Therefore, this issue is addressed by incorporating the guidelines of IMO and ISO, which covered all sides such as the port or coastal state, flag state and the service provider. The incorporation of the international guidelines into the existing MOHA framework, which harmonies the scopes and requirement of stakeholder on PMSC would improve and internationalize the existing MOHA framework.

References

[1] B. H. Dubnerf and C. Pastoriusf, "On the Effectiveness of Private Security Guards on Board Merchant Ships off the Coast of Somalia- Where is the Piracy ? What are the Legal Ramifications ?," *North Carolina J. Int. Law Commer. Regul.*, vol. 39, no. 4, 2014.

[2] The Sunday Mail, "Straits of Malacca hardly a war zone," *The Sunday Daily*, Kuala Lumpur, 28-Mar-2006.

[3] M. N. Anis, "Straits no more a war risk zone," *The Star*, Kuala Lumpur, 09-Aug-2006.

[4] ReCAAP, "Incident Report 01/2014," Singapore, 2014.

[5] ReCAAP, "Incident Report 02/2014," Singapore, 2014.

[6] ReCAAP, "Incident Report 03/2014," Singapore, 2014.

[7] ReCAAP, "Incident Report 04/2014," Singapore, 2014.

[8] ReCAAP, "Incident Report 05/2014," Singapore, 2014.

[9] ReCAAP, "Incident Report 06/2014," Singapore, 2014.

[10] ReCAAP, "Incident Report 08/2014," Singapore, 2014.

[11] Y. Yussop, "Pirates rob oil tanker in Bintulu waters," *Borneo Post Online*, Kuching, 12-Jun-2014.

[12] ReCAAP, "Incident Update Product Tanker, Ai Maru," Singapore, 2014.

[13] ReCAAP, "Incident Update Oil Product Tanker, Moresby 9," Singapore, 2014.

[14] ReCAAP, "Incident Update Product Tanker, Orapin 4," Singapore, 2014.

[15] ReCAAP, "Incident Update Product Tanker, Srikandi 515," Singapore, 2014.

[16] ReCAAP, "Incident Update Oil Product Tanker, Sunrise 689," Singapore, 2014.

[17] ReCAAP, "Incident Update Tanker, VP Asphalt 2," Singapore, 2014.

[18] ReCAAP, "ReCAAP Piracy / Armed Robbery in Asia - April 2014 ReCAAP Piracy & Armed Robbery At Sea Against Ships in Asia - April 2014," *ReCAAP Information Sharing Centre*, 2014. .

[19] ReCAAP, "Special Report on Incidents of Siphoning of Fuel / Oil at Sea in Asia," Singapore, 2014.

[20] ReCAAP, "Incident Report 01/2015," Singapore, 2015.

[21] ReCAAP, "Incident Update Siphoning of Fuel Oil from Joaquim," Singapore, 2015.

[22] ReCAAP, "Report for November 2015 Piracy and Armed Robbery against Ships in Asia," Singapore, 2015.

[23] ReCAAP, “Annual Report Piracy and Armed Robbery Against Ships in Asia: 1 January 2014-31 December 2014,” Singapore, 2015.
[24] ReCAAP, “Report for 2015 July Piracy and Armed Robbery against Ships in Asia,” Singapore, 2015.
[25] ReCAAP, “Report for 2015 October Piracy and Armed Robbery against Ships in Asia,” Singapore, 2015.
[26] ReCAAP, “Arrest of Suspects involved in Hijacking of Orkim Harmony,” Singapore, 2015.
[27] ReCAAP, “Siphoning of Fuel / Oil from Product Tanker, Lapin,” Singapore, 2015.
[28] ReCAAP, “MT Rehobot Found !,” Singapore, 2015.
[29] ReCAAP, “Recovery of Orkim Harmony,” Singapore, 2015.
[30] ReCAAP, “Vessel Found and Perpetrators Arrested Chemical Tanker, Sun Birdie,” Singapore, 2015.
[31] ReCAAP, “Special Report on Incidents of Siphoning of Fuel / Oil at Sea in Asia (Part II),” Singapore, 2015.
[32] ReCAAP, “Incident Report 07/2015,” Singapore, 2015.
[33] ReCAAP, “Incident Report 06/2015,” Singapore, 2015.
[34] ReCAAP, “Incident Report 05/2015,” Singapore, 2015.
[35] ReCAAP, “Piracy and Armed Robbery Against Ships In Asia (January - June 2015),” Singapore, 2015.
[36] ReCAAP, “Incident Report 03/2015,” Singapore, 2015.
[37] ReCAAP, “Incident Report 04/2015,” Singapore, 2015.
[38] ReCAAP, “Incident Report 02/2015,” Singapore, 2015.
[39] IMB, “ICC International Maritime Bureau Piracy and Armed Robbery Against Ships Report For The Period 1 January – 30 September 2015,” London, 2015.
[40] ReCAAP, “Incident Update Siphoning of Fuel / Oil from Orkim Victory,” Singapore, 2015.
[41] IMO, “Privately Contracted Armed Security Personnel (PCASP) IMO PIRACY GUIDANCE,” 2012. .
[42] IMO, *Revised Interim Guidance To Shipowners, Ship Operators And Shipmasters On The Use Of Privately Contracted Armed Security Personnel On Board Ships In The High Risk Area*. 2012.
[43] IMO, *Interim Guidance to Private Maritime Security Companies Providing Privately Contracted Armed Security Personnel on Board Ships in the High Risk Area*. London: IMO, 2012.
[44] IMO, *Revised Interim Recommendations For Flag States Regarding The Use Of Privately Contracted Armed Security Personnel On Board Ships In The High Risk Area*. 2015.
[45] IMO, *Revised Interim Recommendations For Port And Coastal States Regarding The Use Of Privately Contracted Armed Security Personnel On Board Ships In The High Risk Area*. 2012.
[46] ISO, *Ships and marine technology — Guidelines for Private Maritime Security Companies (PMSC) providing private contracted armed security personnel (PCASP) on board ships (and pro forma contract) — Part 1: General*, vol. 2015. 2015, p. 28007.
[47] FDFA, *International Code of Conduct for Private Security Service Providers*. 2010.
[48] FDFA Switzerland, *The Montreux Document on pertinent international legal obligations and good practices for States related to operations of private military and security companies during armed conflict*. 2009.

SHIPPING ACCIDENTS – HUMAN ERROR OR HUMAN BEHAVIOR, MET PROSPECTIVE

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Abstract. Every global industry is striving for safe working environment. Same is the case with the maritime industry, specifically ships in ports and at sea. Shipping accidents have a huge impact on environment and economy, in addition to loss of precious seafarer's lives. Main focus of all stakeholders, whether it is IMO, technology or MET institutes, is accident prevention. However, despite all best efforts, accidents do still occur, damaging environment, loss of lives and property. Investigations conducted worldwide into shipping accidents reveal that human element is a major contributing factor [1]. MET institutes are responsible for comprehensive seafarers training but unluckily more importance is given to professional training, with less emphasis on human behavioral sciences. Although, there are few courses on personal safety, social responsibility, multilingual and multicultural working environment, however, human behavior is a neglected part in the curriculum in majority of the MET institutes. Personality traits and human behavior have a very strong impact on the professional life of any individual. Around 1.5 million seafarers [2] are working around the globe on board ships. The majority of the seafarers are from developing countries, where a culture of safety and safe working environment is not given much emphasis. We are aware that extensive research is in progress on unmanned ships, to prevent accidents due to human error. This may have great advantages as far as safety is concerned, however hundreds of thousands of seafarers will lose their jobs, resulting in the economy of many countries depending on seafarer's remittances being jeopardized. There is no doubt that it is very difficult to change personality traits [3], behavior, old traditional and unsafe working practices of different nationalities, because most of the seafarers belong to underdeveloped / developing countries, where safety has least importance. Shipping industry cannot alleviate multinational and

multicultural crewing. The only remaining viable solution is to train seafarers with the highest attitude towards safety and change their behavior towards unsafe practices, to ensure human error is eliminated. In such circumstances, responsibility of MET institutes increases manifold. In this paper, hundreds of shipping accidents, unsafe practices and unsafe working culture of different countries, behavioral science, human attitude towards safety issues, the impact of local safety culture on seafarer's personalities and the role of MET institutes has been discussed. This paper also proposes to develop an IMO model course "Human Behavior and Safety Culture"

Key Words: Shipping Accidents, Human Error, Human Behavior, MET Institutes, Seafarers, Safety Culture

Introduction: Every global industry is striving for safe working environment. Same is the case with the maritime industry, specifically ships in ports and at sea. Shipping accidents have a huge impact on environment and economy, in addition to loss of precious seafarer's lives. Focus of all stakeholders, whether it is IMO, technology or MET institutes, is accident prevention. However, despite all best efforts, accidents do still occur, damaging environment, loss of lives and property. Investigations conducted worldwide into shipping accidents reveal that human error is a major contributing factor [1]. MET institutes are responsible for comprehensive seafarers training but unluckily more importance is given to professional training, with less emphasis on human behavioral sciences. Although, there are few courses on personal safety, social responsibility, multilingual and multicultural working environment, however, human behavior is a neglected part in the curriculum in majority of the MET institutes. Personality traits and human behavior have a very strong impact on the professional life of any individual. Around 1.5 million seafarers [2] are working around the globe on board ships. The majority of the seafarers are from developing countries, where a culture of safety and safe working environment is not given much emphasis. We are aware that extensive research is in progress on unmanned ships, to prevent accidents due to human error. This may have great advantages as far as safety is concerned, however hundreds of thousands of seafarers will lose their jobs, resulting in the economy of many countries depending on seafarer's remittances being jeopardized. There is no doubt that it is very difficult to change personality traits [3], behavior, old traditional and unsafe working practices of different

nationalities, because most of the seafarers belong to underdeveloped / developing countries, where safety has least importance

Shipping Accidents: While we use any mode of transport, chances of accidents are bound to happen. Like road and air accidents, maritime accidents also occur in the vast oceanic area because thousands of ships sailing, millions of fishermen out at sea for fishing, oil exploration is at its peak, warships are patrolling across the oceans. That is why; these accidents have very severe impact on the environment, economy, human and marine life. If we look at the number of shipping accidents during 2017, it reaches to about 114 till September [4]. It is very alarming situation that no day without major or minor accident. Experts have categorized following types of marine accidents according to the severity:

- Offshore oil rigs
- Oil/Gas and chemical tankers accidents
- General cargo and container ship accidents
- Accidents in shipyard, docks and port areas
- Tug boats and barges mishaps
- Fishing vessels mishaps

The outcome of such accidents is explosions, heavy fire and oil spill especially offshore oil rigs, oil and chemical tankers, Grounding, Sinking, Collision, Capsize, Cargo shift, Loss of human life, damage to the property and environment.

Looking at the report by Canadian Transport Safety Board, in 2016, 304 marine accidents were reported to the TSB, up from the 2015 total of 248, up from the 2011-2015 average of 282. Over the past 10 years, 83% of marine accidents were shipping accidents, while the remaining were on board ships. [5]

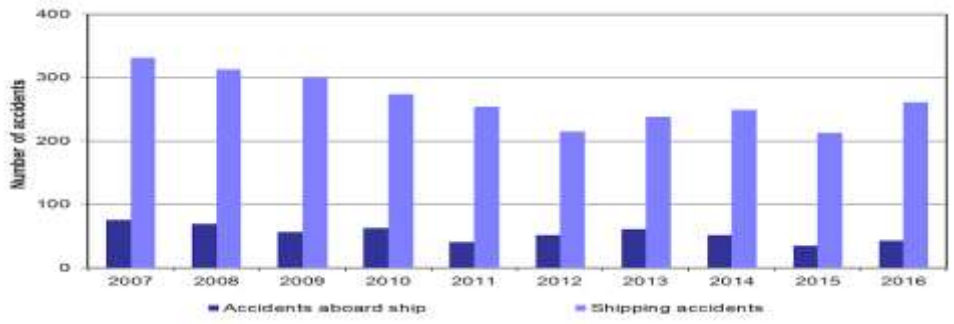


Fig- 1 Accidents aboard ship and shipping accidents, 2007-2016

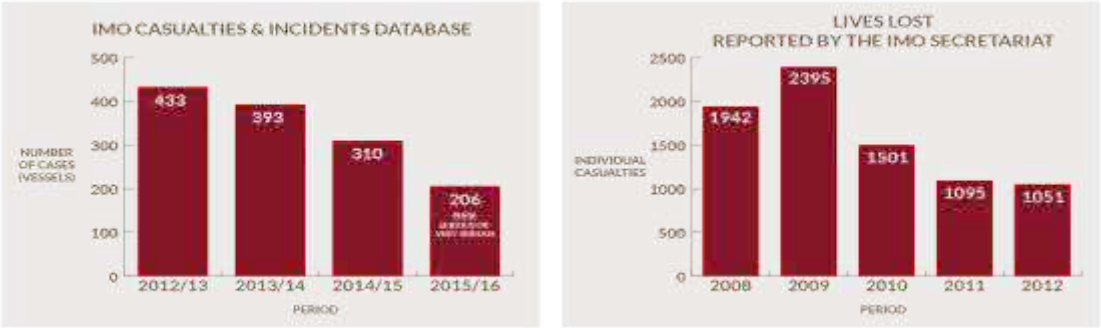


Fig -2 IMO Casualties Incidents and live lost data

Although IMO casualties and incident data base [6] shows decline in shipping accidents and individual causalities but it still needs lot of efforts to reduce shipping accidents

Major Known Causes of such Accidents

a. Severe weather conditions/ natural disasters
b. Machinery failure
c. Human error

Human Error and Marine Industry: This paper focuses on human error particularly human behavior involving safety culture. "the causes that top the list like collision, fire, explosions, tanker accidents etc. are all results of human errors in one way or the other" [7]. Different studies of marine accidents have shown amazing results that in most of the cases (almost 96%), the root cause was human error with classic examples of Torrey Canyon and Titanic. Although technology in shipping industry has gone tremendously sophisticated but human involvement to use this technology is unavoidable factor unless the industry opts for unmanned ships. Very minor human error has led to sinking of a ship like not ringing emergency alarm. "Human Error contribution to shipping accidents, 84-88% of tanker accidents, 79% toeing vessel, 89-96% grounding, 75% collisions and 75% of fires and explosions attributes towards human error" [8]. According to a presentation by Clamber University of Technology, Gothenberg Sweden in 2013 "human error" is one of the biggest contributing factors for maritime accidents [9]. "A study conducted by Dutch authorities of 100 marine casualties revealed that 96 accidents out of 100 occurred involving human error" [10]. This factor costs maritime industry $550 million/year, as per UK P&I Club. A study of 6091 major accident claims (i.e., over $100,000) of commercial ships, over a period of 15 years by UK P & I Club, revealed that 62% of the claims were due to human error [11]. Ashok

Mahapatra, Dy. Director, Maritime Training and Human Element Section, Maritime Safety Division, IMO underscored the fact that "80 per cent of the accidents occurring at sea was the result of human errors" [12]

Following are the major contributor in the human error.

a. Overworked and fatigue
b. Disorientation of crew members
c. Wrong decisions based on insufficient information
d. Crews over confidence
e. Miscommunication (internal and external)
f. Insufficient knowledge and training
g. Under manning and Multilingual and multicultural crewing
h. Wrong management decisions
i. Poor bridge team work
j. Lack of emergency drills
k. Unhealthy and unsafe working environment
l. Poor maintenance
m. Company management pressure because of too much commercialism and competition
n. Negligence because of poor safety culture background

Human Error or Human Behavior? Most of the studies show that "Human Error" is the major contributor of marine accidents. There is no doubt in that but a very important part is neglected and that is human negligence due to human behavior reflecting safety culture of his background, maritime training institute and overall community safety culture. Personality traits and human behavior have a very strong impact on the professional life of any individual. Around 1.6 million seafarers are working around the globe on board ships. Most of the seafarers are from developing countries, where safety culture and safe working environment is not given high priority. There is no doubt that it is very difficult to change personality traits [3], behavior, old traditional and unsafe working practices of different nationalities, because most of the seafarers belong to underdeveloped / developing countries, where safety has least importance. Very recent example of negligence, grounding of General cargo ATLANTIC south of Oskarshamn, eastern Sweden, Baltic Sea on 23 Sep 2017. Investigations revealed that Master and Officer of the Watch,

(crew Russian and Filipino Nationalities) were heavily drunk. They did not change course and sailed straight ahead until grounded.

Seafarers Supplying Countries: Since ages, people had been travelling and trading through the sea. Seafarers always exited wither on wood logs or on ULCCs. In today's global economy, shipping is the most vital source of good's transportation. Clothes we wear and food we eat is transported through sea by ships and ship without seafarers are meaningless. It will not be wrong to admit that they are the major driving force for the global economy and without it world would halt. Seafarers working on merchant ships are estimated to 1,647,500 of which 774,000 are officers and 873,500 are ratings. China, Philippines, Indonesia, Russian Federation and Ukraine are the five largest seafarers supplying countries. [13]

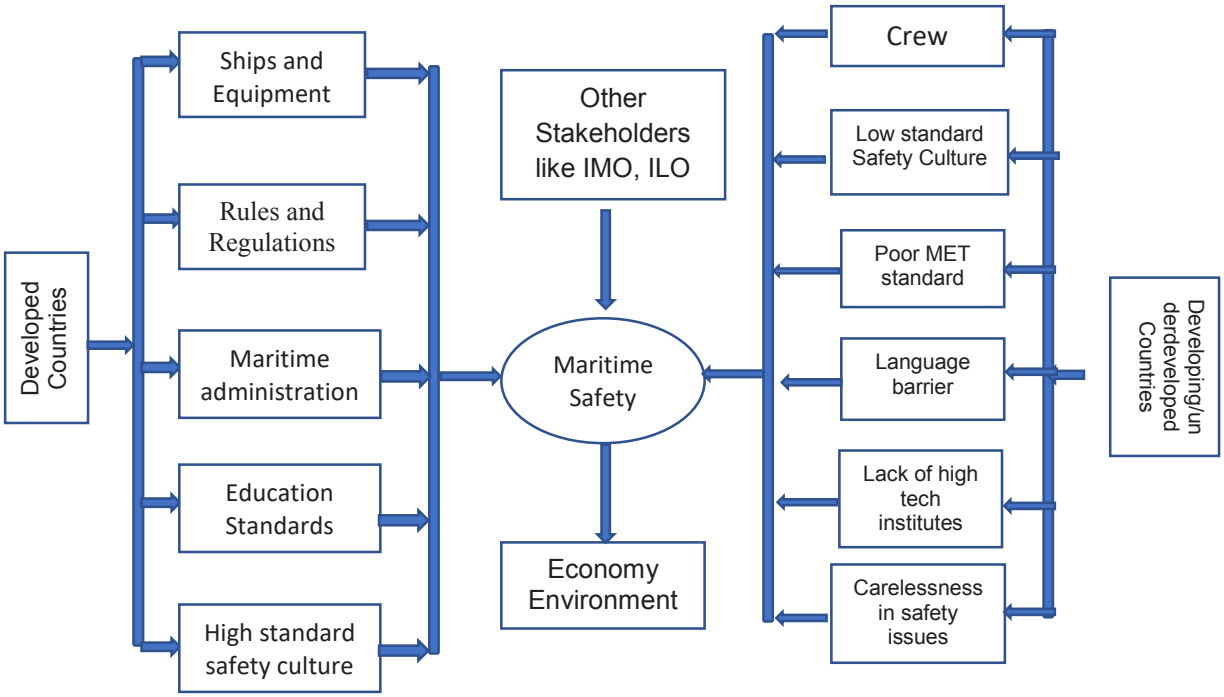


Fig- 3 maritime safety and stakeholders (c)

The gray area in shipping industry is that ships are constructed in highly developed countries like Japan and Korea, fitted with very high-tech equipment's and seafarers are produced in underdeveloped countries where seafarer's training is not adequate even though some developed countries help MET institutes but absence of basic safety culture inculcated in them since childhood is big hurdle. "Shipping is one of the safest transport means, yet thousands of accidents occur and majority of these involve human error. The main issues which can influence the potential for human error are education, training and working conditions. EU registered ships are often

crewed by seafarers who are not from EU member states. This fact needs to be considered when determining the best ways ensuring that the crew members on board EU registered ships are appropriately educated and trained "[14]. EMSA is one of the example inspecting and visiting underdeveloped countries to make sure the compliance of STCW. It has visited more than 80 countries, covering more than 90% of seafarers operating in EU waters, as well as all others operating on EU registered ships around the world" [15]. This situation can best be described by the following diagram.

Human Behavior and Safety Culture: Most of the developing countries spend very low budget to promote safety culture because of budget deficit. Same is carried away in the population and becomes a habit and behavior. On the other hand, developed countries spend lot of money to promote safety culture in the society. If we make a comparison between developed and developing countries about safety culture, we find that Sweden has one of the world's lowest traffic-related fatality rates. This is achieved through education, public service and public awareness, starting from childhood. On the other hand, Saudi Arabia has population of 30 million with 17 deaths per day on roads because safety is not taken very seriously by the public despite lot of government efforts. You can see a driver with baby in his lap while driving during heavy traffic, on highways and rush hours indicating the safety culture. For example, only in Jeddah city with 400000 people, for 8 hours, speed and safety cameras on road take almost 10000 snapshots of traffic violation.

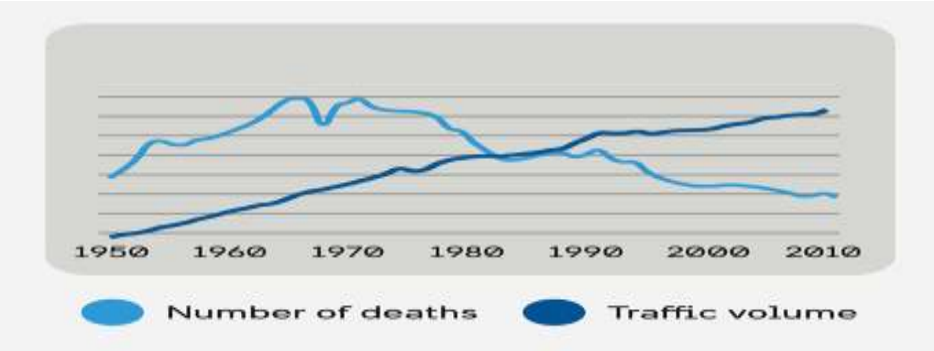
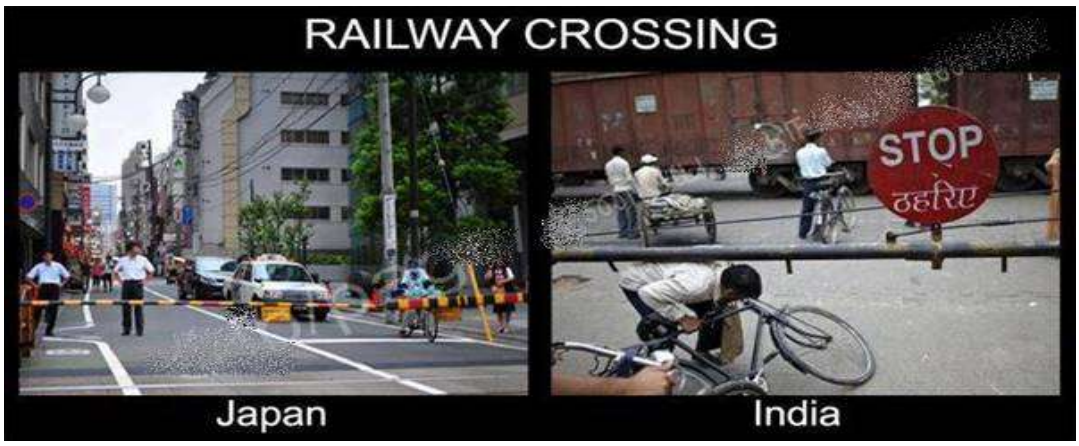


Fig -4 Sweden road safety achievements

This issue in underdeveloped countries is much worst like Philippine, Vietnam, Pakistan, India, Bangladesh and so on. One Swedish company lost a very big contract because it refused to cut in budget allocated for safety installations. So many inventions were made to ensure safety of people. On the contrary, following few pictures can depict the situation of safety culture in the underdeveloped and developing countries from where most of the seafarers are supplied.

In japan railway, there are about 19 safety checks before train reaching to a railway platform. Intercity buses in japan, surprisingly driver checks tire after every 18 to 20 kilometers where as in Pakistan or India, driver will come to know about the tire condition after it has busted.



These pictures show that how safety has been taken so seriously. School curriculums are not designed to teach children and young students about safety culture and safe practices. These children carry the same throughout their life and practice the same unsafe methods unintentionally on-board ships because of their personality traits.

Human Behavior and Personality Trait: Personality traits and human behavior have a very strong impact on the professional life of any individual. Previously the idea was conceived that personality traits, habits and social behavior cannot change but now the psychologists have found

out that personality traits can be changed by providing continues and rigorous training. Here comes the role of MET institutes. Most of the MET institutes are conducting IMO Model courses, undergraduate and post graduate programs but a specific human behavior course on behavioral sciences subject is not taught neither it is part of GP -rating.

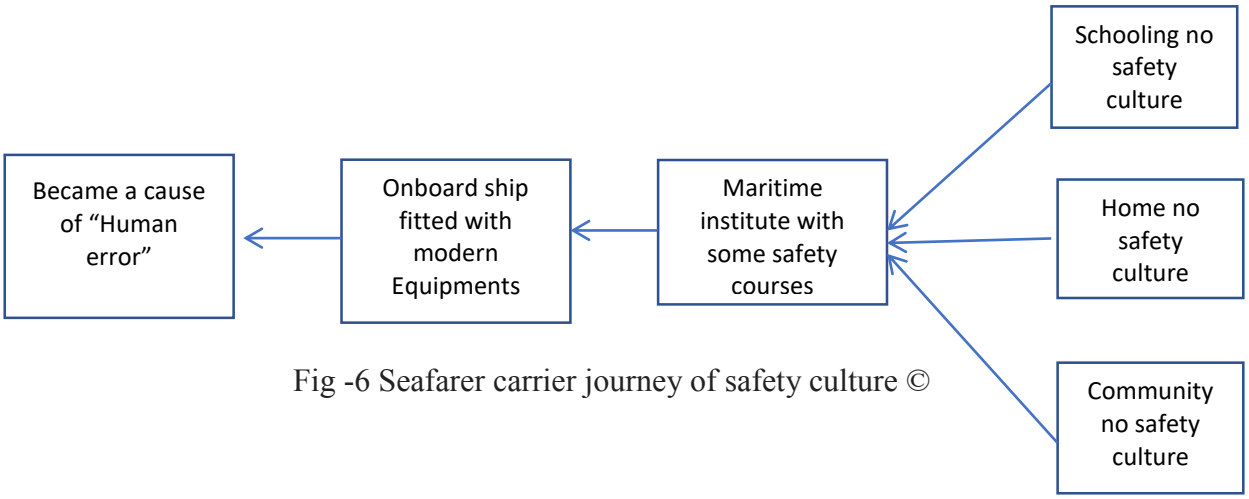


Fig -6 Seafarer carrier journey of safety culture ©

Role of MET Institutes: A survey was conducted. 12 MET institutes from different countries were sent a questionnaire to ascertain whether they are conducting such courses or not to alleviate safety culture in the seafarers. Following questions were asked:

a. Do students have any idea about safety culture?
b. Local people adhere to safety culture?
c. Does government spending enough money to promote on safety culture?
d. Do people follow crude methods to deal with safety issues
e. Is Human behavioral science and safety culture course in the curriculum?
f. Is this part of B.Sc. Program?
g. Do you think such course needed?
h. Will this improve safety culture?
i. Can this be helpful to reduce accidents?
j. Do you think personality traits contribute towards safety culture?
k. Should it be an IMO Model course?

Reply to the questionnaire indicates that people are not much aware of safety culture and they are not adhere to it. Crude methods are used to deal with safety issues. MET institutes believe that students educational background does not carry valuable knowledge of safety culture. Institutes,

though conduct short mandatory course like PSSR but that is not sufficient to bring students at par with developed countries as for safety culture is concerned. MET institutes strongly supported the need to have behavioral science as part of curriculum as well as an IMO model course on the subject. Countries providing majority of seafarers should put more funds to improve safety culture and remove notion of using old traditional crude methods to deal with safety issues specially on-board ships.

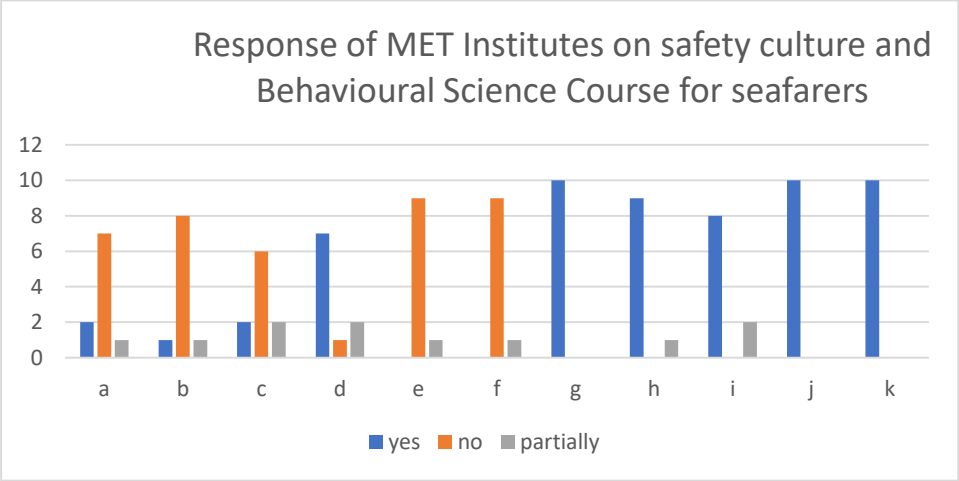


Fig -7 Survey analysis

If MET institute did not realize their responsibility to train people in safety culture and inculcate safety behavior and as personality trait, it will be difficult to reduce shipping accidents. The practice of blaming "human error" should be cribbed and seafarers should be made realized that human negligence is the most dangerous act on board ships to put life of other seafarers and ship in danger. If this is not improved, we all know that

We are aware that extensive research is in progress on unmanned ships, to prevent accidents due to human error. This may have great advantages as far as safety is concerned, however hundreds of thousands of seafarers will lose their jobs, resulting in the economy of many countries depending on seafarer's remittances being jeopardized

Conclusion: Human survival is impossible without shipping and ships cannot be operated without seafarers. Mostly seafarers are from developing countries where safety culture has been given least importance. As number of ships and size of ship increasing, chances are for accidents, and "vision zero" can only be achieved through comprehensive training. MET Institutes needs to take up the issue of human behavior during different situations and circumstances, especially

during emergencies. Developing countries safety culture will improve with development and education but MET institutes needs to tailor some course to cater for personality traits and change poor habits in safety matters.

Recommendations:

1. MET institutes should make "Human Behavioral Science and safety culture" as part of the curriculum
2. IMO Model course be prepared and implemented along with other safety courses.
3. Shipping companies may introduce such courses and drills on board ships to minimize human negligence
4. Investigation of shipping accidents should point out negligence on the part of the crew instead labeling the accidents just as "human error"

References:

[1] http://www.marineinsight.com/marine-safety/the-relation-between-human-error-and-marine-industry/ retrieved on 14 March 2017

[2] http://www.ics-shipping.org/shipping-facts/shipping-and-world-trade/global-supply-and-demand-for-seafarers retrieved on 15 March 2017

[3] McCrae RR, Costa PT. The stability of personality: Observation and evaluations. Current Directions in Psychological Science. 1994; 3:173–175.

[4] https://en.wikipedia.org/wiki/List_of_shipwrecks_in_2017 retrieved on 20 April 2017

[5] http://www.tsb.gc.ca/eng/stats/marine/2016/ssem-ssmo-2016.asp retrieved on 15 August 2017

[6] http://seafarersrights.org/seafarers-subjects/deaths-and-injuries-at-sea/ retrieved on 20 September 2017

[7] http://www.marineinsight.com/marine-safety/the-relation-between-human-error-and-marine-industry/ retrieved on 20 September 2017

[8] http://www.marineinsight.com/future-shipping/rolls-royces-futuristic-unmanned-ships-will-sail-without-seafarers/ retrieved on 20 September 2017

[9] http://www.marineinsight.com/future-shipping/rolls-royces-futuristic-unmanned-ships-will-sail-without-seafarers/ retrieved on 20 September 2017

[10] "HUMAN ERROR-THE MAIN FACTOR IN MARINE ACCIDENTS" Raluca APOSTOL-MATES and Alina BARBU "Mircea cel Batran" Naval Academy Scientific Bulletin, Volume XIX – 2016 – Issue 2. https://www.anmb.ro/buletinstiintific/buletine/2016_Issue2/FCS/451-454.pdf retrieved on 20 September 2017

[11] *Just Waiting to Happen*... The Work of the UK P & I Club, The International Maritime Human Element Bulletin, No. 1, October 2003, pp. 3–4. Published by the Nautical Institute, 202 Lambeth Road, London, U.K. retrieved on 20 September 2017

[12] https://www.maritimeprofessional.com/blogs/post/complacency--a-major-cause-of-ship-accidents-13098 retrieved on 21 September 2017

[13] http://www.ics-shipping.org/shipping-facts/shipping-and-world-trade/global-supply-and-demand-for-seafarers retrieved on 20 September 2017

[14] wherhttp://emsa.europa.eu/visits-a-inspections/training-of-seafarers.htmle they were educated, trained and certified. retrieved on 24 September 2017

[15] wherhttp://emsa.europa.eu/visits-a-inspections/training-of-seafarers.htmle they were educated, trained and certified. retrieved on 25 September 2017

THE IMPACT OF SAFETY CULTURE ON MARINE ENVIRONMENT

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Abstract. Maritime safety is the comprehensive term of the safety of individuals and marine environment. However, the meaning of safety culture, which is part of the maritime safety at sea, is the culture of the human factor and the ship management with all the aspects related to the human factor. Considering the marine accidents, 80% of maritime accidents are due to human error and the consequences of these incidents that affect the marine environment.

Safety culture is one of the basic factors that cause maritime accidents and thus affect the marine environment because it is the direct link between the management, the vessel, and individuals with each other. Besides, the International Maritime Organization (IMO) has set the International Safety Management system (ISM) code to identify regulatory controls to manage the ship, but the importance of safety culture was not highlighted in this code because it is an intangible culture and thus it was not mentioned in the code, but due to its seriousness, the IMO began to introduce the meaning of safety culture and its gravity.

Due to the impact of safety culture on the marine accidents, the SHEL investigation model (Software, Hardware, Environment, and Liveware), which is used in analyzing the human factors to identify the actual causes for accidents was amended by introducing the factor of safety culture to be SCHEL investigation model (Software, Culture, Hardware, Environment, and Liveware) to determine the causes leading to accidents in a thorough way. This research paper will define the meaning of safety culture and analyze the impact of safety culture on the marine environment. In addition, it will explain the proposed procedures to decrease the human errors, which negatively affect the marine environment.

Key words: Safety Culture, Human Factor, SHEL Investigation Model, SCHEL Investigation Model.

1. Introduction

The maritime transport sector is directly affected by marine accidents, which adversely affect the human and marine environment, as well as properties and activities onboard ships and ashore in various forms. The effects of accidents vary from minor injuries to fatalities and from insignificant damage to severe damage to the environment and property. Marine accidents affect marine environment in different ways, not only grounding and collisions are the reasons of marine pollution, but also human errors as oil spillage, solid waste, oil transfer or bunkering spills cause marine pollution. Therefore, The International Maritime Organization (IMO) have set different goals for protecting human and the marine environment, and also properties by issuing maritime safety treaties and codes such as: The International Convention for the Safety of Life at Sea (SOLAS) 1974, as well as the International Convention for the Prevention of Pollution from Ships (MARPOL) 1973, that are related to the protection of the marine environment from oil spills, sewage, garbage, and early air emission.

However, the IMO also issued the International Safety Management (ISM) Code, which is a code established to provide an international standard for the safe management and operation of ships and for pollution prevention. Marine accidents still occurs on different types of vessels as shown in Figure (1), which shows the retreat in the number of lives lost onboard vessels especially onboard cargo ships(*ICS, 2013*).

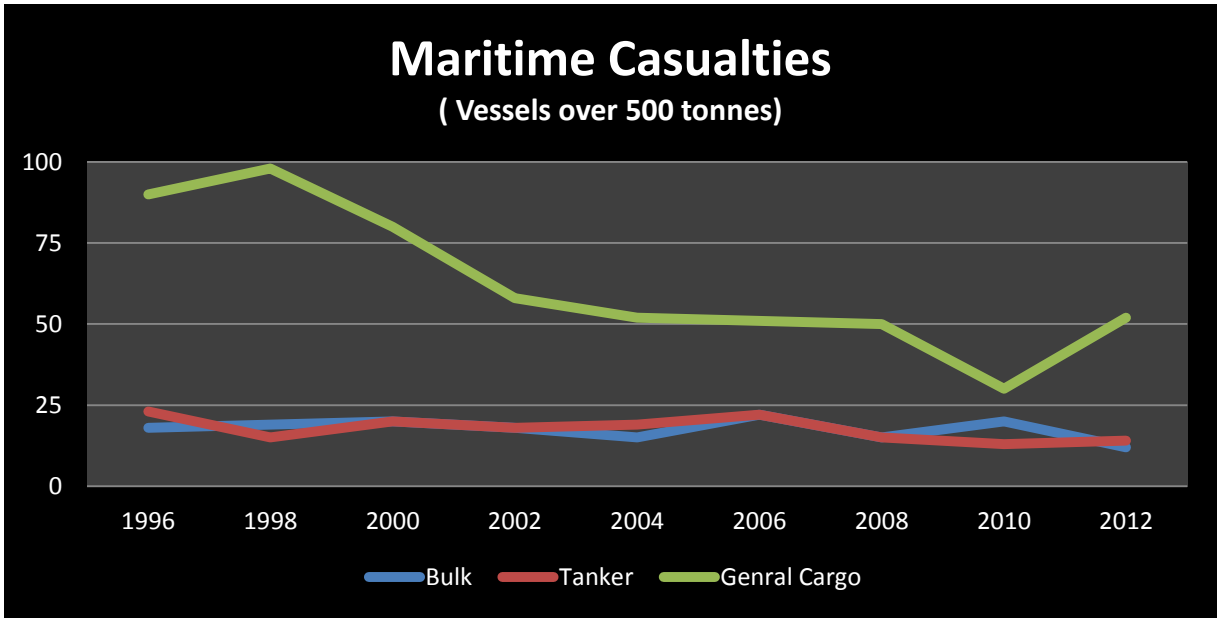

Figure1. Number of Total Lives Lost

Source: International Chamber of Shipping, (2013).

As mentioned before, the marine accident and marine causalities decreases by implementing the IMO conventions, ISM code and other related codes, so the IMO started searching for the main reason for the continuous occurrence of marine accidents, until it found that the main factors in this system are the company and the human element, but the question is what is the relation between these two factors, the answer is, marine safety culture, which is a tool used to help the maritime system to operate in a safe environment, which also aim to reduce accidents and thus protect safety of lives, and the marine environment (*Havold, 2005*).

This research paper will explain the concept of safety culture and its impact on the marine accidents and marine environment. In addition, it will analyze the SHEL investigation model (Software, Hardware, Environment, and Liveware), which is used in analyzing the human factors to identify the actual causes for accidents, which was amended by introducing the factor of safety culture to be SCHEL investigation model (Software, Culture, Hardware, Environment, and Liveware) to determine the causes leading to the marine accidents in a thorough way. Moreover, the paper will describe the proposed procedures to decrease the human errors, which affect the marine environment. The structure of this paper consists of a clear introduction about safety culture, explanation of the new SCHEL investigation model, and finally comes the conclusion & recommendations.

2. The Concept of Safety Culture

In order to be able to understand the impact of safety culture on the marine accidents and marine environment, investigations of marine accidents should be carried out in order to reach the correct concept of this culture. The following figure (2) shows the result of investigating a number of large spills (over 700 tones) of marine accidents from 1970 to 2012, the statistics show that the number of large spills (over 700 tones) has decreased significantly during the last 42 years. The average number of major spills in the previous decade (2000-2010) it is more than three, approximately eight times less than in the 1970s. Looking at this downward trend from another perspective, 55% of the large spills recorded occurred in the 1970s, and this percentage has decreased each decade to 7% in the 2000s (IMO, 2012). However, the statistics show that the number of major oil spills has declined, but marine accidents still occurs due to the error of the human element, which results from the misunderstanding of safety culture onboard the vessels. Therefore, the concept of safety culture has to be clear to those working onboard so as to avoid the human element error, which will consequently result in the drop of the number of marine accident.

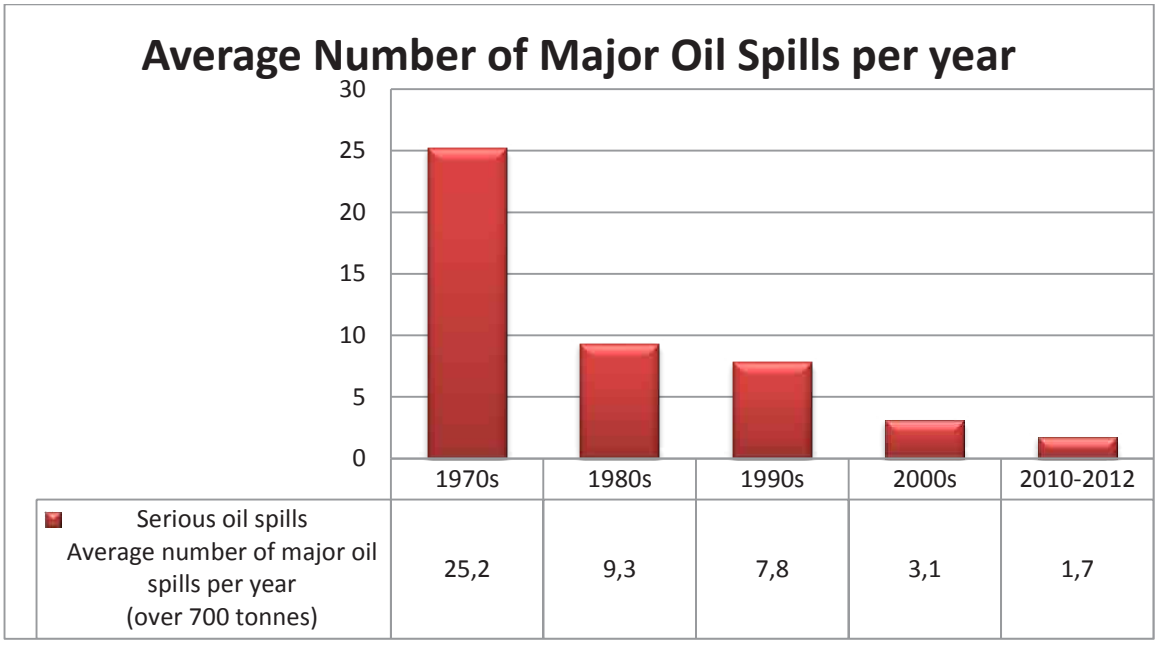

Figure2. Large Oil Spills (over 700 tones) from 1970 to 2012

Source: International Chamber of Shipping, (2013).

2.1 Definition of Safety Culture

The marine safety culture is one of the most important factors in the real marine system, whether onboard or in the management system, so the true meaning of safety culture have to be defined as follows; it is the attitudes, beliefs and perceptions shared by natural groups as defining norms and values, which determine how they act and react in relation to risks and risk control systems (*Butalia, 2014*). Safety culture can also be defined as a culture that requires multiple efforts to reduce the risks resulting from individuals, ships or the surrounding environment. This goal can be achieved through the actual application in the work environment and organization of work through economic and social development and the proper balance between safety and trade *(Rusconi, 2013)*. In addition, developing safety culture with the effective and correct application of human factors plays a vital role in the implementation of health, safety and environmental protection policies. Safety culture is defined in a number of different ways, but generally contains the following elements: it is a concept defined at group reflects on the shared values among all the shipboard, shore side, and organization members, it is concerned with formal safety issues within an organization, it reflects the organization's willingness to develop and learn from errors, incidents, and accidents, it also embraces communication and teamwork *(Zhang et al., 2004).*

3. Elements Affecting Safety Culture

As mentioned above, there are a number of elements that affect safety culture and understanding them onboard the vessels and also at shore s a must. Firstly, safety culture reflects all organizational and behavioral attitudes and clarifies all rules governing individuals in the maritime system. Secondly, safety culture is the first priority that preserves human life and marine environment and not the all maritime system as a result of operational, environmental and social conditions. Thirdly, safety culture is regulated through attitudes, standards and behaviors, which is the way in which issues and situations are managed. Finally, the last element that affect safety culture that it is linked to the provision of a safe voyage beside that each person onboard must perform his duties in a safely manner to fulfill the final objective of the voyage which is that the vessel run safely, bearing in mind the safety and the protection of the marine environment.

As a result, it have been approved that safety culture depends on two main elements, namely the organization and the human factor, however, the human factor is the influential factor that deals with the marine system as a whole, so it was found that understanding the concept of safety culture is the main goal that develops the individuals as well as the entire marine system. Therefore, the next step will be an explanation of the elements affecting safety culture, and lead to marine accidents and harm the marine environment.

3.1 Fatigue Element

There are many human elements influencing safety such as fatigue, automation, situation awareness, poor communication, and stress. These individual elements can be contributory causes in accident causation; however, the safety climate on the vessel is also influence whether or not an individual engages in safe practices. One of the most important elements affecting safety culture is fatigue. According to the IMO, fatigue can be described as a state of feeling tired, weary and sleepy, which results from mental and physical pressure over a period of time *(IMO, 2007)*. By analyzing a number of the marine accidents, which led to loss of life and pollution of the environment, the result was that 86% of these accidents were due to lack of sleep. Failure to sleep for six continuous hours may lead to a lack of concentration at work. The work done by the crew whether during watch- keeping watches or daily routine work and during the loading and discharging operations may lead to marine accidents *(MIAB, 2004)*. The following figure (3) presents a number of factors that affect the crew and leads to accidents and incidents. Here comes the role of safety culture in protecting the environment by making all individuals involved aware of safety to organize work properly

and give the crew the required rest times onboard, which consequently reduce marine accidents.

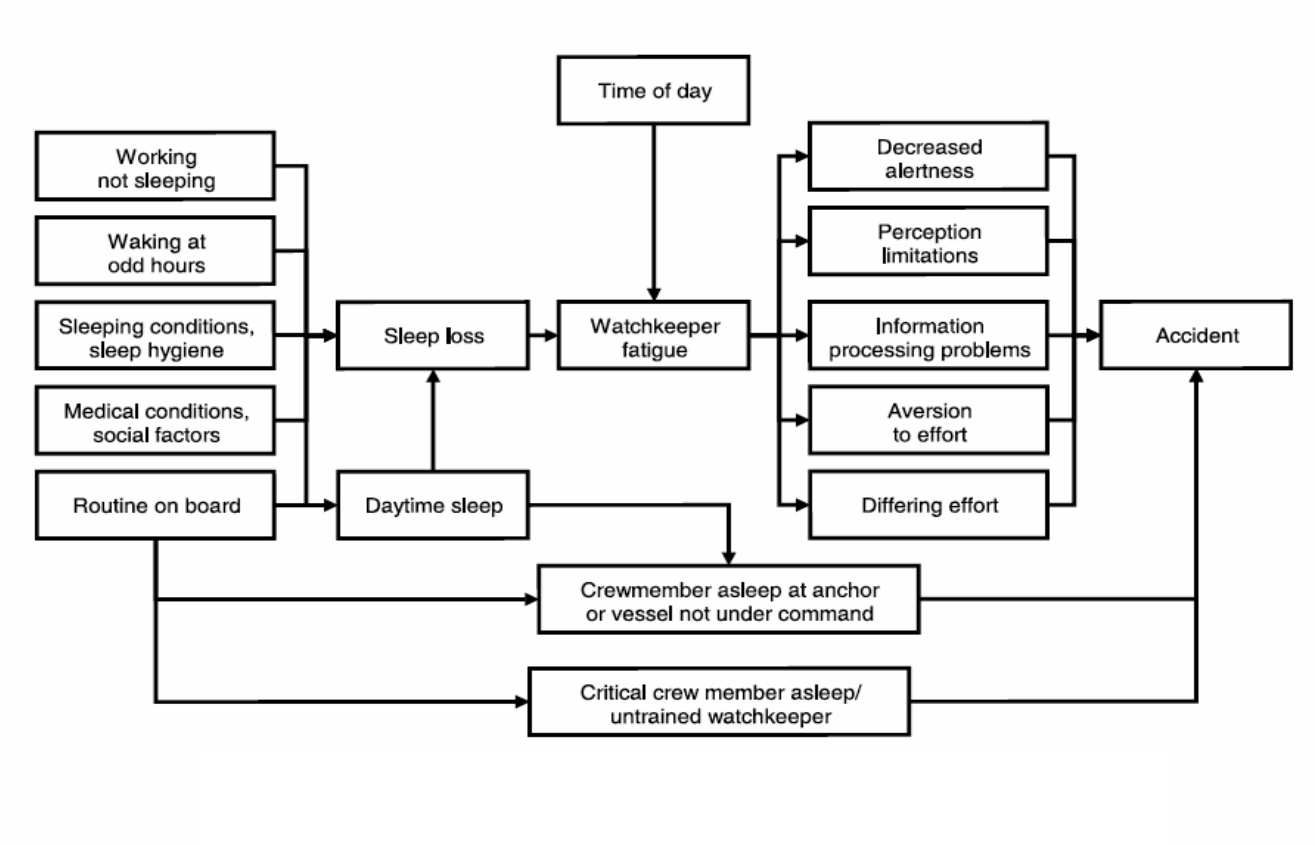

Figure 3. Relationship between Sleep Loss, Fatigue, and Accidents

Source: Phillips, (2010).

3.2 Communication Element

To start with, the process of communication is a complex process and one of the key elements in safety culture, it is well known that most of ship owners tend to have different nationalities onboard, using different languages and cultures, which lead to marine accidents and damage the marine environment. The failure of the communication process or the difference in communication language harms the marine system, as it interferes with the work environment onboard, as understanding among the crew becomes difficult, which leads to written errors due to not understanding the orders and the inability of applying the application of safety on the ship, especially in the process of loading and discharging the ship and also during sailing or berthing in ports (Pyne& Koester, 2005). An example of maritime accidents resulting from the failure of the communication process is the vessel “Costa Concordia”, in which the helms man did not understand the captain's orders in changing the ship course due to difference in nationality and difference in the English language accent.

Statistics shows that the communication process is one of the basic problems, which affect safety culture, as it is one of the main causes of marine accidents that results in injuries and deaths as shown in figure (4).

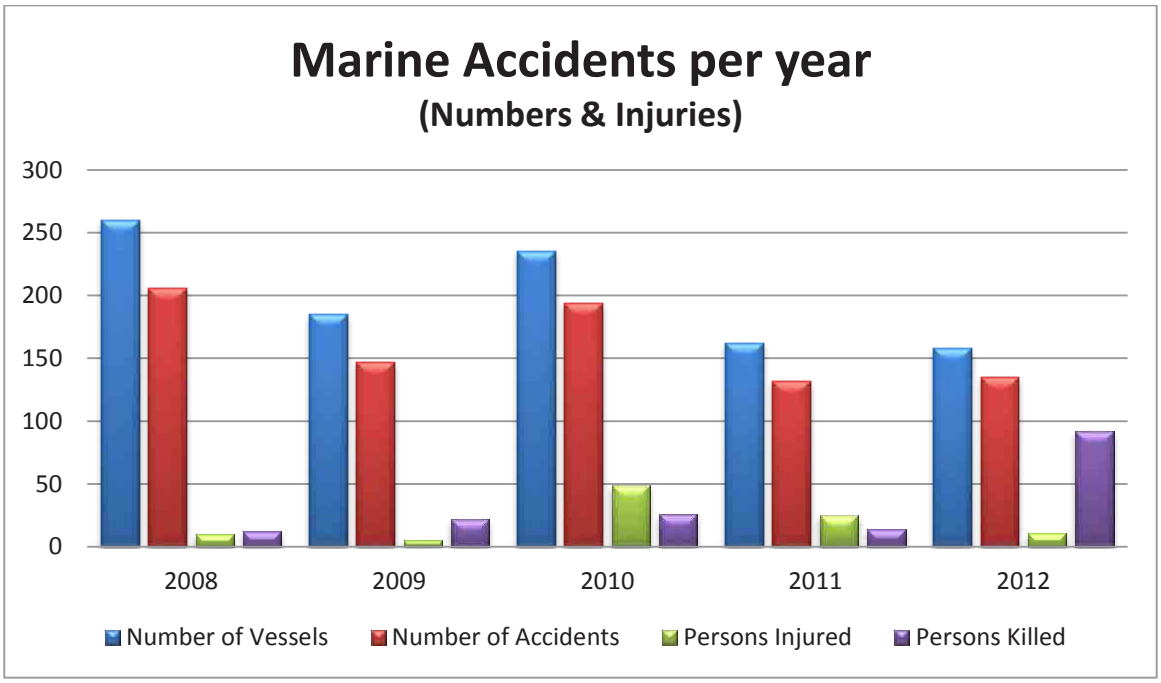

Figure 4. Marine Accidents from 2008 to 2012

Source: Ceyhun, (2014).

In many countries, marine accident data is recorded in the database of the maritime administration, this statistics is officiated by Turkish Ministry of Transport, Maritime Affairs and Communications. According to Ministry's reports, figure (4) shows a number of vessels involved in maritime accidents and incidents, persons killed and persons injured in the years from 2008 to 2012. These statistics include both Turkish flagged and foreign flagged vessels, 206 accidents occurred in Turkish Seas in 2008,147 in 2009, 194 in 2010, 132 in 2011 and 135 in 2012, so the figure shows that accidents are still happing, but in 2012 the number of persons killed due marine accident increased, which indicates the absence of understanding of the concept of safety culture *(Ceyhun,2014)*. Therefore, the administration should conduct personal interviews and make sure that the new members know the meaning of safety culture and understand the communication process among the crew onboard before assigning those members to the ship. Those working onboard should attend safety meetings so that they can communicate together, reduce falling in incidents, and protect the marine environment from pollution.

4. The Process of Measuring and Investigating Safety Culture

An organization that decides to improve and measure its safety culture should follow a systematic, closed-loop process, which is presented in the following figure (5).

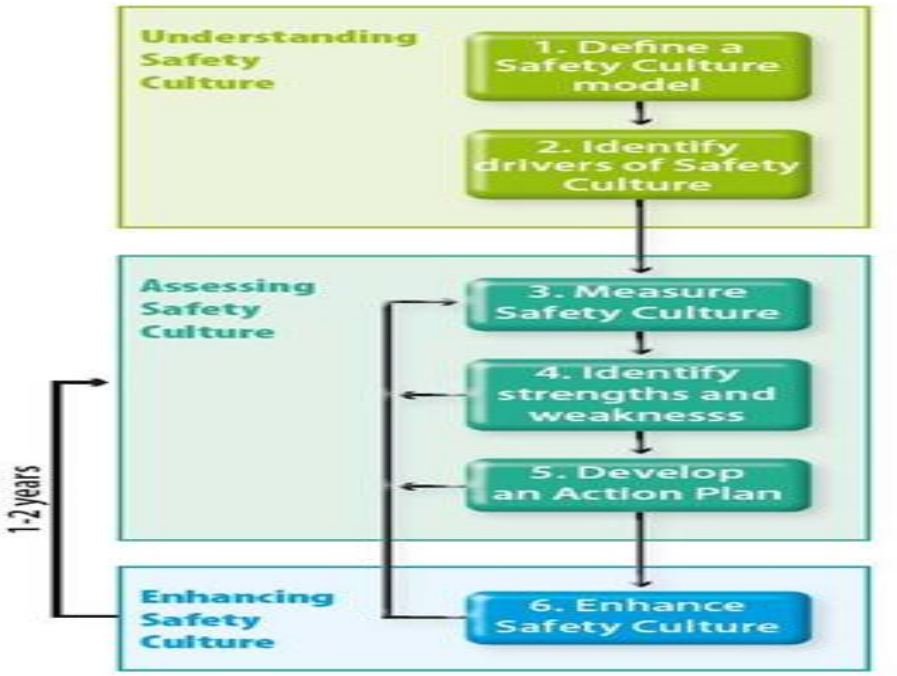

Figure 5. Measuring Safety Culture Process

Source: Berg, (2013).

The first phase consists of defining safety culture and understanding the meaning of safety culture in the management perspective of the organization. This requires identifying the characteristics of safety culture to look at, and their sub-components, these first two steps are important to measure safety culture effectively. The next phase of the process is the assessment stage, where the organization carries out a survey to measure its own safety culture, Surveys and other techniques contribute to the identification of strengths and weaknesses of safety culture. Based on this assessment, an action plan is developed, in which these actions help to improve safety culture, and then after a reasonable period, safety culture can be assessed again to determine if the organization situation has improved.

In addition, investigating safety culture depends on the human factor, which is the basis of the investigating process. The initial idea in the investigation of the human factor was SHEL model, which depends on the investigation of the human factor and in terms of the maritime system. The basic principle of the SHEL model is dividing the whole ship system into four elements: Software, Hardware, Environment, and Livewire. First, the Software presents the regulations, manuals, procedures and some other irrelevant things related to

maritime transport system; Hardware means the physical materials such as equipment, tools and the ship hull; Environment includes the internal and external climate, temperature, vibration, noise and other factors which constitute the conditions under which people are working; and finally Liveware which is the people working onboard *(Zeng & Gao, 2010)*. The most essential element of the SHEL Model is the Liveware, which is the subject of accident investigation, since that element interacts with all the other elements in the system. According to the SHEL model, the unsmooth interaction between these people and the other elements is the cause of the marine accidents.

5. Relation between the Elements of SHEL Model

To begin with, the relation between the Liveware and the Hardware. this relation show the search and scrutiny between the treatment of human and physical objects, which is called man-machine and here the investigation process shows the human handling with the existing devices and equipment*(Hawkins, 1987).*Secondly, the relation between the Liveware and Software , which is the search and scrutiny between the treatment of humans and intangible things, and here in the investigation, internal information should be looked at in the devices and the introduction of information and whether it is true or not. Knowledge-based mistakes which refers to those faults resulting from ignorance, inadequate knowledge or the misunderstanding of some critical principles. The related personnel do not know how to respond to and handle some situations, therefore they make mistakes. These kinds of mistakes seldom happen to highly educated officers and engineers. However, for sailors and motorman, if these mistakes are not duly corrected, accidents may take place. Skill-based mistakes often occur due to insufficient working experience, such as inefficient drilling, inadequate practice and lack of experience exchange with other colleagues. Rule-based mistakes are the consequence of incorrectly using the rules, or the self-righteous application of a simplified rule (*Reinhont, 1996*).

Thirdly, the relation between the Liveware and Environment can be shown in the ship system, the environment includes the external environment, such as the natural condition, fairway condition and the internal work environment, such as temperature and ship's movement. Different from other interactions, in most cases people can do nothing but adapt themselves to the environment around them. The internal work environment directly affects one's ability to perform. For example, the human body performs best within a restricted temperature range. Performance will be degraded at temperature outside that range, and fail altogether in extreme temperature for example in the boiler room *(Zeng & Gao, 2010*). Finally,

the relation between the Liveware and Liveware can be clear in the way of communication barrier, which means any disturbing, blocking, or break down of communication, which could be physical or man-made. The physical barrier onboard ship includes noise, distance and vibration; while the man-made barrier includes different languages, accents, speed and pronunciation which results in misunderstandings.The ship is a mini society, seafarers come from different parts of the world and different countries on open-registered ships. They have different cultural backgrounds, habits, personalities and moral levels. However, they have to work together for several consecutive months. It is normal for them to have different opinions. If these conflicts accumulate gradually and without an effective abreaction, they will erupt and seriously destroy the harmony of teamwork, which may result in accidents (*Kebabjian, 2005*).

However, given the method of investigation, the element of safety culture has not been addressed in the investigation process, and the importance of this marine element and its impact, which leads to marine accidents. The SHEL theory has changed into a new model in which safety culture has been developed and transformed into SCHEL. Therefore, safety culture has been developed to force the investigator to investigate this element mentioned before, so in this context, during the investigation of marine accidents, the investigator must begin to investigate the element of the safety culture, and how people treat and understand each other, whether in communicating with each other, or during training and safety drills, or while facing emergency situations or dealing with the vessel equipment and confirming how to use safety technology in the real sense of ship safety (*Eral,2006).* In addition, it has to be clear that the concept of investigating the root cause has differed in that it is necessary to deal with safety culture and its importance to the human element, so the IMO can conduct appropriate maritime safety community and set restricted measures for environmental protection.

6. Conclusion & Recommendation

In general, safety culture has been found to be important across a wide variety of organizations and industries. While initial studies of safety culture took place in jobs that have traditionally been considered high-risk, Moreover, the evidence recommends that safety culture may not be the only determinant of safety in the organizations, but it plays a substantial role in encouraging people to behave safely.The essence of safety culture is the ability and willingness of the organization to understand safety, hazards and means of preventing them, as well as ability and willingness to act safely, prevent hazards from happing and promote safety.

Safety culture also refers to a dynamic and adaptive state; it can be viewed as a multilevel phenomenon of social processes organizational dimensions, and psychological

states of the personnel. The achievement of an effective safety culture is recognised to be a vital element of achieving and maintaining satisfactory levels of safety performance. A Systematic Safety Culture Enhancement Process is a managerial tool allowing organizations to identify areas where safety culture may be enhanced. The enhancement process moves onto measuring and evaluating safety culture. There are many available tools for measuring and evaluating safety culture. The selection of the appropriate measurement tools begins with the model and takes many factors into effect including but not limited to cost, time, confidentiality requirements, ease of data analysis and usefulness of output for planning of enhancement actions. It is important to recognize that the Systematic Safety Culture Enhancement Process is a closed loop system. Following implementation of enhancement actions, an organization must begin again by measuring safety culture to determine the impact of those actions.

The Safety Culture can be improved on board the vessels by training the crew, because training is one of the vital processes on which safety culture depends on, as well as the staff and management level to be aware of safety culture. Also, the IMO in its MARPOL, and SOLAS Treaties called upon safety culture to reduce the risk of loss of life and to protect the marine environment. Training depends on three axes: Conducting the necessary training when a new treaty is signed by both ILO & IMO, training on modern techniques whether on communications onboard or in land as well as modern techniques in all equipment on board, and training the ship crew to increase knowledge and transfer experiences among members of the same system. Therefore, the training process helps in raising the safety level on board ships or in a more precise sense of safety culture, which raise the efficiency of staff and personnel in the process of maritime safety and environmental protection in all situations that people are exposed to in dangerous situations such as marine accidents and pollution of the marine environment.

References

1. Berg, H.P., (2013). "Human *Factors and Safety Culture in Maritime Safety*", the International Journal on Marine Navigation and Safety of Sea Transportation, Volume 7 Number 3 September 2013.

2. Civil Air Navigation Services Organization, (2013). "*Safety Culture Definition and Enhancement Process*", www.canso.org/cansomembers.

3. Ceyhun, G.C., (2014). "*The Impact of Shipping Accidents on Marine Environment*", European Scientific Journal, August 2014 edition vol.10.

4. Earl, L., (2006).” *Aviation Human Factors Study Guide*”, Massey University, New Zealand.

5. Havold, J., (2005). “*Safety-culture in a Norwegian shipping company”*, Norwegian University of Science and Technology, Trondheim, Norway.

6. Hawkins, F.H., (1987).” *Human factors in flight*, Ashgate, UK.

7. IMO, (2007). “*Education and Training Requirements for Fatigue Prevention, Mitigation and Management”*, Submitted by the Netherlands, STW 37/INF.5, 18 November 2005 Available at: www.imo.org.

8. IMO, (2012). “International *Shipping Facts and Figures Information Resources on Trade, Safety, Security, Environment”,* London, UK.

9. International Chamber of Shipping, (2013).” *Implementing an Effectives Safety Culture*”, IMO Symposium on the Future of Ship Safety.

10. MIT, (2013). “*Report on safety technical investigation about costa Concordia*”, Ministry of Infrastructures and Transports Italy, Retrieved in Apr. 2017 from http://www.safety4sea.com/images/media/pdf/Costa_Concordia_Full_Investigation_Report.pdf.

11. Phillips, R., (2000). “*Sleep, Watch keeping, and Accidents: A content analysis of incident at sea reports*”, Transportation Research Department.

12. Pyne, R. & Koester. T., (2005). “*Methods and Means for Analysis of Crew Communication in the Maritime Domain*”. The Archives of Transport.

13. Reinhart, R.O., (1996). “*Basic Flight Physiology*”, McGraw-Hill, New York, USA.

14. Rusconi, C., (2013). “*Interactive Training, a Methodology for Improving Safety Culture*”, International Experts’ Meeting, on Human and Organizational Factors in Nuclear Safety in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant, May 2013, International Atomic energy Agency, Vienna.

15. Sarabjit B., (2014). “*Safety Culture and the Human Element*”.

16. The Marine Accident Investigation Branch, (2004). “*Fatigue and Safe Manning*”, UK.

17. Zeng, X.,& Gao, Y., (2010). “*The Application of SHEL Model on Ship Safety Management”,*IEEE's Publication Principles, TPII@ieee.org.

18. Zhang, H., Thaden, T. L. v., Sharma, G., & Mitchell, A. A., (2004). “*Safety Culture: A concept in Chaos*”, the 46th Annual Meeting of the Human Factors and Ergonomics Society, Santa Monica.

THE ANALYSIS OF COMMUNICATION PROVISION FOR THE PASSENGER SHIPS SAFETY

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Abstract: The aim of the paper is to analyze the factors, causing the accidents related to the passenger ships operation and to present the ways of their prevention. In order to reach the stated goal, we analyzed the chain of the passenger ships' accidents which significantly influenced upon the establishment and development of safety at sea. The conclusion of the first part contains the latest requirements of the SOLAS, 74 directly related to provision of the passenger ship safety.
The second part of the analysis deals with research of the top mistakes done despite the latest safety requirements. Thus, third part of the paper, we present implementation of the series of trainings for a group of Batumi State Maritime Academy students to provide them with necessary communication skills.

Keywords: communication provision, passenger ship, safety, SOLAS, SMCP

Introduction

The goal of the research is to study the factors, which mainly cause the accidents onboard the passenger ships and to propose the ways of their prevention. Accordingly, the database of our research is presented by analysis of statistical data of the IMO, EMSA, USCG and Cruise Lines International Association resources.
The aim of the paper is to analyze the factors, causing the accidents related to the passenger ships operation and to present the ways of their prevention. In order to achieve the stated goal, in the

first part of the research, we analyzed the chain of the passenger ships' accidents which significantly influenced upon the establishment and development of safety at sea. The conclusion of the first part contains the latest requirements of the SOLAS, 74 directly related to provision of the passenger ship safety.

The second part of the analysis deals with identification of the top mistakes done despite the latest changes and amendments to the SOLAS, directly related to the passenger ship safety.

In the third part of the paper, as the method of prevention of such problems, backed by the results of conducted analysis we decided to implement the series of theoretical and practical trainings for a group of Batumi State Maritime Academy students (who will pass their onboard training on the passenger ships of TallinkGrupp) to provide them with necessary communication skills.

The novelty of the noted training is in involvement of the students (who also participated in research) into the teaching process in capacity of co-instructors of the trainings.

Accordingly, the trainings compiled the application of appropriate IMO SMCP use during the lifeboat drills.

Interrelation between Safety Measures Development and Passenger Ships Accidents

The safety of life at sea is IMO's principal goal. Accordingly, safety of the passenger ship as of the place where considerable amount of people accumulated has been under special interest and care of the IMO. Thus, passenger ships in operation today are subject to a vast array of regulations and standards covering every aspect of ship construction and operation. A number of incidents over the years have led to improvements in safety requirements, including those relating to fire safety measures - such as escape routes and fire protections systems for the large atrium typical of cruise ships - and life-saving appliances and arrangements.

As creation as well as the whole history of the SOLAS is directly related to notorious facts of cruise ships accidents. Accordingly, the first part of our analysis deals with the chain of the passenger ship accidents resulted in the creation and amendments to one of the most important conventions of the International Maritime Organization.

April 15, 1912 - RMS Titanic (1,517 dead) sunk after striking an iceberg carried only 20 lifeboats only sufficient to carry around half of those on board.

Subsequent safety initiatives: The International Convention for the Safety of Life at Sea (SOLAS) was established in 1914. The International Ice Patrol was established to monitor north

Atlantic icebergs. "Radar, as an anti-collision system was envisioned as a desirable tool especially after the successful use of radio communications in the Titanic disaster in 1912."

May 29, 1914 - RMS Empress of Ireland (1,012 dead) struck another vessel and sank.

Subsequent safety initiatives: The disaster led to changes to the design of ships' bows to reduce the amount of damage caused in the event of a collision. Designers began employing "raked" bows, still in use today, which lessen damage below the waterline.

September 8, 1934 – Fire on board SS Morro Castle (137 dead).

Subsequent safety initiatives: The Merchant Marine Act was passed in 1936 and the United States Merchant Marine Academy was established in 1942, both to improve the training of merchant marine officers (http://www.telegraph.co.uk/travel/cruises/articles/Cruise-ship-safety-timeline-of-disasters-and-safety-regulations/).

Series of fires, 1980s and 1990s:

- October 4, 1980 - MS Prisendam - sunk following a fire, without loss of life;
- July 30, 1986 - Emerald Seas - 15 passengers and two crew member injured in a fire;
- April 7, 1990 - SS Scandinavian star - fire on board passenger ferry resulted in 159 deaths;
- November 30, 1994 - Achille Lauro - fire resulted in two deaths;
- July 22, 1995 - Regent Star - fire in two injuries (http://www.telegraph.co.uk/travel/cruises/articles/Cruise-ship-safety-timeline-of-disasters-and-safety-regulations/);

Subsequent safety initiatives: Since 1997, all new cruise ships must have all stairways enclosed in self-contained "fire zones". Smoke detectors and smoke alarms must be fitted in all passenger cabins and all public spaces; there must be low-level lighting to show routes of escape (such as in corridors and stairways); all fire doors throughout the ship should be controllable from the ship’s navigation bridge, and emergency alarms must be audible in all cabins.

March 23, 2006 - A fire on board Star Princess killing one passenger and injuring 13 others.

Subsequent safety initiatives: The ship's owners installed sprinklers to all the ship's balconies and replaced plastic furniture with non-combustible alternatives. SOLAS regulations, introduced in 2010, prohibit the use of combustible materials in new cruise ships.

November 23, 2007 - MS Explorer sank near the South Shetland Islands after striking an iceberg. All 154 people on board were evacuated.

Subsequent safety initiatives: Regulations in 2011 banned ships from carrying heavy fuel oil in the Antarctic to protect the environment in the event of a fuel leak.

July 2010 - Pacific Sun: at least 42 passengers were hurt after it was struck by huge waves. Injuries included cuts and broken bones - many of which were caused by unsecured furniture and gambling machines.

Subsequent safety initiatives: All tables and furniture on the ship was secured to its walls and floors (http://www.telegraph.co.uk/travel/cruises/articles/Cruise-ship-safety-timeline-of-disasters-and-safety-regulations/).

Other incidents:

- August 4, 1991 - MTS Oceanos sank in 1991 off the coast of South Africa.
- August 23, 1992 - Royal Pacific - sank in the Straits of Malacca after colliding with a Taiwanese fishing vessel, resulting in two deaths.
- April 16, 2005 - Norwegian Dawn struck by three 70ft waves, smashing windows and injuring four passengers.
- March 3, 2010 - Louis Majesty - rogue waves killed two passengers on a 12-day Mediterranean cruise (http://www.telegraph.co.uk/travel/cruises/articles/Cruise-ship-safety-timeline-of-disasters-and-safety-regulations/).

Other safety initiatives:

Since 2002, ocean-going cruise ships on international voyages have also had to carry VDRs. Crew members attend frequent emergency drills, lifeboat equipment is regularly tested, and fire-detecting devices, systems and alarms are checked, and simulated fires are set.

In 2010, a package of SOLAS amendments adopted in 2006 entered into force, affecting passenger ships built after 1 July 2010. The amendments were the result of a comprehensive review of above mentioned passenger ships accidents. Increased emphasis is placed on reducing the chances of accidents occurring and on improved survivability, embracing the concept of the ship "as its own best lifeboat" (http://www.telegraph.co.uk/travel/cruises/articles/Cruise-ship-safety-timeline-of-disasters-and-safety-regulations/).

Therefore, under SOLAS 2006 concept the following guiding philosophy is agreed:

The regulatory framework should place more emphasis on the prevention of a casualty;

Future passenger ships should be designed for improved survivability so that, in the event of a casualty, persons can stay safely on board as the ship proceeds to port.

Passenger ships should be crewed, equipped and have arrangements to ensure the safety of persons on board for survival in the area of operation, taking into account climatic conditions and the availability of SAR functions.

Passenger ships should be crewed and equipped to ensure the health-safety, medical care and security of persons on board until more specialized assistance is available.

But despite 100 years of the efforts aimed at provision of safety of life, tragedy of Costa Concordia resulted in loss of 32 lives in 2012. Therefore, from 1 January 2015, passengers must undergo safety drills, including mustering at the lifeboat stations, before the ship departs or immediately on departure.

Passenger muster: The amended regulation III/19 in the International Convention for the Safety of Life at Sea was adopted in 2013 in the wake of the Costa Concordia incident, to ensure that passengers undergo safety drills, including mustering at the lifeboat stations, before the ship departs or immediately on departure.

Enclosed-space entry and rescue drills: An amendment to SOLAS regulation III/19, on emergency training and drills, makes mandatory the carrying out of enclosed-space entry and rescue drills, which will require crew members with enclosed-space entry or rescue responsibilities to participate in an enclosed-space entry and rescue drill at least once every two months.

Analysis of the most often deficiencies happened on board the passenger ships

Having studied the above mentioned cases, and taking into consideration the sinking of the MV Sewol occurred on 16 April, 2014 (297 dead), we directed the second part of our research to detection of the most often deficiencies happened on board the passenger ships despite all noted above.

In order to research the problems related to the passenger ship safety, still happening at sea, we studied the cases of the passenger ship accidents:

- Drills and Crew Training Issues: various deficiencies were issued for problems associated with crew training and drills. The deficiencies included crews' inability to communicate effectively during fire and abandon ship drills. There were also deficiencies written for crews that did not have the required STCW training for Crowd Control Management and Crisis Management.

- Problems with Lifeboats and Rescue Boats;
- Improper Utilization of Categorized Spaces;
- Problems with Fire Detection systems/Smoke Detection;
- Fire Suppression Systems;
- Issues with Pollution Prevention Equipment;
- Emergency Lighting Issues;
- Fuel and oil leaks (United States Coast Guard Top Cruise Ship Deficiencies of 2014).

The analysis shows that the deficiencies related to crews' inability to communicate effectively during different onboard drills may be eradicated at the stage of education and training of the students of maritime specialties.

Maritime Education and Training as the Part of Accident Prevention

That is why we decided to conduct the series of theoretical and practical trainings for a group of BSMA students to provide them with necessary communication skills.

As the basis of the briefing and instruction we used the appropriate IMO SMCP which help the Masters, officers and crew members of passenger vessels and passenger ferries to inform passengers on safety aspects and to manage them in case of an emergency.

We provided the group with communications skills giving possibility to inform the passengers how they should conduct on board.

The novelty of the noted training is in involvement of the students (who also participated in research) into the teaching process in capacity of co-instructors of the trainings.

Figure 1. BSMA student acts as the co-teacher (the series of theoretical and practical trainings for a group of Batumi State Maritime Academy students (who will pass their onboard training on the passenger ships of Tallink Grupp) to provide them with necessary communication skills.)

We also provided them with the speech skills on briefing on prohibited areas, decks, and spaces and warned that safety regulations do not permit passengers to enter the following spaces:

- navigating bridge
- engine room
- manoeuvring areas at the front and back end of the vessel
- cargo rooms and compartments
- all areas and spaces marked "Crew only"
- all closed, sealed or roped off areas, spaces and rooms
- car decks when the vessel is at sea (IMO SMCP: IMO Standard Marine Communication Phrases, 2002, London: IMO).

Then they continued with the passenger care and provided instructions on how to embark and behave in lifeboats / liferafts

Figure 2. BSMA student acts as the co-teacher during the series of practical trainings for a group of Batumi State Maritime Academy students

We warned that the crew member should inform passengers that they should:

- Enter the lifeboat / liferaft only when ordered by an officer / lifeboatman.
- Clear the entrance of the lifeboat / liferaft immediately after entering.
- Not to push each other when entering the lifeboat / liferaft.
- Hold on to ropes or to their seat when lowering / hoisting.
- Keep their lifejackets on.
- Strictly obey all instructions given by the officer / lifeboatman.
- Remember that discipline in the lifeboat / liferaft is of vital importance (IMO SMCP: IMO Standard Marine Communication Phrases, 2002, London: IMO).

Then we continued with the passenger care and used the phrases which help Masters, officers and crew members of passenger vessels and passenger ferries to inform passengers on safety aspects and to manage them in case of an emergency.

We provided instructions on how to embark and behave in lifeboats / liferafts.

We warned that the crew member should inform that passengers that they should:

- Enter the lifeboat / liferaft only when ordered by an officer / lifeboatman.
- Clear the entrance of the lifeboat / liferaft immediately after entering.
- Not to push each other when entering the lifeboat / liferaft.
- Hold on to ropes or to their seat when lowering / hoisting.
- Keep their lifejackets on.
- Know that provisions and drinking water will be distributed by an officer / lifeboatman only.
- Strictly obey all instructions given by the officer / lifeboatman.
- Remember that discipline in the lifeboat / liferaft is of vital importance (IMO SMCP: IMO Standard Marine Communication Phrases, 2002, London: IMO).

Then we delivered communication provision of instruction about the on scene measures and actions in lifeboats/liferafts for the passenger ship crew. Using appropriate SMCP they will be able to:

- Keep a sharp lookout for persons in the water.
- Be informed about the ration of provisions and water.
- Know about the danger related to drinking sea water (IMO SMCP: IMO Standard Marine Communication Phrases, 2002, London: IMO).

We also offered briefing on safety regulations, preventive measures and communications providing familiarization of the passengers with their assembly stations, life-saving equipment and emergency procedures.

Communication provision of:

- preventing and reporting fire
- Person overboard
- Protective measures for children

We also offered communication provision of Evacuation and Boat Drill when allocating / directing to assembly stations and describing how to escape (IMO SMCP: IMO Standard Marine Communication Phrases, 2002, London: IMO).

Conclusion

Using the provided communication skills it becomes possible to explain the passengers that in case of the general emergency alarm is sounded, which consists of seven short blasts and one prolonged blast, all passengers have to go to their assembly station, take their lifejackets and blankets with them, put on warm clothing, long trousers, long sleeved shirts / jackets, strong shoes and head covering. Taking into account the results of the conducted analysis and implemented training we want to pay special attention to the ways of the possible accident prevention: The crew of the passenger ship should be able to use the appropriate part of the IMO SMCP: "Passenger Care". The onboard crew safety drills should be strictly implemented using the appropriate IMO phrases, giving possibility to train the multinational crew members to perform their duties without communication failure.

References:

www.imo.org

SOLAS, 2016, consolidated edition, London: IMO

IMO SMCP: IMO Standard Marine Communication Phrases, 2002, London: IMO

United States Coast Guard Top Cruise Ship Deficiencies of 2014

Cruise ship safety: timeline of disasters and safety regulations (http://www.telegraph.co.uk/travel/cruises/articles/Cruise-ship-safety-timeline-of-disasters-and-safety-regulations/);

Marine Accident Investigation Branch - GOV.UK: https://www.gov.uk/government/organisations/marineaccidentinvestigation-branch

European Maritime Safety Agency: http://www.emsa.europa.eu/implementation-tasks/accidentinvestigation.html

Cruise Lines International Association: https://www.cruising.org/

RISK ASSESSMENT, AS AN INTERDISCIPLINARY SUBJECT

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Abstract

Accidents at sea have been continuously occurring despite the development in the performance of navigational equipment. One of the techniques to reduce their impact is risk assessment followed by risk management. Risk assessment, introduced by ISM Code, MLC 2006 and also by Manila amendments to STCW Convention and ISPS Code encouraged AMSU-MIS to develop the new interdisciplinary course for prospective deck officers under the title "Risk assessment in shipping industry". Inclusion by IMO the risk topics into STCW 78 Convention and Code can be considered as a very wise step to raise the quality of Maritime Education and Training (MET) and to maintain the due level of safety, security and protection of environment.

Risk assessment, as preliminary procedure for decision making and as an interdisciplinary subject plays the great role not only for encouraging of more deep learning of all professional competencies, but also plays role of an efficient motivator for seafarer to be competent on board the ship, otherwise the non adequate and non professional assessment of risk in shipping operations followed by improper decision might produce the harm instead of benefit. In frames of this course students learn the fundamentals of risk assessment and management. Some items of the course devoted to a very important topic as "risk perception". The paper shares some experience of teaching the subject "Risk assessment in shipping industry" and describes some sensitive topics and difficulties faced while the delivering the subject. The paper also proposes to expand Risk Matrix into Human Element area by applying Heinrich's Law approach.

Keywords: risk assessment, Heinrich's Law, human element.

Introduction

Risk assessment as a basis for decision-making in shipping industry is regulated both the ISM Code and by other international instruments such as STCW 78 Convention, ISPS Code, Polar Code and the IGF Code, MLC 2006 and by number of other instruments.

There are many definitions of the term "risk" and also the variety of methods to assess it, but in shipping industry seafarers mainly use methods based on approaches of technical sciences, which are described in IMO documents (MSC-MEPC.2/Circ.12/Rev.1 2015, p.4).

If to say about "risk assessment" as an educational subject, it is quite obvious that it is interdisciplinary one. Moreover, by the opinion of the author, it can be considered as motivaiting subject for mastering the entire set of competences regulated by the STCW 78 Convention in order the prospective officer can be issued the first Certificate of Competency (CoC). It is impossible to make statements about safety, environmental protection or security at sea, not knowing how properly assess the risk in ship operations. It is also hardly possible to make effective decisions on this basis, without mastering the competencies to the full.

Risk assessment and STCW 78 competencies

Fig.1 presents the numbers of tables consisting the specifications of minimum standards of competences for officers under the STCW 78 Code, where the provisions for risk assessment as components of various competencies (white circles) are included.

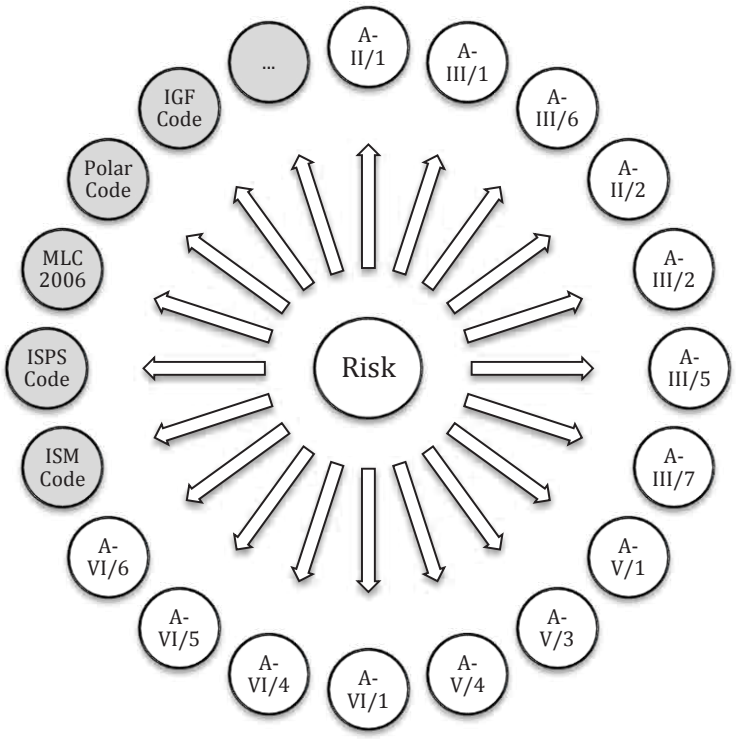

Figure 1. Some international standards regulating risk assessment in shipping industry

Other instruments, regulating the risk assessment in shipping industry are also shown on the Fig.1.

The IMO defines risk as: The combination of the *frequency* (*F*) and the *severity* (*S*) of the consequence (MSC-MEPC.2/Circ.12/Rev.1 2015, p.4). Simple formula to assess risk is as follows:

$$R = FS \quad (1)$$

Where, *F- frequency* is defined as the number of occurrences per unit time (e.g. per year). In a lot of documents the terms *probability* and *likelihood* are used instead the term *frequency*. For practical tasks these terms are interchangeable; *S* is defined as the outcome of an accident or severity of consequences from accidents.

Initial ranking of accident scenarios

For the initial ranking of accident scenarios the risk elements *F* and *S* are presented in tables 1,2 and 3 below (MSC-MEPC.2/Circ.12/Rev.1 2015, p.40).The risk assessment matrix is based on the artificial indices *RI*, *FI* and *SI* replacing the real values of *R, F* and *S*, which allows to apply more simple approach for risk assessment procedures in practice by using integer positive numbers instead of using decimal fractions. For this, a logarithmic scale is used and formula (1) is transformed in the form (2), where *A*, *B* and *C* are positive integers, assuming that $A = B + C$:

$$log\ (R) + A = log\ (F) + B + log\ (S) + C \quad (2)$$

The document introduces the following definitions:

$RI = log\ (R) + A$ is the risk index, ($A = 9$); $FI = log\ (F) + B$ is the frequency index, ($B = 6$);

$SI = log\ (S) + C$ is the severity index of the consequences, ($C = 3$).

As a result, *R* is estimated through the corresponding indices as follows:

$$RI = FI + SI \quad (3)$$

Frequency index *FI* varies from 1 to 7, see Table 1.

Table 1. Frequency and Frequency index

Frequency index			
FI	FREQUENCY	DEFINITION	*F* (per ship year)
7	Frequent	Likely to occur once per month on one ship	10^{1}
5	Reasonably probable	Likely to occur once per year in a fleet of 10 ships, i.e. likely to occur a few times during the ship's life	10^{-1}
3	Remote	Likely to occur once per year in a fleet of 1,000 ships, i.e. likely to occur in the total life of several similar ships	10^{-3}
1	Extremely remote	Likely to occur once in the lifetime (20 years) of a world fleet of 5,000 ships.	10^{-5}

Severity index *SI* varies from 1 to 7, see Table 2.

Table 2. Severity and Severity index

Severity index				
SI	SEVERITY	EFFECTS ON HUMAN SAFETY	EFFECTS ON SHIP	*S* (Equivalent fatalities)
1	Minor	Single or minor injuries	Local equipment damage	10^{-2}
2	Significant	Multiple or severe injuries	Non-severe ship damage	10^{-1}
3	Severe	Single fatality or multiple severe injuries	Severe damage	10^{0}
4	Catastrophic	Multiple fatalities	Total loss	10^{1}

Risk index *RI* varies from 2 to 11, see Table 3.

Tables 1 and 2 form Risk matrix.

Table 3. Risk matrix

Risk Index (*RI*)						
Frequency of incidents (F) and Frequency Index (FI)			Severity (*S*) and Severity Index (*SI*) in equivalent of fatalities			
FI	*F* (per ship year)	*SI*	1	2	3	4
		S	10^{-2} Minor	10^{-1} Significant	10^{0} Severe	10^{1} Catastrophic
7	10 (Frequent)		8	9	10	11
6	10^{0}		7	8	9	10
5	10^{-1} (Reasonably probable)		6	7	8	9
4	10^{-2}		5	6	7	8
3	10^{-3} (Remote)		4	5	6	7
2	10^{-4}		3	4	5	6
1	10^{-5} (Extremely remote)		2	3	4	5

The following criteria are broadly used in other industries and have been also published in the same circular: *RI*=3 or $R=10^{-6}$, it is negligible fatality risk to crew member per year; *RI*=6 or $R=10^{-3}$, it is maximum tolerable fatality risk to crew member per year; *RI*-from 4 to 6 is ALARP zone (As low as reasonably practicable).

A straightforward approach was introduced in circular, suggesting an equivalence ratio between fatalities, major injuries and minor injuries:

- one (1) fatality equals ten (10) severe injuries; and
- one (1) severe injury equals ten (10) minor injuries.

Risk assessment up to decimal order accuracy is fully justified for practical tasks by the presence of uncertainties in the estimation of its parameters *F* and *S*. The similar approach is used in most ship forms used for risk assessment.

The following coments are given in paper (IACS 2012, p.8): Risk is not a constant, measurable, concrete entity. Quantitative assessments of risk must be understood as estimates that are made at particular moments and are subject to considerable degrees of uncertainty. They are not precise measurements, and the rarer (and usually more catastrophic) the event, the less reliable the historical data and the estimates based on them will be.

The tables 1,2,3 are not mandatory. The risk matrix may be expanded to include more rows and columns, depending on how finely the company wishes to distinguish the categories. The terms used for *likelihood* (frequency, probability) and *consequence* may be changed to assist understanding. For example, *likelihood* may be expressed in terms of “once per trip”, “once per ship year” or “once per fleet year”, and consequence may be made more specific by the use of “first aid injury”, “serious injury” or “death”, not forgetting the consequences for property and the environment (IACS 2012, p.5).

One of the cornerstones in the ideology of on-board Safety Management Systems (SMS), regulated by the ISM Code, is the fundamental principle of feedback, without which no control mechanism can be built. Within the frames of risk assessment field this mechanism works on the basis of Heinrich's law, and its application is regulated by the 9th section of ISM Code. In accordance with ISM Code paragraph 9.1 «The safety management system should include procedures ensuring that non- conformities, accidents and hazardous situations are reported to the Company, investigated and analyzed with the objective of improving safety and pollution prevention».

Human element, Heinrich's Law and risk assessment

Little is known on psychological outcomes for seafarers who experience near miss grounding or near miss collision or other near miss incident.

It is necessary to state the fact that one of the sensitive parameters in the risk assessment prosess is the human element (MSC-MEPC.7/Circ.7, p.1), which it is one of the main causes of accidents and incidents at sea. The level of mental state of the seafarers' work is an important component of the human element, and it is difficult to account for, but a probabilistic approach to its consideration is possible if the information basis is taken by statistics described by Heinrich's law, which reads: the number of accidents is inversely

proportional to the severity of those accidents. It leads to the conclusion that minimizing the number of minor incidents will lead to a decline in major accidents (Skybrary 2016).

Graphical interpretation of the Heinrich's law describes four levels of negative events and is shown below. These levels from I to IV in the interpretation of NYK company (Chepok 2009) as well as by document (MSC-MEPC.2/Circ.12/Rev.1 2015, p.39) are given with accuracy up to a decimal order:

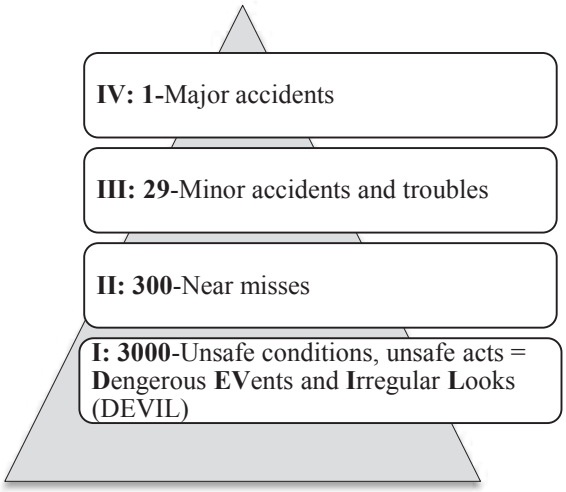

Figure 2. Heinrich's Law levels

Levels I and II do not lead directly to accidents and catastrophes, but they increase the likelihood (frequency) of their occurrence, which can lead to a mental strain of seafarers. If situations at levels I and II occur frequently, it is reasonable to assume that this can cause the increased mental tension and stress, which in turn can raise the level of risk in ship operations with an increase in the frequency F of such kind of events.

Using the approach to compiling the risk matrix described in (MSC-MEPC.2/Circ.12/Rev.1 2015, p.40) and combining it with Heinrich's Law levels I-IV, we can build an expanded risk matrix by linear extrapolation of the parameter S into the levels I and II. It is in principle consistent with the 9th section of the ISM code on near miss reporting procedures.
To do this it is necessary that the indicated constants A, B and C have the following values: $A = 11$, $B = 6$, $C = 5$.

As a result, the risk assessment matrix will look like this:

Table 4. Expanded Risk assessment matrix

Risk Index (*RI*)								
Frequency of incidents (*F*) and Frequency Index (*FI*)		Severity (*S*) and Severity Index (*SI*) in equivalent of fatalities						
FI	*F* (per ship year)	*SI*	1	2	3	4	5	6
		S	10^{-4} Mental tension	10^{-3} Mental stress	10^{-2} Minor	10^{-1} Significant	10^{0} Severe	10^{1} Catastrophic
7	10^{1} (Frequent)		8	9	10	11	12	13
6	10^{0}		7	8	9	10	11	12
5	10^{-1} (Reasonably probable)		6	7	8	9	10	11
4	10^{-2}		5	6	7	8	9	10
3	10^{-3} (Remote)		4	5	6	7	8	9
2	10^{-4}		3	4	5	6	7	8
1	10^{-5} (Extremely remote)		2	3	4	5	6	7
Heinrich's Law levels			I: Unsafe conditions, Unsafe acts = DEVIL	II: Near misses	III: Minor accidents or troubles	IV: Major accidents		

Where *RI*=5 or $R=10^{-6}$, it is negligible fatality risk to crew member per year; *RI*=8 or $R=10^{-3}$, it is maximum tolerable fatality risk to crew member per year; *RI*- from 6 to 8 is ALARP zone.

In this way, the levels of Heinrich's law are harmonized with the IMO document MSC-MEPC.2/Circ.12/Rev.1. Two sets of events, described by the Heinrich law, are incorporated into the risk matrix, which makes possible to assess the risk, taking into account the occurrence of "near miss and DEVIL" situations, see Fig.2.

Difficulties in perception and understanding of risk by students

The main difficulties in understanding and perception of risk, as a certain value describing the level of safety of a particular ship operation, are associated with a lack of knowledge and experience to perform these ship operations, as well as with uncertainty of the information used to assess the risk. These uncertainties exist in the both risk components *F* and *S* due to the application of the probabilistic approach to assess them.

Uncertainity in risk assessment indicates that the event is not determined in advance, that is, it may occur, or it may not happen, but the uncertainity will reduce when our knowledge level

increases. Thus, the presence of uncertainties is an additional motivating factor for studying those areas (competences) in which risk is assessed.

The identification of hazards is the first and most important step since all that follows depends on it. It must be complete and accurate, and should be based, as far as possible, on observation of the activity. But hazard identification is not as easy as it may first appear. Completeness and accuracy can be achieved only if the process is systematic. Those charged with the task must have sufficient training and guidance to ensure that it is conducted in a thorough and consistent manner (IACS 2012, p.4).

The identification of hazards and scenarios for avoiding of their realizations is the main step in assessing and managing risk. It makes clear why risk assessment is an important interdisciplinary subject in all STCW 78 training programs for seafarers. The catch phrase "Safety first" is the unuversal slogan supporting the further need to study the process of risk assessment and conduct research in this area.

Conclusion

(1) Practically all the competences regulated by the STCW Code 78 include, to some extend, the skill of a prospecrive officer to assess and manage risk. Based on the experience of teaching the subject "Risk assessment in shipping industry" it becomes obvious that the subject has an interdisciplinary nature and is an important motivating factor for a deeper understanding and study of all the competencies required for issuing the first CoC under the STCW Convention 78. In turn, this also gives ground for enriching MET programs by including risk assessment and management into them.

(2) The paper proposes also to include levels from Heinrich's law into risk assessment matrix for expanding the risk matrix into the human element area, which is in principle consistent with the provisions of the 9th section of the ISM Code and can be a basis for risk assessment in view of hazardous situations and near miss incidents.

References

MSC-MEPC.2/Circ.12/Rev.1 Revised guidelines for FSA for use in the IMO rule-making process, 18 June 2015, 70 p., available from:
https://www.google.ru/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjB9PyOvbbVAhUCJJoKHWuZAbEQFggmMAA&url=http%3A%2F%2Fwww.msa.lt%2Flt%2Fpapildomas-meniu%2Ftjo-dokumentai%2Fjuru-saugumo-komiteto-4151%2Fmsc.2-msc.3-msc.5-aplinkrasciai%2Fmsc-aplinkrasciai%2F2075%2Fdownload%2F5459.html&usg=AFQjCNE4dnEbH1Fe5XDSfMPJFoRBAOuEJQ

IACS Recommendation No.127 “A Guide to Risk Assessment in Ship Operations”, June, 2012, 8p., available from:
https://www.google.ru/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjqieSLyLfVAhUDJFAKHYRVCp8QFggmMAA&url=http%3A%2F%2Fwww.iacs.org.uk%2Fmedia%2F2655%2Frec_127_pdf1842.pdf&usg=AFQjCNH7OsDwacH77AOl8bZOUhIjJsQLxQ

MSC-MEPC.7/Circ.7 Guidance for near–miss reporting, 10 October 2008, 6p., available from:
https://www.google.ru/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwih5IeVybfVAhVPblAKHYbhCzYQFgguMAE&url=https%3A%2F%2Fwww.register-iri.com%2Fforms%2Fupload%2FMSC-MEPC.7-Circ.7.pdf&usg=AFQjCNE9jv89EepzQRVVZbAPN39SFfDQTw

SKYBRARY ,2016, *Heinrich Pyramid*
Available from: https://www.skybrary.aero/index.php/Heinrich_Pyramid

CHEPOK, A., 2009. *Heinrich Law to floor the DEVIL*, available from:
http://alexeychepok.blogspot.ru/2009/12/heinrich-law-to-floor-devil.html

IMPACT OF OIL SPILL IN THE MARINE ENVIRONMENT

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Abstract Petroleum contamination is a growing environmental concern that harms both terrestrial and aquatic ecosystems. However, the public and regulatory and scientific communities have given more attention to the contamination of marine habitats. This is because marine oil spills can have a serious economic impact on coastal activities, as well as on those who exploit the resources of the sea. Thus, communities that are at risk of oil disasters must anticipate the consequences and prepare for them. The deliberate release of around 6 million barrels of oil during the 1991 Gulf War in the marine environment is the largest oil spill in history. In the Gulf of Mexico, the BP Deepwater Horizon (DWH) oil spill on 20th April, 2010, which lasted over approximately three months, is the second largest in human history. When oil is spilled at sea it initially spreads out and moves on the water surface as a slick. It is a few millimetres thick and moves with the wind and current. At the same time, it undergoes a number of chemical and physical changes. The spreading of marine oil spills is affected by the action of winds, waves, water currents, oil type and temperature. The natural actions, which are always at work in aquatic environment, include weathering, evaporation, oxidation, biodegradation and emulsification. Generally, the effects of oil toxicity depend on a multitude of factors. These include the oil composition and characteristics (physical and chemical). If the levels exceed the threshold concentration, the additive toxic effect of hydrocarbons can lead to mortality. PAHs are the major contributors to toxicity. They have different metabolic pathways that produce metabolites. Inhaling hydrocarbons can cause respiratory tract irritations, as well as narcosis in mammals and birds. This is due to the volatile nature of hydrocarbons. Oil dispersants, which are a common tool used after oil spills, are also toxic and threaten pelagic and benthic organisms, as well as fish. In recent years, written studies have provided a considerable amount of information regarding the impact of oil spills and contamination of the seawater by hydrocarbons. The impact on marine life is impaired by the toxicity and tainting effects resulting from the chemical composition of oil, as well as by the diversity and variability of biological systems and their sensitivity to oil pollution. Marine life may also be affected by clean-up operations or,

indirectly, by the physical damage to the habitats in which plants and animals live. Communities that are threatened by marine oil spills have developed their own plans and policies to counteract the risk of marine oil contamination. These range from permitting or prohibiting increased oil transport volumes, to developing the capacity to respond to and recover from potential oil spill disasters. The multi-million dollar fish industry will be threatened, as well as the desalination of plants that supply most of the Gulf populations freshwater. Furthermore, people with careers in scuba diving will lose their jobs. As a result, the scuba diving tourism sector will also come under threat.

Keywords: Contamination, Crude, Hydrocarbon, Impact, Life, Marine, Oil, Petroleum, Spill, Toxicity, Water and threat

Introduction

Our planet, Earth, has large reserves of oil and gas trapped deep beneath its surface. Occasionally, these reserves develop cracks and some of the oil or gas seep out. However, this is a part of nature and rarely causes any major damage. On the other hand, there are times when the same problem is causes because of human interference and it can cause a great deal of damage to marine ecosystems. In the last thirty odd years, the issue of oil spills and their effects has taken on much importance. This is because when an oil spill occurs, it causes a multitude of problems for the environment and us.

Oil spill can seriously affect the marine environment both as a result of physical smothering and toxic effects. Oil spill can seriously affect the marine environment both as a result of physical smothering and toxic effects. The severity of impact typically depends on the quantity and type of oil spill spilt, the ambient conditions ad the sensitivity organism and their habitats to the oil.

Oil spill can cause a wide range of impacts in the marine environment and are often portrayed by the media as environmental disaster with dire consequences predicted for the survival of marine flora and fauna. In the major incident the short-term environmental impact can be severe, causing serious distress to ecosystems and to the people living near the contaminated coastline, affecting their livelihoods and impairing their quality of life.

The impact of spills have been studied and documented in the scientific and technical literature over several decades. Consequently, the effect of oil pollution is sufficiently well understood to allow for broad indication of the scale and duration of damage for a given

incident. Long-term damages have been recorded in a few instances. However in most cases even after the largest oil spills, the affected habitats and associated marine life can be expected to have broadly recovered within a few seasons.

What is an oil spill and how does it happens?

An oil spill happens when liquid petroleum is released into the environment by vehicle, vessel or pipeline. It happens on a large scale and is mostly seen in water bodies. It happens due to human negligence and is a major form of pollution. The source of the spill is many. Tankers on land can release crude oil. In water bodies, the spill occurs due to drilling rigs, offshore oil platforms and well. Oil spills and their effects can also be experienced with refined petroleum or even waste oil from large-scale industries. What is common in all of them is that the damage caused by them is permanent and takes a long time to clean up.

When you hear oil spill, you probably think about all of the commercials that feature small animals covered in oil, but do you really know what causes the spill.

- People making mistakes or being careless.
- Equipment breaking down.
- Natural disasters such as hurricanes.
- Deliberate acts by terrorists, countries at war, vandals, or illegal dumpers.

When oil is spilled or dumped, it will float on the water. This layer of oil on top of the water is called an oil slick, as the water continues to spread the oil will become what is called a sheen which looks like a rainbow. When oil is spilled in the ocean, it is very hard to clean up. Most of Spilled oil the time; oil in the middle of the ocean is cleaned up naturally by waves. However if the oil drifts towards beaches it will cling to the sand and stones and clump together. This could potentially poison the beaches, and render them unusable. This ordinarily only happens when large amounts of oil are spilled into the ocean.

SOURCE OF OIL SPILL

Crude oil and its properties

Crude oil is a complex mixture of organic compounds. These mainly consist of hydrocarbons, in addition to heterocyclic compounds and some heavy metals. The different hydrocarbons that make up crude oil come in a wide range of molecular weights and structure compounds. These compounds include methane gas, high molecular weight tars, asphaltenes, resins, waxes and bitumens. They also include straight and branched chains, single or condensed rings and aromatic rings such as the monocyclic (benzene, toluene, ethylbenzene and xylene). They additionally include polycyclic aromatic hydrocarbons (PAHs) such as naphthalene, anthracene and phenanthrene.

Toxicity of oil

The general effects of oil toxicity depend on a multitude of factors. These include the oil composition and characteristics (physical and chemical), condition exposure routes and regimen, and the bioavailability of the oil. One major effect of oil is narcosis, a reversible anaesthetic effect caused by the oil partitioning into the cell membrane and nervous tissue. This causes dysfunctions of the central nervous system.

The additive toxic effect of hydrocarbons can lead to mortality, if the levels exceed the threshold concentration. When marine animals ingest oil hydrocarbons, they travel to the liver where enzymes activate PAHs to become more toxic and reactive products. The metabolites of polycyclic aromatic hydrocarbons (PAHs) and aliphatic hydrocarbons can be highly toxic and carcinogenic. In particular, PAHs are the major contributors to toxicity, with different metabolic pathways producing metabolites. These have oxidative and carcinogenic properties due to their ability to attack and bind to DNA and proteins. Hydrocarbons have a volatile nature and, therefore, inhalation of them results in respiratory tract irritation and narcosis of mammals and birds.

Oil spills can cause huge amounts of damage to the water and animals that live in the water.

Depending on the circumstances, oil spills can be very harmful to marine birds and mammals and also can harm fish and shellfish. You may have seen dramatic pictures of oiled birds and sea otters that have been affected by oil spills. Oil destroys the insulating ability of fur-bearing mammals, such as sea otters, and the water-repelling abilities of a bird's feathers, thus exposing these creatures to the harsh elements. Many birds and animals also ingest (swallow) oil when they try to clean themselves, which can poison them. Depending on just where and

when a spill happens, from a few up to hundreds or thousands of birds and mammals can be killed or injured.

Effects of oil spill

Environmental Effects: First of these is the environmental effect. The animal life that lives in the water or near the shore are the ones most affected by the spill. In most cases, the oil simply chokes the animals to death. Others that live face a number of other problems. The oil works its way into the fur and plumage of the animals. As a result, both birds and mammals find it harder to float in the water or regulate their body temperatures.

Many baby animals and birds starve to death, since their parents cannot detect their natural body scent. Birds that preen themselves to get rid of the oil accidentally swallow the oil and die due to the toxic effects. In many cases, the animals become blind due to repeated exposure to the oil. Dolphins, sea otters, fish, countless species of birds and many oceanic mammals face these consequences. Countering these effects and cleaning the oil can take anywhere between a few weeks to many years, depending on the damage caused.

Effect on Economy: The second major effect of the oil spill is seen on the economy. When precious crude oil or refined petroleum is lost, it affects the amount of petroleum and gas available for use. This means more barrels have to be imported from other countries. Then comes the process of cleaning the oil spill, which requires a lot of financing. Although the company responsible for the oil spills and their effect has to clean it up, there is a lot of government help required at this point.

Effect on Tourism Industry: The local tourism industry suffers a huge setback as most of the tourists stay away from such places. Dead birds, sticky oil and huge tar balls become common sight. Due to this, various activities such as sailing, swimming, rafting, fishing, parachute gliding cannot be performed. Industries that rely on seawater to carry on their day-to-day activities halt their operations till it gets cleaned.

While the long term issues cause by oil spills and their effects is yet to be fully observed, the daily problems are clear. However, most corporations still do not have a solid plan in place for when this emergency may strike.

One must understand that oil spill is not the only threat that marine life is facing. Increasing pollution contamination of industrial chemicals, exploitation of the resources they provide are also some of the serious threats.

Impact of il spill on marine enviroment

Oil destroys the insulating ability of fur-bearing mammals, such as sea otters, and the water repellence of a bird's feathers, thus exposing these creatures to the harsh elements. Without the ability to repel water and insulate from the cold water, birds and mammals will die from hypothermia.

Many birds and animals also ingest oil when they try to clean themselves, which can poison them. Fish and shellfish may not be exposed immediately, but can come into contact with oil if it is mixed into the water column. When exposed to oil, adult fish may experience reduced growth, enlarged livers, changes in heart and respiration rates, fin erosion, and reproduction impairment. Oil also adversely affects eggs and larval survival.

Depending on the circumstances, oil spills can be very harmful to marine birds and mammals and also can harm fish and shellfish. You may have seen dramatic pictures of oiled birds and sea otters that have been affected by oil spills. Oil destroys the insulating ability of fur-bearing mammals, such as sea otters, and the water-repelling abilities of a bird's feathers, thus exposing these creatures to the harsh elements. Many birds and animals also ingest (swallow) oil when they try to clean themselves, which can poison them. Depending on just where and when a spill happens, from a few up to hundreds or thousands of birds and mammals can be killed or injured.

Marine environment

The following sections consider the difference types of damage caused by ship source oil spills in various environments.

- offshore and coastal waters
- plankton
- fish and sea food, seabirds and marine mamals reptiles
- sea grass, corals reef,
- shorelines, rocy and, sandy shore, saltmarshes, mangrooves

Oil spill incidents

One of the biggest oil spills seen in history happened during Gulf war when approximate 240 to 336 million gallons of crude oil flowed into the Persian Gulf. It was considered one of the worst disasters, Oil spill in Mexico. Recent major oil spill happened when an oilrig, Deep-water Horizon sank in the Gulf of Mexico. The spill released somewhere between 172 to 180 million gallons of crude oil into the environment. In the year 2010 alone, six oil spills were seen in the USA. Outside of the United States, oil spills have happened in Canada, Nigeria, France, United Kingdom and in China. Hydrocarbons shot up the well at an uncontrollable rate and ignited, causing a series of explosions on the rig.

Major oil spills in Indian waters

- **T**anker: Trans Huron, 1974 (Laxadives), Sagar Vikas (blow out) year 1982 (Bombay High)
- Tanker: Maersk Navigator year1992 (Andaman Sea), Bombay High (Offshore) year 1993pipe line leakage
- MV SEA TRANSPORTER, 5 June 1994 - ore carrier grounded near Sinquerim, Goa.
- MARITIME WISDOM 23 March, 2005, iron-ore barge 'Prapti'
- MSC Chitra Oil Spill off Mumbai August 7, 2010 (09.48 hrs) - MSC Chitra collided ,with MV Khalijia – III about 10 Km off Mumbai coast ,2662 tonnes fuel oil BW Maple,January 28, 2017 (Chennai)

Clean up and recovery

Clean-up and recovery from an oil spill is difficult and depends upon many factors, including the type of oil spilled, the temperature of the water (affecting evaporation and biodegradation), and the types of shorelines and beaches involved.

When oil spills, there is potential for huge amounts of damage. To prevent this damage, the oil has to be cleaned up. There are many ways to clean up the oil. According to this area they are:

Containment and recovery: Surround the oil with booms and recover the oil (for cleaning and reuse) with skimmers. Skimmers separate oil from the water by:

- **Sorbents:** Remove oil with absorbent sponges made from diaper-like substances. Some sorbents are made from natural materials -- straw, grasses, coconut husks, or wood chips.
- **Dispersants:** These are chemicals that act like detergents to break oil up into tiny droplets to dilute the oil's effect and to provide bite-sized bits for oil-eating bacteria that occur naturally, particularly in areas that have had a history of oil spillage Oil Spill.
- **Burning:** Burning is usually 95-98% efficient, but does cause black smoke. The smoke is not more toxic than if the oil were burned as intended in fuels. One gallon of oil burned this way creates the same pollutants as three logs in a fireplace or woodstove.
- **Bioremediation:** Enhancing natural biodegradation by natural oil-eating bacteria by providing them with needed fertilizers or oxygen. Oil on ocean floor
- **Shoreline clean up:** High-pressure hosing to rinse oil back into water to be skimmed up. This usually does more harm than good by driving the oil deeper into the beach and by killing every living thing on the beach. This was used extensively after the Exxon Valdez spill due to public and state pressure to make the beaches "look clean again," despite the known risks.

Equipment used includes:

- Booms: large floating barriers that round up oil and lift the oil off the water
- Skimmers: skim the oil
- Sorbents: large absorbents that absorb oil
- Chemical and biological agents: helps to break down the oil
- Vacuums: remove oil from beaches and water surface
- Shovels **and other road equipment**: typically used to clean up oil on beaches

Prevention

Offshore oil spill prevention and response

Secondary containment methods to prevent releases of oil or hydrocarbons into environment.

Oil Spill Prevention Containment and Countermeasures (SPCC) program by the United States Environmental Protection Agency.

Double hulling - build double hulls into vessels, which reduces the risk and severity of a spill in case of a collision or grounding. Existing single-hull vessels can also be rebuilt to have a double hull. Thick-hulled railroad transport tanks. Appropriate evacuation zones and procedures, availability of fire suppression equipment. Disposal containers for spill clean up materials and the first aid procedures that might be required.

Conclusion

Marine oil spills can have a serious impact on marine life, as well as on the economic coastal activities and the communities that exploit the resources of the sea. Generally, the effects of oil toxicity depend on a multitude of factors, including the oil composition and characteristics (physical and chemical), condition (i.e., weathered or not), exposure routes and regimen, and bioavailability of the oil. Oil dispersants, which are a common tool used after oil spills, are also toxic and threaten pelagic and benthic organisms, as well as fish. Marine life can also be affected by clean-up operations or indirectly through the physical damage to the habitats in which plants and animals live. Communities that are threatened by marine oil spills have realized the risk and have, therefore, developed their own plans and policy issues to counteract the risk of marine oil contamination. Due to the different anthropogenic activities relating to oil spills, in addition to the natural environmental stresses of the Gulf, a number of socio-economic impacts are predicted.

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REFERENCES

http://www.itopf.com/stats.html (Accessed 19 Dec. 2014). http://www.itopf.com/knowledge-resources/data-statistics/statistics/(Accessed 22 Nov. 2014).

http://www2.epa.gov/emergency-response/alphabetical-list-ncp-product-schedule-products-available-use-during-oil-spill (Accessed 27 Dec. 2014).
http://www.itopf.com/knowledge-resources/data-statistics/statistics/ (Accessed 22 Nov. 2014).
http://www2.epa.gov/emergency-response/alphabetical-list-ncp-product-schedule-products-available-use-during-oil-spill (Accessed 27 Dec. 2014)
http://www.epa.gov/oem/docs/oil/edu/oilspill_book/chap1.pdf (Accessed 27 Dec. 2014).
Www.oilspillcommission.gov.
http://www.joincca.org/media%20room/Gulf/oil_opening102210.htm. (Accessed 4th Jan. 2015)

THE SEEMING CONTRADICTIONS OF THE INTEREST OF THE PORT AUTHORITIES AND INVESTMENT COMPANIES - THE DRIVING FORCE FOR THE DEVELOPMENT OF THE PORT OF GDAŃSK

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Abstract Today the port of Gdansk are experiencing a revival as a major transportation hub located on the southern never iced coast of Baltic sea – in area believed to be one of the easiest developing regions of the European continent. Territory of port of Gdansk very logically assembly with specialized berth and terminals. New investors ask permission for example for opening a new liquid cargo terminal in inner port of Gdansk and contrary is proposition to adopt crude oil pier located in outside port for possibilities of developed passenger terminal for biggest cruisers which draft not allowed to enter inner port.

Another idea to establish car hub in part of port which was specialized in timber and refrigeration cargos. Traditional distribution of port activities due different circumstances have to change. In this situation: maritime administration, port pilots, security officers and others are extremely unhappy and against to the new ideas. From one side some organizations try developed new business and activities, but from other hands important local organization are against due to environmental protection increasing dangerous areas etc. Apart of EU project of corridors (from Croatia to Gdansk and Scandinavia) new government of Poland press to create pararel new corridor which not include Gdansk as a port of discharging. Intention of developing of eastern part of Poland project offer port of Klajpeda as more effective than Gdansk and Gdynia. Certainly Gdansk and Gdynia do not accept competitive solution.

Gdynia Maritime University was asked last year to prepare an expertise concerning mentioned new projects. Using our simulators and theoretical approach was prepared a controversial for some organization opinions and declarations.

Keywords: port authority, GMU, port management, security, maritime administration

1. Characteristic of Port of Gdansk

The largest share in the commodity port structure was general cargo, which served over 14.5 million tons, or 23% more than in 2015. The share of general cargo in Gdansk increased from 30% in 2015 to 39% in 2016, exceeding For the first time in history liquid fuel turnover. This is all due to the increased dynamics of container transshipment at the DCT terminal, which over the past 12 months has reached as high as 1.3 million TEUs and was 19% higher than in 2015.

The second in the Port of Gdansk transhipment statistics, liquid fuels recorded a 13 million tons turnover last year and were 13% less than in 2015. In this loading category, there are interesting changes in the proportion of exports and imports. In 2015, the ratio of imported oil in export to export was 97% to 3%, while in 2016 the ratio was 85% to 15%, mainly due to new investments by PERN (tanks), which restored oil port in the port in export relation.

In the category of bulk cargo, coal handling exceeds 5 million tons (13% increase compared to 2015), which has been unreachable in recent years. Last, the best result in this respect was recorded 12 years ago, when in Gdansk in 2005 nearly 7 million tons of coal was transhipped. Since then, port reloading in this commodity group has been very uneven and has fluctuated between 1 million tons in 2008 and 4.6 million tons in 2013. The key to this trade has also changed. While in the year 2015 the dominating relationship was exports of coal and coke, which accounted for 57% of the group's transhipment structure at the time, in the past year exports were 38%. At present, the Port of Gdansk receives more coal from abroad than it sends it to the world.

Good transshipment results were also obtained in the group referred to as "other bulk cargoes". Over the past 12 months, they have been reloading 3.5 million tonnes, which is 4% more than a year ago. Just like in 2015, almost half of the aggregates were reloading aggregates, which in the past year amounted to 1.66 million tonnes. There were also nearly half a million tons of granular sulfur and less than 200,000 tons of feldspars. The characteristic for last year was a large one, as the over 70 percent increase in soda handling, which in total completed last year 280 thousand tons.

The remaining iron ore category was a very small part of the overall port reloading. In 2016 it was over 200 thousand tons - it was much more than a year earlier (85 thousand tons).

Significant falls at the level of 21% were recorded in the transshipment of cereals. In total, last year, they shipped 1.15 million tonnes (1.6 million tonnes in 2015). The biggest drop in this drop was in the meal, which in 2016 was over 60% less than the year before. Wheat (25%) and corn (up 113%) were significantly better.

In 2016, for the first time in two years, the share of exports in port cargo traffic increased. Both in 2014 and 2015 in Gdansk, the ratio of exports to imports was 39% versus 61%, while in the past year exports accounted for over 41%.

2016 was a successful year for the Port of Gdansk. In January, the expansion of the intermodal container terminal at the Inner Harbor was completed. In the same month of use, a new cooler was built by PAGO - a specialist in the field of comprehensive logistics services for frozen products in Poland.

April saw the opening of the first underwater tunnel under Martwa Vistula in Poland, which merged the left and right bank of the port. The continuation of this investment was the modernization of the railway line no. 226 and the construction of the railway bridge to the Martwa Vistula River, which is the main transport axis for railway traffic in the port.

In July, the CEF Transport Coordination Committee approved a list of transport projects, including three projects submitted by the Port of Gdansk Authority SA for a sum of more than 600 million zlotys, from the CEF. This decision was finally crowned in October when the Port of Gdansk Authority signed a grant agreement.

Picture 1 shows :

1. Project of Oil Company ORLEN of revitalization inner port (Wislane/Szczecinskie Quay). Project No.1 analyzed in chapter 3
2. Project of 1000m concrete quay in Outer Port (North Port). Project No. 2 analyzed in chapter 4
3. Deep Water Container Terminal 2
4. Oil Storage “PERN”
5. The planned situation area for the construction of the Central Port.

Pic. 1 . Port of Gdansk and 5 the most important investment projects

2. Two research projects realized by Gdynia Maritime University

In 2016 Bogumil Laczynski and Adam Weintrit received 2 proposition of different research projects concerning development and changing usage of existing quays in Port of Gdansk.

No. 1

Project No. 1 ordered by the biggest Polish Oil concern ORLEN who is a new owner of part of Inner Port of Gdansk and storage / loading shore infrastructure. “ORLEN” intent to invest in way of modernisation of Wislane / Szczecinskie quay and prepare place for loading / discharging operation of max 20,000 tons specialized product tanker. Researchers should answer few questions : is above possible to achieve ? and how to eliminate any objections of Port of Gdansk users ?

No. 2

Should analyze and show possibilities of adopting North Port pipeline pier to bursings 1000m long new quay with unknown yet occupancy. Gdynia Maritime University researchers should answer only one question : what is an influence of new 1 km long concrete quay for other parts and terminals located in outer port (North Port) ? What are manoeuvring possibilities of entering ships, what are the restrictions of port safety office and finally researchers should propose occupancy in the future.

3. Project No. 1

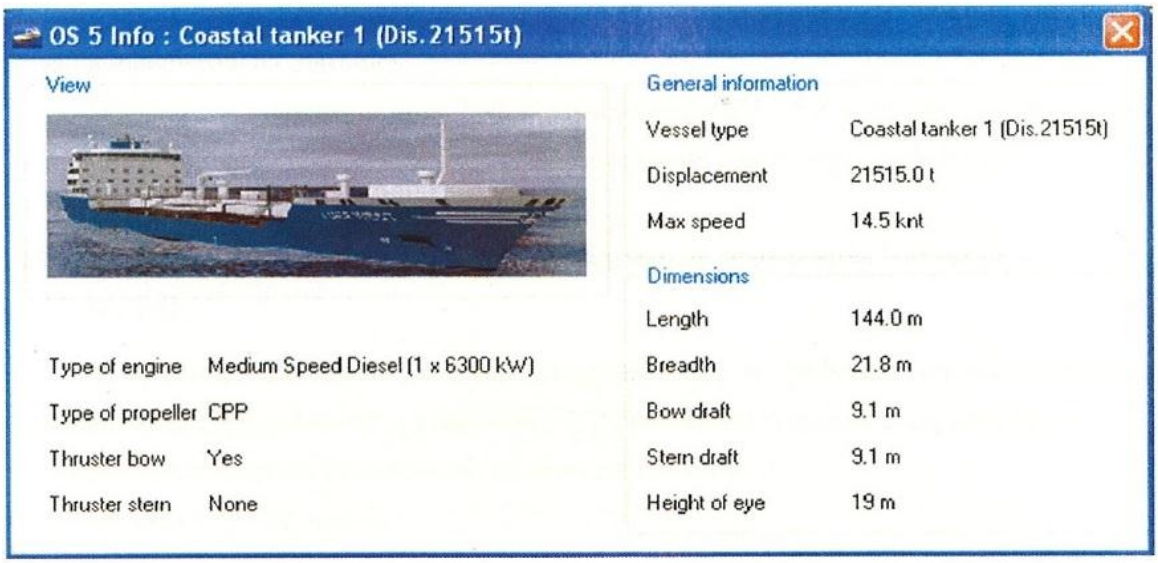
Gdynia Maritime University , apart of Szczecin Maritime University, was asked to prepare an expertise of navigational approach and future functionality modernized Szczecinskie and Wislane quay in Inner Gdansk Port.

Polish Oil Concern, Orlen owned old part of Port (CPN-3) with old tanks and shore equipment and intent to adopt pier to discharging operation of costal tankers up to 20000 DWT (pic.2). Research content optimalization of vessel approaching for berthing, mooring operation and shifting (if any) (pic. 3) safety enter to port condition of berthing, shifting and mooring operation.

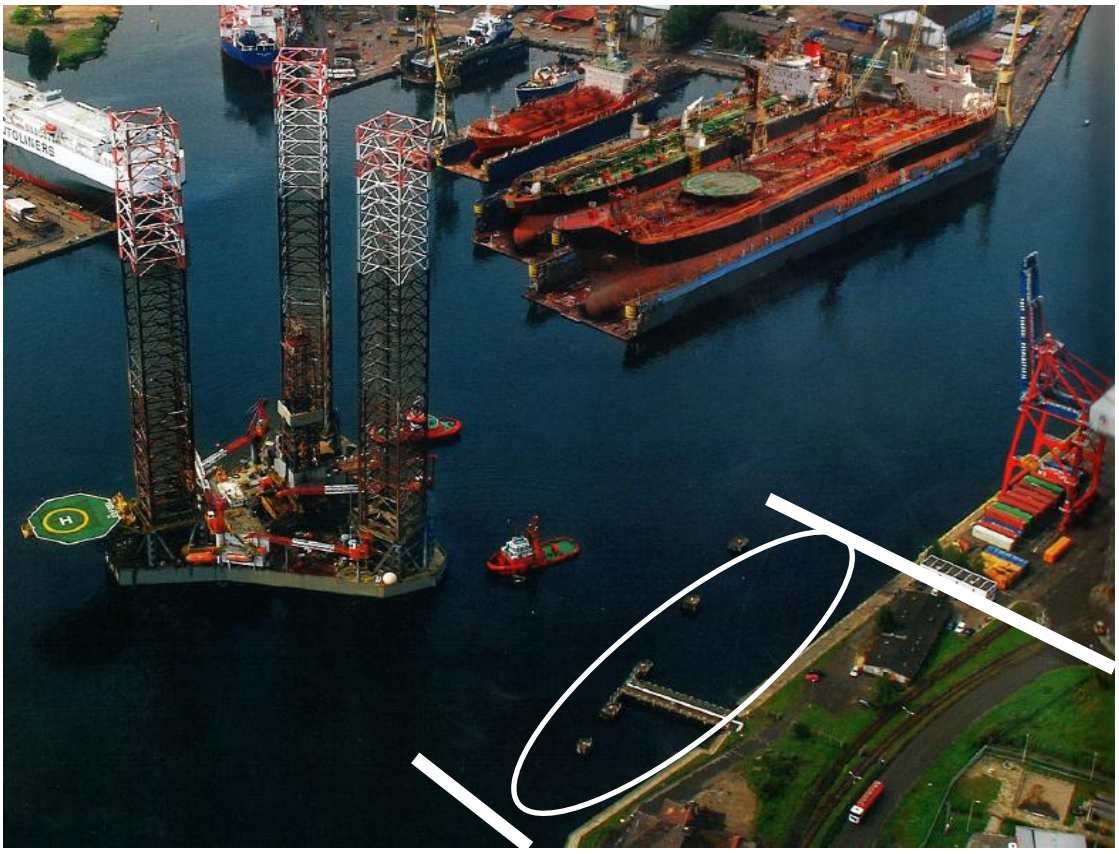
All existing mooring equipment will be eliminated, new turning circle with diameter 330 m replace existing 300 m circle. Conditions for piloting, using tugs and berthing operations were prepared. Optimal distribution of pollard berth equipment were calculated (pic. 4).

Orlen is ready to establish anti pollution system. Experiment on Simulator NaviTrainer 5000

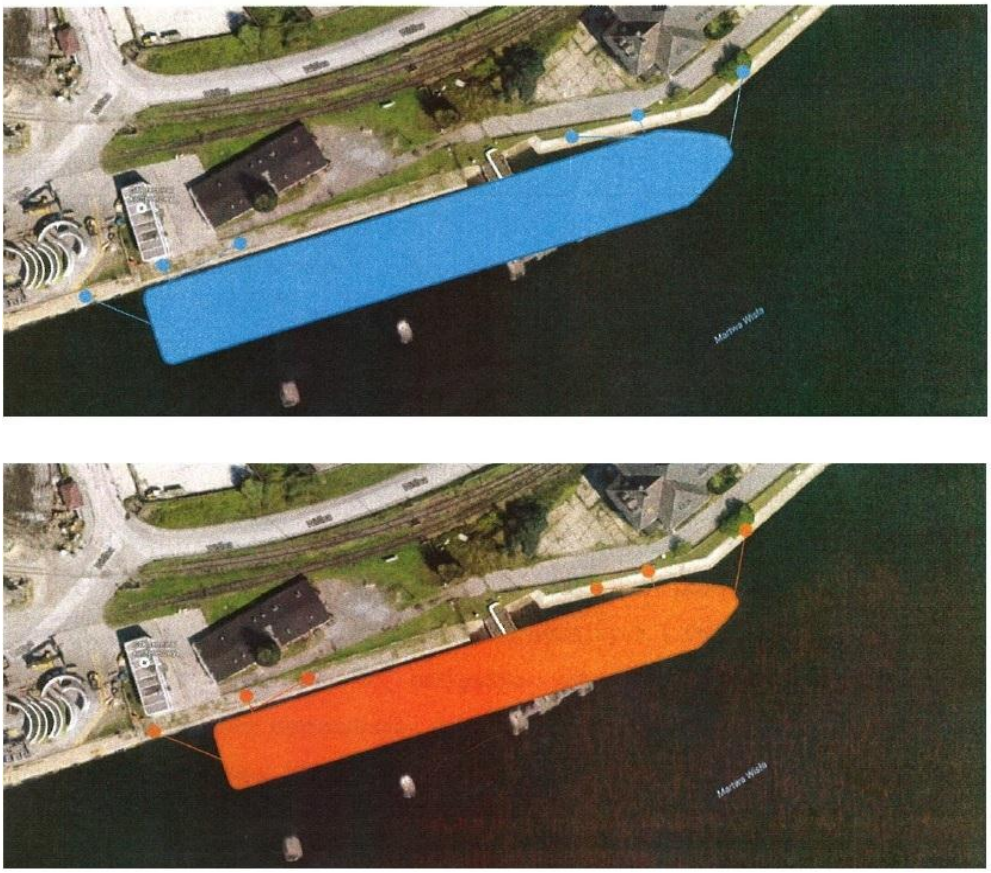
cooperating with Simulator NaviSailor 4000 (Transas) helps to pass 42 passages done by authors of the article (pic. 4). General observation for maneuvering in different conditions (direction of wind, waving) were shown. Certainly pilots and safety officers do not like new ideas and concepts, but after the discussion and giving the guarantee of protection of new quay, trained personnel, monitoring from shore and water side, etc. they became more friendly for proposed ideas.



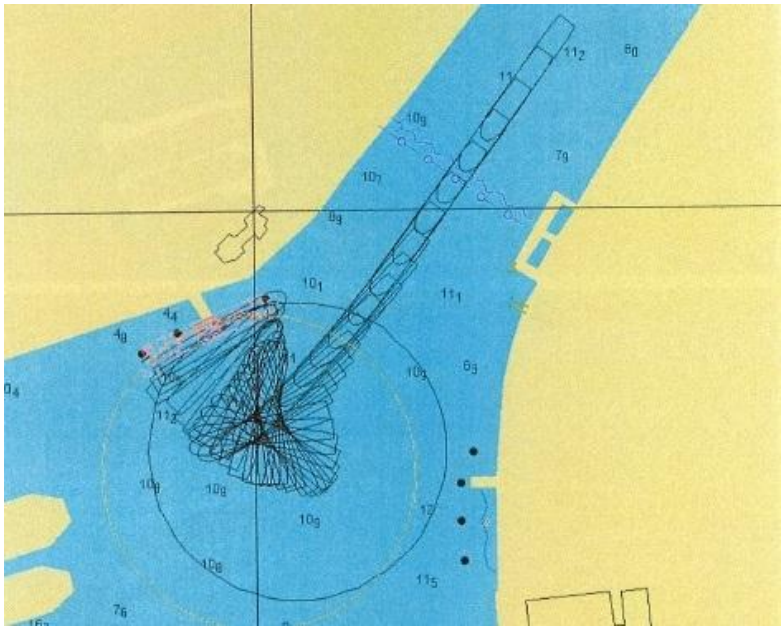
Pic. 2 Typical tanker for Wislane / Szczecinskie pier



Pic. 3 Location of new proposed Wislany/Szczecinski Quay.



Pic. 4 Berthing possitions of 100,000 and 200,000 tons tankers



Pic. 5 Print out of one of 42 passages and approaching new quay

4. Project No. 2

Final decision of authors from Gdynia Maritime University is YES.

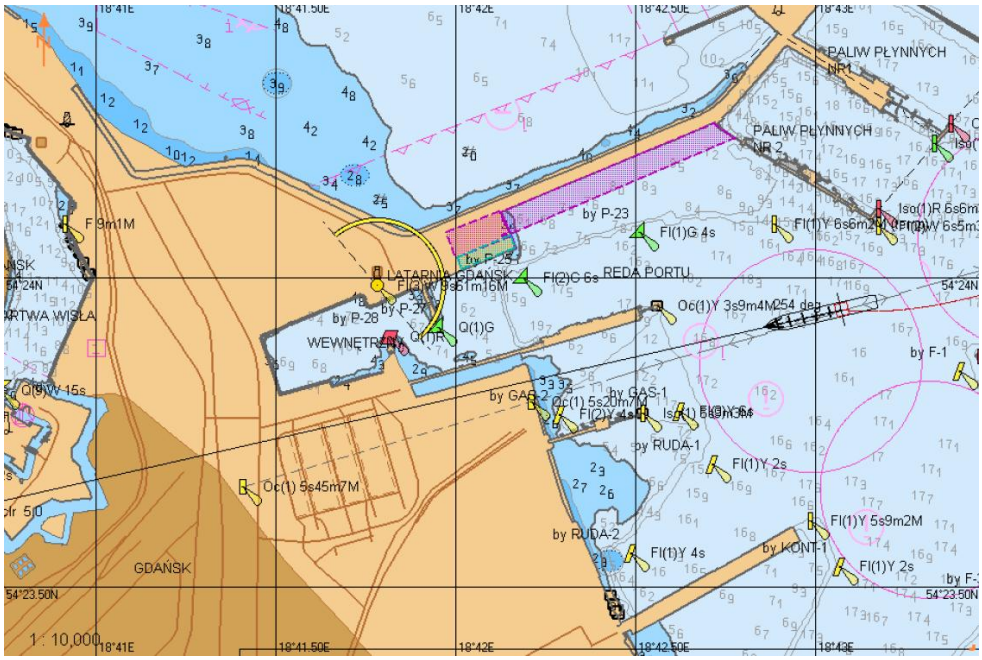
New Northern Berth as a new construction should be accepted by all neighbor companies

acting in North Port. 3 steps of building consist of 108 m + 478 m + 416 m new berth (Pic. 6 and pic. 7). According to local regulations minimal distance from oil pipelines should be 20 m. No any infrastructure on new berth except system of routes / ways will be done. New pier will be dedicated for big passenger vessels. Actually Gdańsk offer places for 240 m long cruisers and with draft up to 8 m. in expertise was analyzed distribution of reflected waves inside port and their influence for other mooring vessels.

NNW wind directions (80% per year) will not complicate mooring operations. Apart of cruisers new place can be offered for layed-up vessels, short period repair position, occasionally for operation Sail Tall ship races, place for Polish offshore vessels and many others. Analyze of cargo operations possibilities and elimination of dangerous situation in such close distance to oil terminal there is a part research. System of security, monitoring and safety guarding should be established.

New system of turning cycles and fairways for the proposed pier were done by Gdynia Maritime University.

Pic. 6 View of new quay location



Pic. 7 Location of proposed new berth.

5. Conclusions

Several discussion with representatives of different port's offices and organizations shown to researchers many unexpected problems and adversities.

Existing formal restriction can be changed and adopted by for example Maritime Administration. Traditionalistic orientation as a part of human character and natural reserve to any fundamental changes is an important indicator to break.

Researchers observed more elastic orientation of Port Authorities after every next meeting and new reconciliations.

In project No. 1 there are limitations of port space, but "ORLEN" decided to cover all expenses that arise in situation of temporary shifting of product tanker along quay (tugs, pilots, etc.) to give a free practice for big objects entering a shipyard (what happens not very often apr. once a month).

Big developing of rail and highway in last years gives a chance to organize loading/discharging operation to/for specialist container and trucks as well as storages into shore based tanks particularly in inner port.

Proper organization, safety restrictions, fully monitoring operation – practically minimalize danger (pollution, collisions, fire, explosions, etc.) Pessimistic oriented experts shown new underwater tunnel, football stadium, etc. as a potential risk.

Traditional antagonistic 2 parties situation:

One side rich company intent to invest in obtained part of port and the other side different

organisation presented potential and fictitious danger.
Experiment done on special prepared simulator fully confirm possibilities of access to analyzed parts of port. In both projects should be issued as practical berthing guide authorized by Maritime Administration Office in Gdynia.

Two projects realized by Gdynia Maritime University are an important part of great port development plan

The Gdańsk port in 10 years is supposed to be much bigger. The strategy predicts construction of deep-water new quays and terminals.

Gdansk harbor has a development plan envisaging gigantic investments. Under the assumptions of the development strategy until 2027 is the construction of the Central Port. It is located between Naftoport and the outlet of the internal port channel. There are deep-sea container terminals, container terminals and transshipment facilities. Also planned is the construction of a new ro-ro terminal in the outer port, in the immediate vicinity of the DCT Gdansk terminal. Faculty of Navigation of Gdynia Maritime University hopes to participate in ambitious development plan of the biggest Polish port, Gdansk.

References:

[1] Laczynski Bogumil, Laczynski Tomasz, "*Recent Developments in International Maritime Education and Training - Enhancing the Productivity, Safety and Energy Efficiency in Maritime Transport* ", IAMU AGA 15, IAMU Proceedings

[2] Laczynski Bogumil, *"The Impact of Shipping Company Environment Industry to Extend Studies at the Faculty of Navigation in Gdynia Maritime University",* 11th INTERNATIONAL CONFERENCE TRANSNAV 2015 ON MARINE NAVIGATION AND SAFETY OF SEA TRANSPORTATION, Gdynia, Poland 2015

[3] Laczynski Bogumil, Laczynski Tomasz, *"Development of specialized terminals in ports of Gdansk and Gdynia in perspective 2020",* 12TH INTERNATIONAL CONFERENCE TRANSNAV 2017 ON MARINE NAVIGATION AND SAFETY OF SEA TRANSPORTATION, Gdynia, Poland 2017

[4] www.Obserwatormorski.pl , *"Ponad 37 mil ton ładunków w Porcie Gdańsk"*, No.1 / 2 (104-105), Szczecin, Feb. 2017

A MODEL TOWARDS DEVELOPING LIFE SKILLS AMONG MARITIME STUDENTS FOR LONGER SERVICE AT SEA

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Abstract This study aimed to determine where maritime cadets are in terms of their life skills and to propose a model designed to develop and strengthen their life skills so they may choose to serve longer at sea. Descriptive design using the survey method was employed in gathering the baseline data for the study. The level of life skills of the students were determined through the use of a researcher-made instrument which was validated by experts in the field. Reliability was obtained using Cronbach's alpha which yielded an alpha coeeficient of 0.88. the survey was administered to a total of 1699 maritime students randomly selected from three Maritime Higher Education Institutions (MHEIs) during the second semester of school year 2016-2017. The statistical tools used were the mean, standard deviation, and multiple regression. Taken as a whole, the data showed that the maritime students have a HIGH level of life skills as shown by the composite mean score of 3.08. Among the four dimensions, the Interpersonal Communication/Human Relations had obtained the highest level of life skills (M = 3.11). This means that students can easily relate with people that they trust in their immediate environment and that they are capable of maintaining a positive social relationship most of the time. On the other hand, Physical Fitness/Health Maintenance obtained the lowest mean (M= 3.06). This implies that even if the overall (M = 3.08) has a high level of life skills, there is still a need to enhance the student's life skills. The value of R^2 is 0.917, which indicates that 91.7% of the variation in life skills can be attributed to the problem-solving/decision making. This means that the ability to make decisions and solve problems plays the most important roles in order to improve the students' life skills. It is the role of the academe to develop and demonstrate the problem-solving and decision making skills among the maritime students.

Keywords*:* Life skills, maritime students, life skills model, sea service, human factors

1. Introduction

Future seafarers need to be equipped with a reservoir of skills that can help them sustain themselves through life---skills that can make them effectively manage challenges and tough times of everyday shipboard life, not just on the personal and academic level but in their preparation for their career life ahead. These life skills also referred to as coping skills, are essential as they prepare to take their place in the industry as responsible officers. According to Mofrad (2013) and Packer (2006), today's generation of future officers needs to develop optimum skills to easily adapt to the realities of seafaring.

Merchant seafaring is a unique occupation that has traditionally been associated with high risks of fatal accidents (Tomaszunas & Weclawik, 1997). Currently, the maritime industry is beset with perennial issues related to crewing. These issues include stress and fatigue, shortage of workforce, heavy workloads, increased demand in standards of training, homesickness anxieties, threats on safety and security, incidents of depression leading to suicidal behavior, work discrimination, and interpersonal conflicts on board such as bullying. While attractive financial rewards remain to be a major motivation for choosing the seafaring profession, a growing number of seafarers opt to take a land-based job after acquiring sufficient funds to support their families. The challenge now is how to mold and retain competent seafarers who are willing to render longer sea service while remaining positive about reaching the peak of their career as Masters and Chief Engineers. According to Caesar, Cahoon, and Fei (2015), prolonging the number of years that seafarers spend at sea and their subsequent retention is, therefore, an important issue that requires further attention.

For the maritime industry to sustain itself in the years to come, it needs to have a stable fallback in terms of human resource by ensuring a steady supply of quality workforce. The industry needs to breed marine officers who do not only possess the technical competence and skills, but also the soft skills to enable them to cope and survive. Such expectations require more professional adequacy, not mentioning substantial preparation in a holistic sense. Yadav and Iqbal (2009) point out that equally important as with the acquisition of cognitive skills is the development of social and emotional coping skills or life skills that help promote the development of well-being and competence in young people as they face the challenges and realities of life. Unfortunately, as observed by Burns, Ruby, Seaman and Brannan (2015), with all the advances in technology and human expectations, the development of non-technical skills or "people skills" such as interpersonal and social skills, communication skills, leadership and teamwork, self-management and other life skills have failed to keep pace and are deemed insufficient.

For maritime students, just like many others who train for other fields of profession, the expectations are immense. With the maritime industry providing for more than 50, 000 vessels worldwide and with an estimated 90% of the goods traded and transported by sea (International Labor Organization), the seafarer's career is characterized by increasing stress. According to Oldenburg & Jensen (2012), a seafarer may be at least comfortable and sure of his position and skills and the expectations of others on board a vessel, but ashore, he may be seen as immature, carefree, and lacking social skills. Hence, putting a high value on the human element, the International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) with its latest major revision in 2010 has strongly emphasized the importance of human factors in developing future seafarers. Behavioral competencies or the development of "soft skills" such as leadership and teamwork has become the latest talk in the maritime industry, putting a value on the importance of workforce and the need to provide future seafarers with life skills that can make them succeed through life.

1.1 Objectives

This paper aimed to determine where maritime cadets are in terms of their life skills and to propose a model designed to develop and strengthen their life skills so they may choose to serve longer at sea. Specifically, it aims to:

a) Determine the level of life skills of first year maritime students in terms of the four dimensions: Interpersonal Communication/Human Relations, Problem-Solving/Decision Making, Physical Fitness/Health Maintenance, and Identity Development/Purpose in Life, and when taken as a whole;
b) Identify which of the four dimensions can best predict the life skills of maritime students
c) Design a model that could develop and strengthen the life skills of seafarers

1.2 Framework

Life skills also called coping skills or strategies, is defined as the individuals' thoughts and actions used to deal with threatening or stressful situations. According to Flannery (2016), it can be positive or negative (Centre for Studies on Human Stress, 2017). Expectedly, future maritime officers are supposed to develop positive life skills or coping skills to survive in their profession.

The concept of this study is anchored on Brooks' (1984) Taxonomy of Developmental Life Skills, which was classified generically by Picklesimer and Miller (1998) into four main categories: (1) interpersonal communication/human relations, (2) problem-solving/decision-making, (3) physical fitness/health maintenance, and (4) identity development/purpose in life.

Interpersonal communication/human relation skills comprise the development of certain psychosocial behaviors such as empathy, confrontation, warmth, genuineness, management of interpersonal intimacy and clarity of expression (Brooks, 1984).

The second category, *problem-solving/decision-making*, according to Fishoff (1980), is the life skill that involves problem identification, goal setting, information seeking, time management and conflict resolution. It is a task of illustrating decision, consequently to provide an answer to any problematic situation that causes perplexity.

Furthermore, the third category as identified by Picklesimer and Miller (1998) is *physical fitness/health maintenance*. One of the developmental tasks of adolescents is developing healthy habits and skills to cope with stress (Hurlock, 1982). According to Brooks (1984), the life of young adults comprises the maintenance of proper nutrition, stress management, coordination, selection of leisure activity inclusive of physiological health and sexuality.

Identity development/purpose in life is the fourth skill, comprising of self-esteem, moral choices, self-monitoring, sex role development and emotional expression. The development of "Persona" according to Jung (2014), a Swiss Psychiatrist, is the social face the individual presents to the world---a kind of mask designed to make a definite impression upon others and to conceal the true nature of the individual. The development of a variable "social persona" is a vital part of adapting to and preparing for adult life in the external social world. A strong ego is related to the outside world through a flexible persona.

From the perspective of Maritime Education and Training (MET), the development of life-skills is emphasized in Table A-VI/1-4 of STCW which mandates among seafarers a competency that can contribute to the effective human relationship. Such mandate promotes the need for seafarers to undergo training and certification to equip them with the ability to maintain good human and working relationship, work in the spirit of teamwork, and deal with conflicts that they could experience on board ship.

The present study is also anchored on Swanson's System Model for Performance Improvement. This model relies on the integration of different items of the environment into a comprehensive frame of reference. In this study, the model is formed by integrating into its dimensions various concepts and constructs that were based on an extensive review of related literature on factors that bear upon the development of life skills among students. The results of the study on life skills of maritime students were also considered as baseline data for the model that is proposed in this paper.

2. Methods

Descriptive design using the survey method was employed in gathering the baseline data for this study. The level of life skills of students were determined through the use of a researcher-made instrument which was validated by experts in the field. Reliability was obtained using Cronbach's alpha which yielded an alpha coefficient of 0.88. The survey was administered to a total of 1699 maritime students randomly selected from three Maritime Higher Education Institutions (MHEIs) during the Second Semester of the school year 2016-2017. The level of life skills of these students was determined based on a four-point Likert Scale and interpreted as Very High (3.51-4.0), High (2.51-3.50), Low (1.51-2.50), and Very Low (1.0-1.50). The statistical tools used were the mean, standard deviation, and regression analysis. Furthermore, the indicators of the description of the levels of life skills are shown below:

Table 1 ***Mean Scale, Description, and Indicators***

Mean Scale	Description	Life Skills			
		Interpersonal Communication/ Human Relations	Problem-Solving/ Decision-Making	Physical Fitness/Health Maintenance	Identity Development/ Purpose in Life
3.51 – 4.0	Very High	Very easily relates with everyone in his immediate environment; Maintains a positive social relationship at all times	Very quick at identifying problems and seeking possible solutions; Very good at setting his goals; Very effective in managing and resolving conflicts that may arise	Very good at coping with stress and maintaining proper health and nutrition for a sound mind and body; Strongly adheres to good health habits	Possesses a very high self-esteem; Very effective in making moral choices and in expressing himself and his individuality to other people
2.51 – 3.50	High	Easily relates with people he trusts in his immediate environment; Maintains a positive social relationship most of the time	Can identify problems and possible solutions with a little help from others; Able to help manage and resolve conflicts	Able to cope with stress; Conscious of maintaining good health habits and practices most of the time	Possesses a high self-esteem; Able to make moral choices and express himself and his individuality to other people
1.51 – 2.50	Low	Has some difficulty in relating with people in his immediate environment; Occasionally isolates himself from others	Is slow at identifying problems and thinking of possible solutions; has difficulty in managing and resolving conflicts	Has a problem coping with stress; Often disregards the importance of maintaining good health habits and practices	Often regards himself as inferior to others; Has difficulty in making moral choices and in expressing himself and his individuality to other people
1.0 – 1.50	Very Low	Does not attempt to socialize with others; Most of the time isolates himself from the group	Lacks the ability to identify existing problems or think of possible solutions; Unable to manage or resolve conflicts	Does not know how to deal and cope with stress; Does not give importance to maintaining good health habits and practices	Has a very low opinion of himself; Cannot express himself and his individuality to others; Withdraws in the background when forced or compelled to work with other people

3. Results

3.1 Life Skills of Maritime Students

The mean scores shown in Table 2 indicate the level of life skills of the maritime students as perceived by the different respondents in terms of four dimensions. As a whole, the data showed that the maritime students have a **HIGH l**evel of life skills as shown by the

composite mean score of 3.08. Among the four dimensions, the Interpersonal Communication/Human Relations had obtained the highest level of life skills (M = 3.11). This means that students can easily relate with people that they trust in their immediate environment and that they are capable of maintaining a positive social relationship most of the time. On the other hand, Physical Fitness/Health Maintenance obtained the lowest mean (M= 3.06). This implies that even if the overall (M = 3.08) has a high level of life skills, there is still a need to enhance the student's life skills.

Table 2 ***Level of life skills of maritime students***

Dimensions	Mean	SD	Description
Interpersonal Communication/Human Relations	3.11	0.50	High
Problem-Solving/Decision Making	3.07	0.50	High
Physical Fitness/Health Maintenance	3.06	0.49	High
Identity Development/Purpose in Life	3.08	0.49	High
Total	3.08	0.47	High

For these data, R is 0.957. The value of R^2 is 0.917, which indicates that 91.7% of the variation in life skills can be attributed to the problem-solving/decision making. This means that the ability to make decisions and solve problems plays the most important roles in order to improve the students' life skills.

It is the role of the academe to develop and demonstrate the problem-solving and decision making skills among the maritime students.

Table 3 ***Predictors of students' life skills***

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.957[a]	.917	.917	.13682

a. Predictors: (Constant), Problem-Solving/Decision Making
b. Dependent Variable: Overall Mean

3.2 The Model: Pillars of Life Skills for Tougher and Longer-Serving Seafarers

Given the results of the first objective as baseline data, this study proposes a model which identifies four strong pillars that need to be established and strengthened to develop the life skills of future seafarers.

3.2.1 Personal Factors

The proposed model begins with the premise that there are personal factors that influence the acquisition of life skills among individuals. Some of these factors are personality, attitude, aptitude, motivation, commitment, and competence.

Personality

Personality is an abstraction that is used to explain consistency and coherence in an individuals' pattern of affects, cognitions, desires, and behaviors. What one feels, thinks, wants, and does changes from moment to moment and from situation to situation but shows a pattern across situations and over time that may be used to recognize, describe, and even to understand a person. Researchers have investigated the relationship of Jung's theory of individuals' preferences and their approach to problem solving and decision-making (Lawrence, 1982, 1984; McCauley, 1987; Myers and McCauley, 1985. One conclusion that maybe drawn from these investigations is that individual differences in problem solving and decision making must be considered to adequately understand the dynamics of these processes (Stice, 1987).

Attitude

Attitude refers to the adaptability and sensitivity of the students towards change in any school organization (Pamplona & Magallanes, 2010). Positive attitude drives total change within an individual or learner's behavior. It is a manner of action towards students' courses that affects attitude (Aguro, et al., 2016).

Aptitude

Aptitude is defined as the domain that influences on individual differences and exceptional talent. It has a relationship with performance and extensive practice. The aptitude leads to human physical performance and strong genetic influences (Vinkhuyzen, van der Sluis, Posthuma, Boomsma, 2008). In the study of aptitude, sex differences were observed across nearly all domains.

Motivation

Motivation refers to the reason that underlies behavior as characterized by willingness and volition. Motivation is considered as an attribute that moves students to do something. It energizes and sustains students' activities towards scientific and educational exploration and challenges that lead to better learning outcomes and results (Lai, 2011).It is a positive influence on the students' academic performance, adjustment, and well-being. It has a positive correlation between motivation and performance (Kasurkar, 2011; Ten Cate, Vos, Westers, & Croiset, 2011; Klusmann, Kunter, Beyer, Trautwein, & Baumert, 2012).

Commitment

Commitment has a desirable impact in the individual's performance and organizational behavior. It has an immediate impact to the workers' satisfaction and motivation. Researchers agreed that workers' motivation could be explained by the organizational behavior, which is,

therefore, a consequence in the bond of commitment (Leite, N., de Aguilar Rodrigues, A., de Albuquerque, L., 2010; Lengnick-Hall, Andrade, & Drake, 2009; Rosa & Brito, 2010).

Competence

The demand for continuous learning is an integral part of competence. The individual should continuously develop his work as well as his theory of practice. The ability to think and work independently and collaborate with others are essential qualities that lead to the development of competence (De Angelis, 2003).

3.2.2 The Role of the Academe in the Development of Life Skills

The school plays an important role in contributing life or coping skills. In the maritime field, the school is referred as the Maritime Higher Education Institution or MHEI. Through MHEI's, the maritime education and training (MET) contribute to the life or coping skills of its students for them to stay longer onboard ship. The KNOWME Project (2017) investigated the state of policies and strategies for training, education, and knowledge development in the North-West Europian countries such as Netherlands, Belgium, Denmark, Germany, Poland, Portugal, Russia, Norway, Sweden, UK, Lithuania, Estonia, Latvia, and Greece. Most of these countries listed specific competencies in their maritime education and training in the school curricula such as keeping the quality of education at a high level, promoting maritime research and science, environmental protection, and others. Lobrigo (2014) mentioned that MET continues to be a mechanism for ensuring coherent working and living conditions for seafarers.

Life Skills as a Curricular Requirement

Since a maritime university inculcates competence in the seafaring profession among its students, the curriculum must focus on and must have a strong foundation in maritime education and training (MET). A maritime university sees to it that the curriculum is anchored on national standards, (STCW 1978 as amended in 2010), and other national regulating bodies such as the Commission on Higher Education Memorandum in its Memorandum Order, No. 20, 2015 (Consolidated Policies, Standards and Guidelines for the Bachelor of Science in Marine Transportation (BSMT) and Bachelor of Science in Marine Engineering (BSMarE) Programs. European maritime universities, on the other hand, follow the mandates of the EU or the European Union (Ziarati, Ziarati, and Singh, 2013). MET can influence the quality of education of seafarers as well as their well-being (Ziarati, Ziarati, and Acar) (n.d.).

Utilization of research findings to increase life skills of future seafarers

Research plays an important role in higher education institutions because it can raise the standard of education most especially to its learners, develop new technology to solve problems and create change among its beneficiaries, both in the academic and non-academic aspects. The significant contribution of research is apparently seen in maritime higher education institutions in studies conducted in different maritime institutions (Acar, Ziarati, and Ziarati (n.d.). Cwilewicz and Lisowski (2002) stressed the importance of onboard training and research starting in secondary up to post-graduate education. Research brings life skills in terms of writing, thinking, and reading that adds life skills among its future seafarers.

3.2.3 Socio-Cultural and Economic Factors and Their Influence on Seafarers' Life Skills and Decision to Stay Longer at Sea

How a seafarer could cope with the challenges of his career bears upon his decision to stay or not to stay in the seafaring job. His ability to cope can be influenced by certain social, cultural and economic factors such as: support of family and friends,seafarers' social image and financial security, healthy environment and relationship in the workplace.

Family problems, shore alienation, and separation from family and community of friends, are some of the ongoing causes of stress among seafarers. On the average, the contract with oceangoing vessels could take six months to as long as 12 months or even longer. During the voyage, the seafarers experience all the odds: long hours of fatigue, family issues, discrimination, poor communication (Manalo, Mercado, Paragas, Tenorio, & Dotimas, 2015), harassment, discrimination and bullying (Bullying, Discrimination and Harassment Survey, 2010), time, distance, months of separation, the loss of contact and the loss of communication, and family problems reaching them (Thomas, Sampson & Zhao, 2010).

According to Thomas (2003), the family is the single most significant influence in a seafarer's life. Positive social support of wife and children plays a major role in one's ability to make healthier choices. In addition, social support extended by relatives and friends can create a "feeling of importance," reassuring the seafarer that all his sacrifice matters, providing him a good reason to serve longer and advance in his career.

The social image of a seafarer is associated with tangible and intangible benefits of financial security such as big salary, attractive benefits and privileges, luxurious homes and cars, and the best schools for their children. This is the kind of image that is impressed upon students who are recruited for a seafaring career, and while it could likely develop a strong employment brand that will increase the levels of recruitment and retention (Thai,

Balasubramanyam, Yeoh, & Norsofiana, 2013), it can also be a seafarers' deciding factor between serving their career longer or giving it up.

In some cases, sustaining a high-maintenance life is one of the factors that drive seafarers to continue with their career. When their social circle paints a picture of them in the high-end of the society, it becomes more of trying to live up to this social image. Eighty to 90 percent of seafarers who had been asked said that the decision to serve the sea longer is more of providing their families a cloak of financial security growing economic needs.

In the light of these issues, seafarers need to make sound decisions in setting their goals not just on the basis of how seafaring can benefit them but also on how they can positively contribute to the industry. There might also be a need to redefine the social image painted about the seafarers because, in reality, they are just as vulnerable as everyone else in their struggles to survive in their personal life and advance in their career.

A Healthy Work Environment is one that is safe, empowering, and satisfying. It is not merely the absence of real and perceived threats to health, but a place of "physical, mental, and social well-being," supporting optimal health and safety. In a healthy work environment, a culture of safety is paramount, in which everyone has a responsibility to perform with a sense of professionalism, accountability, transparency, involvement, efficiency, and effectiveness.

An unpleasant working environment and relationships in the workplace could create physical and emotional exhaustion. A study conducted by Oldenburg, Jensen and Wegner (2013) found out that long working days, lack of care taken by the shipboard superiors and/or the shipping company, high responsibility for work organization with those involved in leadership, and social problems due to the long periods of separation from their families were associated with emotional exhaustion.

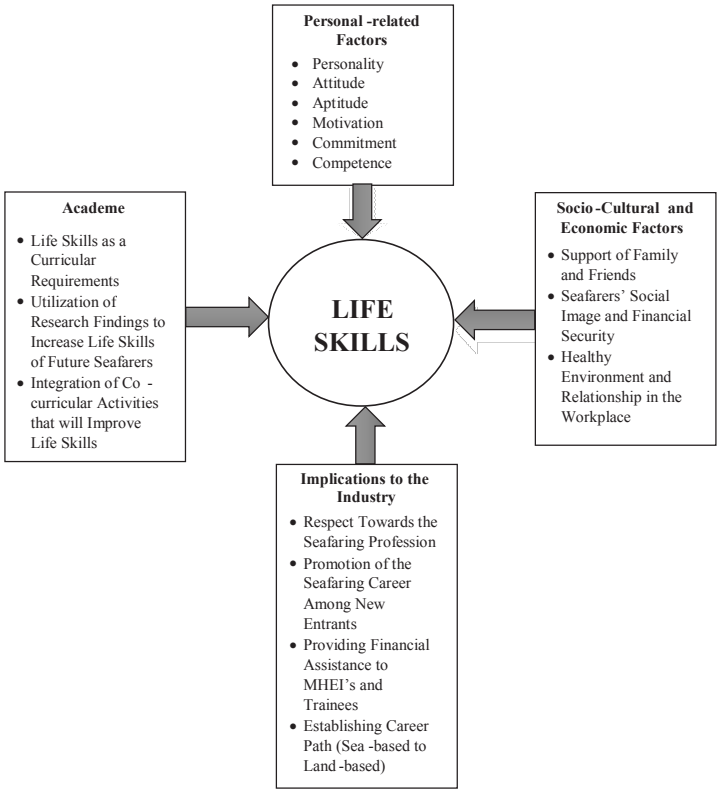
3.2.4 Implication to the Industry

In the last decade the shipping industry has on several occasions warned against an impending shortage of qualified labor on board EU-flagged ships. The relative attractiveness of the seafaring profession has steadily decreased over the years, partly due to the specificities of the profession itself (such as long periods of time away from home) and partly due to misperceptions and a general lack of information (Verhoeven, 2005).

Trained officers seem to quit sea work only after few years (Weber and Nevala, 2006 in Ljung and Widell, 2014) and young people do not any longer seem attracted by the sea as young people were before. Some estimations show that the medium time an educated sea officer stays at sea is eight years (Swedish Maritime Administration, 2010 in Ljung and

Widell, 2014). The same findings was found out in a study onducted by the European Transport Workers Federation (ETF) and European Community Shipowners Associations (ECSA) that the most frequently mentioned period for which they expected to remain at sea was 5-10 years, with the second most frequently mentioned period was 2-5 yrs. In the Philippines, a study conducted by De Guzman (2017) found out that the average number of years spent at sea by the seafarer officers was between 15-20 years with five (5) years as minimum and thirty eight (38) years as maximum. It is therefore seen as a very significant contribution to the recruitment of the new entrants to the seafaring profession if the proposed model will be utilized by all the sectors concerned.

Other considerations that may lead to the development of life skills of seafarers that will eventually lead to longer sea service are:respect towards the seafaring profession, promotion of the seafaring career among new entrants, providing financial assistance to MHEIs and trainees, and establishing career path and succession planning.



4. Implications/Future Directions

The development of life skills among future seafarers is critical factor that could determine their decision to stay or not to stay in the seafaring industry. Hence, it is important that this should be highly prioritized as part of their training preparations. Future directions on this issue should comprise the following:

- Strengthening of the screening process, e.g. conduct of the following tests: motivation check, personality test, aptitude test, AQ, EQ, and RQ aside from entrance test
- Enhancement of pedagocial approaches and strategies to develop problem-solving and decision-making skills in all subjects
- Collective involvement of parents, faculty and the community in various extra-curricular activities to provide support to students in the development of their life skills
- Provide students more challenging activities in the classroom to make the lessons more relevant and realistic
- Conduct more studies on factors that could predict life skills
- Do discriminant analysis to identify the characteristics of seafarers and non-seafarers and use these as indicators for testing the aptitude of new student recruits

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References

Brooks, D. K. (1984). *A life-skills taxonomy: Defining elements of effective functioning through the use of the Delphi technique*. University of Georgia, USA.

Burns, G. A., Ruby, K. L., DeBowes, R. M., Seaman, S. J., and Brannan, J. K. (2015). Teaching non-technical (professional) competence in a veterinary school curriculum. *Journal of Veterinary Medical Education*.

Caesar, L.D., Cahoon, S. & Fei, J. WMU J Marit Affairs (2015) 14: 141. doi:10.1007/s13437-015-0078-0

De Angeles, T. (2003). Why We Overestimate our Competence. Social Psychologists are Examining People's Pattern Overlooking Their Own Weaknesses, Syracuse, New York, USA.

Flannery, B. (2016). A List of Coping Skills for Anger, Anxiety, and Depression.

Gyanunlimited A Hub of Alternative Medicine and Holistic Health. (2012). Co-curricular Activities: Meaning, Definition, Examples, Importance, and Benefits. Retrieved from

KNOWME Project. (2017). The Europian Academic and Industry Network for Innovative Maritime Training, Education, and R & D. 4.1. State of Policies and Strategies for

Training, Education and Knowledge Development. Lai, E. (2011). Motivation: A Literature Review Research Report.

Leite, N., de Aguilar Rodrigues, A., & de Albuquerque, L. (2010). Organizational Commitment and Job Satisfaction: What Are the Potential Relationships? Universidade Federal de Sao Paulo, Brazil.

Lobrigo, E. (2014). KNOWME Project. Deliverable 2.4. Framework towards a Complementarity of Working and Living Conditions.

Mofrad, S. Life Skills Development among Freshmen Students. International Review of Social Sciences and Humanities Vol. 5, No. 1 (2013), pp. 232-238.

Oldenburg, M., Jensen, H. & Wegner, R. (2013). Burnout syndrome in seafarers in the merchant marine service. International Archives of Occupational and Environmental Health. Vol. 86 Issue 4, p407-416.

Packer, C.L. (2006). An investigation of life-skills development, racial/ethnic identity, self-esteem and self-efficacy in high achieving undergraduates of color, Doctoral Thesis, University of Georgia, Athens, Georgia.

Picklesimer, B.K., Miller, T.K. (1998). Life-skills development inventory-college form: An assessment measure. *Journal of College Student Development*,*39*(1), 100-110.

Thai, V. V., Balasubramanyam, L., Yeoh, K. L., & Norsofiana, S. (2013). Revisiting the seafarer shortage problem: the case of Singapore. *Maritime Policy & Management*, *40*(1), 80-94. doi:10.1080/03088839.2012.744480

Thomas, M., Sampson, H. & Zhao, M. (2010). Finding a balance: companies, seafarers and family life. Maritime Policy and Management, Vol. 30, Iss. 1, 2003.

Tomaszunas, S. & Weclawik, Z. Accidents and injuries in Polish seafarers, *Bull Inst Marit Trop Med Gdynia*, 1997, vol. 48 (pg. 59-73)

Viljoen, C. J., & Müller, J. C. (2012). A narrative hermeneutical adventure: Seafarers and their complex relationship with their families. *Hervormde Teologiese Studies*, *68*(2), 1-12. doi:10.4102/hts.v68i2.1171

Yadav, P. and Iqbal, N. (2009). Impact of life skill training on self-esteem, adjustment and empathy among adolescents. *Journal of the Indian Academy of Applied Psychology*, 35, Special Issue, 61-70.

Ziarati, R., Ziarati, M., and Singh, L. (2013). Looking into the Future – LeanShip LeanShip: Development of an Integrated Ship Management System Ensuring Efficient Propulsion and Minimum Emissions of Pollutants.

THE LOSS OF HIRE INSURANCE OF NORDIC MARINE INSURANCE PLAN – WHY IS IT USED IN MANY JURISDICTIONS AROUND THE GLOBE?

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Abstract Marine insurance covers the loss or damage of ships, cargo, terminals, and any transport or cargo by which property is transferred, acquired, or held between the points of origin and final destination. Loss of hire insurance is a sub-branch of marine insurance that protects the ship owners in a situation when the ship for some reason described in this article is not able to make profit for its owners who still need to cover their expences. The insurance clauses in different jurisdictions are very different but they are used internationally. The insurance market works globally and the insurance is product based on the insurance conditions and the pricing of the product. The Nordic marine insurance conditions are called The Nordic Marine Insurance Plan (NMIP). The Loss of hire insurance covers in this NMIP conditions covers loss due to the ship being wholly or partially deprived of income as a consequence of damage to the ship, which is recoverable under the conditions of the Plan. If the hull insurance has been effected on conditions other than those of the Plan, and these conditions have been accepted in writing by the insurer, the rules of the Plan shall be replaced by the corresponding conditions of the insurance concerned when assessing whether the damage is recoverable. Due to this fact, the master is often in a situation where his vessel is insured in several different jurisdictions with several different insurance conditions for different risks. The loss of hire insurance covers loss due to the ship being wholly or partially deprived of income: a. because it has stranded, b. because it is prevented by physical obstruction from leaving a port or a similar limited area, or c. as a consequence of measures taken to salvage or remove damaged cargo etc. This article explains the system of marine insurance conditions combining and risk management planning from the master's point of view. Master should be aware of the risk management structure of the vessel as it affects his actions. It also examines the reasons why the modern and valuable vessels are often insured by the Nordic plan.

Keywords: Maritime law, Marine insurance, Risk management, Maritime economics.

Introduction

Loss of hire policies are frequently purchased in Europe and Scandinavia. Many traditional mortgagee banks require this insurance cover for the vessels they are financing. Loss of hire can be a huge risk for the owners and investors as vessels may be in off-hire without income for months or even years after a large casualty. This is the reason why Loss of hire insurance is often driven by banks and ship financing. The tradition of Loss of Hire cover for vessels has been developed in traditional shipping countries where the financial world has required this cover for the vessels as they require stable and predictable income. For example German KG financing markets customarily require Loss of hire insurance taken out by the owners they are financing.

The Loss of Hire insurance is fairly new mode of risk cover in relation to the hull and P&I cover as it appeared in the market only after the Second World War (Bull, 2017). As a rough estimation in 2017 of world fleet buy loss of hire insurance. For example, in Asian market, the Loss of hire cover is not as widely used and therefore the Loss of hire insurance market is not as well developed as in Europe and especially in northern Europe (Brooker, 2015). In this article, I will analyze the situation more closely in relation to the three insurance markets, Nordic, English and Asian market.

The insurance clauses in different jurisdictions are very different but they are used internationally. The insurance market works globally and the insurance is product based on the insurance conditions and the pricing of the product. The Nordic market has a considerable market share, which is much higher share than their share for example of the hull and machinery markets (Måkestad, Sveinung, 2014). This article explains the system of marine insurance conditions combining and risk management planning from the master's point of view. Master should be aware of the risk management structure of the vessel as it affects his actions. Previously the loss of hire insurance was only a cover for vessels in time charter. The insurance covered the situation when the vessel went into a state called "off-hire" and the vessel was deprived payment from the time charterer (Bull, 2017).

How does Loss of Hire insurance cover work?

The Nordic conditions for loss of hire cover are popular in the markets. Therefore, it is used as an example envisaging how this insurance works in general. The Nordic cover is widely

used also outside Scandinavia. The Nordic Marine Insurance conditions are called The Nordic Marine Insurance Plan (later NMIP). The Loss of hire insurance covers in this NMIP conditions loss due to the ship being wholly or partially deprived of income as a consequence of damage to the ship, which is recoverable under the conditions of the Plan.

The standard loss of hire insurance cover covers loss due to ship being deprived of income as a consequence of damage to ship, which is recoverable under a H&M policy

based on the Plan, but reference to the Plan (Chapter 10-12) can be replaced with

provisions of the actual H&M policy (German, English, American etc.), if agreed in writing. If the hull insurance has been effected on conditions other than those of the Plan, and these conditions have been accepted in writing by the insurer, the rules in Chapters 10 – 12 (Hull insurance for total loss and damage) of the Plan shall be replaced by the corresponding conditions of the insurance concerned when assessing whether the damage is recoverable. (The Nordic Association of Marine Insurers (Cefor), 2016) This basic rule makes it possible to combine the different risk managing strategies based on different insurance covers to Nordic conditions of cover for loss of hire.

Due to this fact, the master is often in a situation where his vessel is insured according to two different jurisdictions with several different insurance conditions for different risks. The basic idea of the loss of hire insurance covers loss due to the ship being wholly or partially deprived of income because of a risk based on a hull policy, typically damage to the vessel, or some other risk specifically named in the cover. In NMIP these specific risks are mentioned as follows : a. because it has stranded, b. because it is prevented by physical obstruction from leaving a port or a similar limited area, or c. as a consequence of measures taken to salvage or remove damaged cargo etc. d. as a consequence of an event that is allowed in general average pursuant to the 1994 York-Antwerp Rules. (The Nordic Association of Marine Insurers (Cefor), 2016)

According to Main rule for calculating compensation in NMIP Clause 16-3, the compensation shall be determined on the basis of the time during which the ship has been deprived of income (loss of time) and the loss of income per day (the daily amount). Loss of time shall be stipulated in days, hours and minutes. According to NMIP Clause 16-4 a period of time during which the ship has only partially been deprived of income shall be converted into a corresponding period of total loss of income. According to NMIP Clause 16-5 The assured's loss of income per day (the daily amount) shall be fixed at the equivalent of the amount of freight per day under the current contract of affreightment less such expenses as the assured saves or ought to have saved due to the ship being out of regular employment. If the ship is

unchartered, the daily amount shall be calculated on the basis of average freight rates for ships of the type and size concerned during the period in which the ship is deprived of income.
In Nordic Marine Insurance plan it is also possible to fix the daily amount for insurance period: If it is stated in the insurance contract that loss of time shall be compensated for by a fixed amount per day, this amount shall be regarded as an agreed daily amount (NMIP Clause 16-6. Agreed daily amount). (The Nordic Association of Marine Insurers (Cefor), 2016)
Loss of hire insurance gives a quite independent cover that in today´s market is offered also to other vessels than just those on time charter for which it was originally intended. Today it can be used by vessels under voyage charter as well of vessels under other types of contracts of affreightment like charters for consecutive voyages. Even cruise vessels and liner vessels without any such contract form can be covered by loss of hire insurance (Bull, 2017). Generally, however loss of hire is considered as quite expensive form of risk management strategy. Therefore, as we explain above, it more or less uncommon in Asian markets where some other solutions have been developed as an alternative risk management strategy.

When will the owner be protected and for which risks?

The ship owner and the financing institutions are well covered in a situation when the vessel ceases to ear its income when protected by loss of hire insurance cover. When acquiring the cover the ship owner must however familiarize with the cover carefully. Even though the Nordic plan has a large market share, the other covers in the market are products on their own terms and they need to be carefully evaluated. The most common alternatives for Nordic conditions are American Loss of Charter Hire Form, SP-40B (Aug 1961)(”Lazard Form”) and the English ABS 1/10/83 wording, including or excluding the War risk (Måkestad, Sveinung, 2014). For the Master it is essential to know which cover and what kind or combination his vessel has when the insurance risk is attaches the vessel as not all risks are covered by all policies.

To obtain cover for the vessel from loss of hire insurance under Nordic Plan, there must in general be damage to the vessel that has caused the loss of income to the vessel. Unless otherwise agreed, an insurance covers only marine perils and war risks are excluded. In practice sometimes a loss of policy is extended to include war perils in addition to marine perils as both hull & machinery as well as war risks can be covered by NMIP under separate insurances under the NMIP condition (Måkestad, Sveinung, 2014). Against piracy loss of hire

under NMIP has hardly any protection of practical value under standard conditions but adequate cover is however available in the market (Måkestad, Sveinung, 2014).

Risk cover for loss of hire revenue is based on named risks in the policy. It is irrelevant if the assured has actually effected for example hull insurance and not all casualties covered by the hull policy can be covered as loss of hire. For example if the vessel is a total loss there will not be normally cover in loss of hire insurance when there is a total loss according to NMIP. According the rules there must be damage covered by the hull clauses. Situations which are not covered by the hull clauses are not covered either as loss of hire like delay by strike, ice or similar situations. The other side of the coin is however that the cover according to the NMIP is extended to include hire lost due to; Grounding without damage to the vessel, blocking and trapping in port, Salvage or removal of damaged cargo, a General Average event. All these extensions make the conditions quite fair and lucrative. For example, the owner does not need to prove that there was damage to the ship when grounding or he doesn´t have to prove the severity of damages. This is supported by the rule 16-1 first sentence, as the owner doesn't have to prove that the damage would be recoverable under the hull insurance. It is also irrelevant if the owners has even effected the hull insurance (Bull, 2017).It is only relevant that the loss can be traced back to marine peril (The Nordic Association of Marine Insurers (Cefor), 2016). No standard deductible

Nordic conditions are based on the idea that there is a deductible period of time in loss of hire insurance. Minimum agreed deductible period would generally be 14 days. Alternatively, 21 or 30 days are quite frequently stipulated in the contract (Måkestad, Sveinung, 2014). Each casualty shall be subject to a deductible period, which shall run from the commencement of the loss of time and last until the loss of time, calculated in accordance with the rule in Cl. 16-4, sub-clause 1, second sentence, is equivalent to the deductible period stated in the insurance contract. Loss of time in the deductible period is not recoverable (The Nordic Association of Marine Insurers (Cefor), 2016). Damage caused by heavy weather or navigating in ice which has occurred during the period between departure from one port and arrival at the next one shall be regarded as one casualty. a separate deductible period for damage to machinery has been agreed on in the insurance contract according to the NMIP (The Nordic Association of Marine Insurers (Cefor), 2016).

A separate deductible period is applied for each casualty; this is in accordance with the other deductible provisions in the Plan, cf. Cl. 12-18 and Cl. 13-4. However, if one and the same casualty leads to a number of separate delays, e.g. delay at the place where the casualty occurred, delay in connection with temporary repairs and delay during permanent repairs,

then only one deductible period shall be applied for the aggregate of all the delays. (The Nordic Association of Marine Insurers (Cefor), 2016).The provisions regulate the right of the assured to choose a repair yard and the consequences his choice of yard has for the extent of the loss-of-hire insurer's liability (The Nordic Association of Marine Insurers (Cefor), 2016). This is a specific issue that needs to be addressed by the Master and the owner when choosing the repair yard after the incident.

Basic differences in marine insurance/loss of hire covers for vessels

There is more similarities in the basic marine insurance cover in the world market than differences as the systems need to be able to cope with each other also because of the reinsurance market. The language of the insurance markets is English and therefore the relevant marine insurance conditions are all translated into English language.

The differences in insurance conditions are also meaningful and they give competitive advantages for both insurers as well as the owners using them. Insurance conditions vary also because of the basic legislation they are based at. Even though the English legal system is dominating the market as backroad law for majority of marine insurance, there are competitors, which are strong in relative fields of these markets. Loss of hire insurance is a typical example of these fields in the markets. The Nordic conditions are strong in the market. As mention above, they have a relevant market share. We have examined the cover and found out that many situations causing the loss of income cannot be found in general hull policies. This does not however explain entirely their strong position in the market. There is also basic differences in the insurance law and insurance cover systems which needs to be examined in order envisage the lucrativeness of another set of cover in relation to others.

The English law of marine insurance is based on warranties, which needs to be obeyed by the assured as a part of the contract. Warranty of seaworthiness is specifically important (Soyer, 2017). Nordic Marine insurance plan had a similar clause on seaworthiness until 2007 but it was abolished from these conditions, which were known at the time as Norwegian Marine Insurance Plan. Nordic Marine Insurance Plan has a different approach in the duties of the assured. They are based on the idea that the person effecting the insurance needs to follow the safety regulations determined in the insurance contract in order to keep the cover in force and get his compensation.

The approach also to the duty of disclosure before entering the insurance contract is also more beneficial for the owners than the equivalent approach in the English law. Prudent owners are well protected under the Plan provisions and defending their cover against the insurer´s

accusation for breach is easier if they have followed the relevant provisions in the Plan and the contract. This effects especially those owners whose have taken the loss of hire cover with Nordic conditions as in principle it is irrelevant for the loss of hire cover whether the assured has lost his cover in relation to the hull insurer for example due to duty of disclosure (Bull, 2017). The issues considered under the chapter 3 of the plan (duties of the person effecting the insurance and the assured) are evaluated independently in relation to the loss of hire insurer (Bull, 2017). This is a relevant advantage for the prudent owners who run well their tonnage and follow the safety regulations and keep their insurers well informed.

Alternatives to Loss of hire insurances

The freight insurances in general cannot replace the cover loss of hire insurance gives for the owners against loss of revenue (Bull, 2017). There are however, insurances on the market which are used by some ship owner´s which find the loss of hire unnecessary expense considering their risk management strategy (Brooker, 2015). Trade Disruption Insurance and Strike & Delay Insurance are two of the most common alternatives. Trade Disruption Insurance (later TDI) gives also cover against losses like fire or explosion on land affecting loading and discharging facilities, port closure, Stowaways, obstruction of a berth or port blockade, delays resulting of refugee rescue, infected deceases etc. This cover varies more depending on which company provides it. Some companies describe their TDI as a product which is a form of Loss of Hire that excludes machinery damage and responds in three specific ways: 1)Loss of Earnings 2) Additional Cost and Expenses 3) Contractual Penalties.

Strike & Delay insurances in general are even more focused on the risks that are third party risks away from the vessel (Brooker, 2015). However, Strike and Delay insurances seem to differ quite substantially from provider to provider. They are often advertised to cover many similar risk as the loss of hire insurances: Strike & Delay Cover Insurance and other "onshore" incidents is an additional cover under Hull & Machinery Policy and very similar to Loss of Hire Insurance. This cover allows Shipowner or Charterer to minimize their expenses when delay of the vessel is caused by unforeseen "onshore" circumstances, which are beyond client's control. These are enumerated in the policy and usually insured events are fire, explosion, port/waterway closure, bad weather conditions, boycotts, strikes of stevedores and other port services etc. Some companies offer under certain conditions that it is also possible to include coverage for unexpected events onboard: strike of the crew, machinery breakdown, deviation due to illness of the crew members, quarantine etc.

The risk evaluation between these options above and "traditional" loss of hire insurance depends highly on several determinants in risk management and their evaluation. For example the trading area. If we consider the TDI cover described above, it is clear that not all parts of the cover are needed in all trading areas. On the other hand the loss of hire risk in places where accessibility to repair yard is good, the minimum deductible for loss of hire might be too long for the owner to get full advantage of the cover when vessel can be repaired quickly and can be back in business after relatively short period at the repair yard.

Conclusions

Loss of hire insurance is an important cover especially when connected to shipping finance. When shipping has been in crisis since the earning dropped heavily after 2008 it has been a valuable cover for many even though it is also considered costly insurance when freight rates are low and earnings have been in decline. Having been part of the shipping finance scheme for the last 30-40 years it is well established.

Nordic plan has become more and more popular as a basis for cover since the conditions of cover are pretty straightforward and fair for the owners who play fair and maintain their vessels well. It has several benefits and competitive advantages. It is stable when it has been formed on the basis of Nordic plan, which has a legislative history that goes back more than 100 years (until 2013 with a name Norwegian Marine insurance Plan) and case law collected in one single collection from Scandinavian Maritime courts and Arbitration Tribunals. Effective, highly skilled and especially cost effective arbitration in Norway is also one of its benefits. As a tool with updated Commentary, it is also possible for foreign arbitrators to understand it. Mainly arbitrated in Norway it offers cost effective and smooth arbitration near the main financial markets, which use it as a standard.

Importance of good management together with Master and crew maintaining the vessel is the basis of the risk management under the Nordic Marine insurance plan. Together they guarantee that the vessel as a source of revenue is protected. When vessel can be repaired quickly, loss of revenue is also protected it can be back in business after relatively short period at the repair yard without any severe disturbances for business.

References

Brooker, Andrew. 2015. *Loss of Hire Insurance - Is there a better way?* Hong Kong : Latitude Brokers, 2015. p. 31.

Bull, Brautaset - Falkanger -. 2017. *Scandinavian Maritime Law, The Norwegian perspective.* Oslo : Universitetforlaget, 2017. 4th edition.

Måkestad, Sveinung. 2014. https://www.uio.no. *https://www.uio.no.* [Online] University of Oslo, 3 20, 2014. [Cited: may 31, 2017.] https://www.uio.no/studier/emner/jus/jus/JUS5450/v14/presentasjoner/loh-at-uio-march-2014_makestad.pdf.

Provins insurance webpage. *Provins insurance webpage.* [Online] Provins Insurance Ltd. [Cited: May 31, 2017.] http://www.provinsinsurance.se/en/6862.trade_disruption_insurance_(tdi).html.

Soyer, Baris. 2017. *Warranties in marine insurance.* Abingdon : Routhledge, 2017.

The Nordic Association of Marine Insurers (Cefor). 2016. The Nordic Marine Insurance Plan of 2013, Version 2016. *The Nordic Marine Insurance Plan of 2013, Version 2016.* [Online] The Nordic Association of Marine Insurers (Cefor), 2016. [Cited: may 31, 2017.] http://nordicplan.org/The-Plan/.

—. 2016. The Nordic Marine Insurance Plan of 2013, Version 2016, Commentary to the plan. *The Nordic Marine Insurance Plan of 2013, Version 2016.* [Online] The Nordic Association of Marine Insurers (Cefor), 2016. [Cited: may 31, 2017.] http://nordicplan.org/Commentary/Part-Three/Chapter-16/#Clause-16-7.

www.kominsur.ee. [Online] Kominsur Ltd. [Cited: May 31, 2017.] http://www.kominsur.ee/en/merekindlustus/laevade-ja-mereriskide-kindlustamine/strike-delay-cover-insurance/.

THE YORK-ANTWERP RULES 2016 – LAW AND PRACTICE FROM MASTER´S POINT OF VIEW

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Abstract The York-Antwerp Rules are part of international maritime law, which form the basis for average adjustments throughout the world. The law of general average is a legal principle of maritime law according to which all parties in a sea venture proportionally share any losses resulting from a voluntary sacrifice of part of the ship or cargo to save the whole in an emergency. For example these rules are applied, when the crew throws some cargo overboard to lighten the ship in a storm. The basic rule to be applied in all cases is that there is a general average act when, and only when, any extraordinary sacrifice or expenditure is intentionally and reasonably made or incurred for the common safety for the purpose of preserving from peril the property involved in a common maritime adventure. The Law of General Average has been expressed since 1890 as York-Antwerp Rules, which have been internationally reformed several times. Following four years of consultation and an extensive review by a CMI International Working Group ("IWG"), the CMI Assembly at its conference in New York adopted the YAR 2016 in early May 2016. The shipping community, including the ship owners and marine insurance companies, has accepted the new rules worldwide. The author of this article was one of the members in the international working group, which consisted of 12 experts in general average adjustments. The decisions in GA situation need to be taken fast. Many of them need to be made by the master without time for consultancy with the ship owner and the cargo owners. This article explains the new rules from the master's point of view. Despite advances in maritime transport technology, general average continues to come into play constantly and masters need to be able to act in emergencies and understand the principles and practice of the rules, which form the basis for their actions.

Keywords: Maritime law, Marine insurance, Maritime accident, Safety of shipping,

Introduction

The Rules on general average base in the fact that, during a voyage, the ship, cargo and freight form part of a common venture. The rules on general average have developed over time from simple principles into complex rules, which nowadays need to be adjusted in modern situations.
The basic rule is however still very much the same as the rules in Rhodean law some 900 BC. For a long time this has been expressed in York-Antwerp Rules as rule A:

Rule A
"1. There is a general average act when, and only when, any extraordinary sacrifice or expenditure is intentionally and reasonably made or incurred for the common safety for the purpose of preserving from peril the property involved in a common maritime adventure." (International)

The Law of General Average has been expressed since 1890 as York-Antwerp Rules, which have been internationally reformed several times. Following four years of consultation and an extensive review by a CMI International Working Group ("IWG"), the CMI Assembly at its conference in New York adopted the YAR 2016 in early May 2016. The shipping community, including the ship owners and marine insurance companies, has accepted the new rules worldwide. The author of this article was one of the members in the international working group, which consisted of 12 experts in general average adjustments. (CMI YEARBOOK 2015 Annuaire, 2015)
This article explains the new rules from the master's point of view. Despite advances in maritime transport technology, general average continues to come into play constantly and masters need to be able to act in emergencies and understand the principles and practice of the rules, which form the basis for their actions.

History and origins of general average

The Rhodian law (ca. 900 BC) degrees that "if in order to lighten a ship merchandise has been thrown overboard, that which has been given for all should be replaced by the contribution of all". This short sentence contains both the principle and example of the peculiar communism to which seafaring men are brought in extremities. (Reeder, 2013) This has been a universal

rule since antiquities among seafaring men, no matter to what country they belonged, being founded upon the necessities of their position (S., 1957).

The Romans were great improvers of other people´s inventions. They recepted and used the best parts of law from the countries they conquered. The Emperor Antoninus said: *"Let it be judged by the Rhodian law which deals with nautical matters, so far as that is directly contrary to our own law. For I am lord of the whole world, but the law is lord of the seas."* (Reeder, 2013)

The Roman law sources had a significant influence on the development of general average in medieval times as the reception of Roman law had influence in most medieval marine legal collections of maritime legislation (S., 1957). Principles of general average survived through medieval times in these collections and when different legal systems started to develop into collections of national legislation the Roman law still had influence. However, English law and continental legal systems started to develop in different directions in many ways. This also affected the rules on general average. This became crucial for the international trade and when vessels started to be bigger and bigger and values of ship and cargo expanded in the middle of 1800 century it was clear that uniformity was needed. The York-Antwerp Rules were formed after two conferences, first York Rules in York and then after conference in Antwerp, they became known as York Antwerp Rules.

These rules have Unique position in maritime law (-Brautaset, 2017). The first version dated from 1877. There have been revisions in 1890, 1924, 1950, 1974, 1994, 2004 and now 2016, when new York-Antwerp Rules 2016 were finally adopted by Comité Maritime International in New York. Comité Maritime International is a private organization and therefore the rules are not a convention. They are incorporated into bills of lading and charterparties and they therefore are a part of practically every maritime contract relating carriage of goods by sea. In some countries, like Scandinavian countries, they are also incorporated into legislation. Therefore they are applicable even though they for some reason would not be incorporated into contract of affreightment (-Brautaset, 2017).

Common safety and common benefit for all

The basic principle of common safety in general average has been expressed in York-Antwerp rules in rule A which was introduced in the introduction. The most significant development from the ancient and medieval times is nowadays called principle of common benefit. This principle means that expenses may include extraordinary expenses incurred for the benefit of

ship and cargo (and crew), even where this was not strictly necessary for the avoidance of danger.

Even though this principle encompasses only few special situations, it has been active source of criticism from the traditional English law which has dominated the marine insurance market. One of the most important rules considered as common benefit are the rules X and XI which where ship seeks a port of refuge. Even expenses not necessary for bringing the ship and cargo out of danger will be compensated according to these rules. Expenses like cost of unloading, handling, storing and reloading while the ship is repaired can be covered according to 2016 rules. Also wages incurred at a port of refugee can be compensated:

Rule XI – Wages and Maintenance of Crew and Other Expenses Putting in to and at a Port of Refuge, etc.

(a) Wages and maintenance of master, officers and crew reasonably incurred and fuel and stores consumed during the prolongation of the voyage occasioned by a ship entering a port or place of refuge or returning to her port or place of loading shall be allowed as general average when the expenses of entering such port or place are allowable in general average in accordance with Rule X(a). (International)

This was not the situation under 2004 rules where common benefit approach was fairly limited.

The York-Antwerp rules 1994 were more tolerant in this respect. It is necessary for the master to be aware of these differences and to know which rules he/she is working when vessel is under charter or carriage of goods contract of some other form. BIMCO has not approved the 2004 rules but informed at its websites almost immediately after the approval of 2016 rules that it will recommend their use (2016) for all shipowners.

New YAR rules which the Masters should know carefully

As BIMCO has not approved the 2004 YAR rules, the Masters should know that these Rules are not industry standard. They should be avoided as rules non acceptable for shipowners in general. They will probably fall into desuetude in the year to come. in general 1994 and 2016 rules are acceptable for the ship owners. The 1994 rules will still exist some time as the older charterparty forms have reference to those and they therefore incorporate these into contracts of affreightment. These can however be replaced by inserting a reference to 2016 rules into the carriage contract or charterparty.

One of the most important rules for the Master is Rule VI – Salvage Remuneration:
(a) Expenditure incurred by the parties to the common maritime adventure in the nature of salvage, whether under contract or otherwise, shall be allowed in general average provided that the salvage operations were carried out for the purpose of preserving from peril the property involved in the common maritime adventure and subject to the provisions of paragraphs (b), (c) and (d)
According to international convention on law of salvage the Master has an independent right to enter into reasonable salvage contracts. The most common salvage contracts (like Lloyd´s Open Form of Salvage Agreement, LOF) are in general considered such contracts. In YAR 2016 and 1994 salvage forms part of general average. Terms differ, but relevance from Masters point of view has little meaning when the vessel is in danger.
For Master and specially tugmaster, the new rule Rule B is especially important:

1. There is a common maritime adventure when one or more vessels are towing or pushing another vessel or vessels, provided that they are all involved in commercial activities and not in a salvage operation.

When measures are taken to preserve the vessels and their cargoes, if any, from a common peril, these Rules shall apply.

2. If the vessels are in common peril and one is disconnected either to increase the disconnecting vessel's safety alone, or the safety of all vessels in the common maritime adventure, the disconnection will be a general average act.
3. Where vessels involved in a common maritime adventure resort to a port or place of refuge, allowances under these Rules may be made in relation to each of the vessels. Subject to the provisions of paragraphs 3 and 4 of Rule G, allowances in general average shall cease at the time that the common maritime adventure comes to an end.
This new version of Rule B clarifies the rules concerning tug and tow salvage and general average situations.

One of the most common GA situation is Rule I – Jettison of Cargo
"No jettison of cargo shall be allowed as general average, unless such cargo is carried in accordance with the recognised custom of the trade." (International)

Expressed in rather strange way, this usually means that if carriage on deck was not allowed, then the jettison will not be compensated, otherwise it will be compensated in GA. This rule in today´s world of shipping usually relates to casting or releasing containers.

The other common rule which the Master has to apply is Rule III – Extinguishing Fire on Shipboard:
"Damage done to a ship and cargo, or either of them, by water or otherwise, including damage by beaching or scuttling a burning ship, in extinguishing a fire on board the ship, shall be allowed as general average; except that no allowance shall be made for damage by smoke however caused or by heat of the fire" (International)
Decisions like this need to be done fast, often in minutes. It is important that the Master knows the financial consequences in order to feel protected by the rules and insurance cover as general average contributions are generally protected by insurance – shipowners insurance or cargo insurance. (Hudson, 2010) Wetting containers on top of the burning ones might mean precious BMW parts to be destroyed days before they should be attached to new models that customers are already awaiting. But it needs to be done in order to save the other interests – And the Master needs to make the decision.
Also stranding a ship to save vessel and cargo is a general average act according to Rule V – Voluntary Stranding:
"When a ship is intentionally run on shore for the common safety, whether or not she might have been driven on shore, the consequent loss or damage to the property involved in the common maritime adventure shall be allowed in general average." (International)
It is fairly common after collision in a narrow fairway that the Master needs to save his/her by deciding on voluntary grounding or stranding instead of losing the vessel with its cargo. One of the consequences in these cases is also, if the vessel sinks on a fairway, that it needs a wreck removal operation which is usually extremely costly exercise paid by the P&I club. Although paid by the club, the loss record will affect the owner´s premiums year to come. When beaching the vessel and cargo successfully, the cargo will contribute also to the damage caused to the vessel by stranding. (Reeder, 2013)
If the vessel is grounded, the Master is able to refloat her with own machinery, this usually saves the common adventure from costly salvage operation. The problem is that this effort can cause damage to machinery. There is a compensation scheme for this situation in YAR Rule VII – Damage to Machinery and Boilers:

"Damage caused to any machinery and boilers of a ship which is ashore and in a position of peril, in endeavouring to refloat, shall be allowed in general average when shown to have arisen from an actual intention to float the ship for the common safety at the risk of such damage; but where a ship is afloat no loss or damage caused by working the propelling machinery and boilers shall in any circumstances be allowed as general average." (International)

It is important for the Master to have this knowledge that if he/she has actual intension to refloat the vessel, and there is damage as a consequence of this intension, the damage will be compensated as general average act by the parties to the adventure. This rule was heavily critcised by marine insurers in CMI conference in Singapore 2001 when there was clear evidence and statistics that some owners had misused the rule to. This criticism was due to some old vessels whose masters had strained the machinery when valuable cargo was onboard. The rule however remains also in the 2016 rules.

The last rule, which I will pick up from the YAR 2016 is important for the Masters to remember. This is Rule F:

"Any additional expense incurred in place of another expense which would have been allowable as general average shall be deemed to be general average and so allowed without regard to the saving, if any, to other interests, but only up to the amount of the general average expense avoided." (International)

This rule establishes that an extra expense, which is incurred instead of another expense, which would have been allowable as general average, shall be deemed to be general average expense. In literature this is called "substituted expense" (-Brautaset, 2017). Some typical substituted expenses are: Air transport of spare parts instead of sea transport, the cargo may be forwarded to destination by other vessels, cargo may be sold and a replacement cargo purchased on completion of repairs, the vessel may be towed to destination after only minimal repairs etc. All these have a common feature. They save time and/money in relation to another expense which would have been compensated as a general average act.

Conclusions

Despite advances in maritime transport technology, general average continues to come into play constantly and masters need to be able to act in emergencies and understand the principles and practice of the rules, which form the basis for their actions. If the master make carriage contracts he/she has to know which rules the contract refers to, and under which rules he/she is transporting the cargo – and the common venture. As described above there is clear

differences in the sets of rules. The new rules are worth learning as they will form the industry standard probably the rest of the working life of those at sea or still studying at the maritime universities.

References

Brautaset, Falkanger and Bull. 2017**.** *Scandinavian Maritime Law, The Norwegian perspective.* Oslo : Universitetforlaget, 2017. pp. 593-601. 4th edition.

CMI YEARBOOK 2015 Annuaire. 2015**.** Antwerp : s.n., 2015. New York I Documents for the Conference.

http://www.bimco.org. [Online] BIMCO, May 10, 2016.

Hudson and Harvey. 2010**.** *The York-Antwerp Rules.* Cornwall : Lloyd´s list, 2010. pp. 95-98.

Comite Maritime International**.** http://comitemaritime.org. *comite maritime international.* [Online] [Cited: May 31, 2017.] http://comitemaritime.org/Review-of-the-Rules-on-General-Average/0,27140,114032,00.html.

Reeder and Cornah **.** 2013**.** *Lowndes and Rudolf The Law of General Average and the York-Antwerp Rules.* London : Sweet & Maxwell, 2013. pp. 261-262. Vol. 14.

S., Selmer Knut. 1957**.** *The Survival of General Average.* Oslo : The Norwegian Reseach Council for Science and the Humanities, 1957. pp. 19-26.

DESIGN OF THEORY TO TEST WHAT MOTIVATES PEOPLE TO TAKE ACTION TOWARD PROTECTING OUR OCEANS

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Abstract: Oceans, often thought of as one of our last global commons, serve many important roles from providing us food and resources to connecting nations for trade. Despite their importance, through a tragedy-of-the-commons effect, our oceans are becoming increasingly stressed. Addressing such issues of the commons require a collaborative international approach, as evidenced by the United Nations sustainable development goal 14 to "conserve and sustainably use the oceans, seas and marine resources" [1] and the IAMU Tasmanian Statement [2]. This paper will explore what makes individuals (and organizations) move from awareness to action when it comes to protecting our oceans. It will propose a theoretical framework by which to test the most effective means of motivating action to protect the ocean environment. The framework will be based upon a non-equivalent group quasi-experimental design [3], [4] which will be used to assess the relative effects of treatments that have been nonrandomly assigned to participants from around the world. Both the treatment and control groups will be subject to pre- and post-testing using an awareness assessment [5], such as the one developed by the Ocean Literacy Project [6]. Several treatments will be explored, including examples such as behavioral conservation [7], to determine the most effective means to be used by NGOs in ocean advocacy. Informed by a review of the literature, this theoretical paper will provide the evidence-based research method for testing and measuring what motivates people to take action toward protecting our oceans.

Keywords: Oceans, sustainability, non-equivalent group design, NGO, conservation, advocacy

Introduction

We rely on our high seas and oceans for food and natural resources, trade and commerce, recreation and tourism, biodiversity and clean water, as well as carbon storage and climate regulation, among many other critical life-sustaining and enriching functions. While our high seas and oceans are unusually resilient and in relatively reasonable health according to some measures [8], it is also in a state of decline (e.g., [9], [10], [11]). Some of this is due to naturally-occurring changes and some is due to man's behaviors. As one of our last global commons, the high seas and oceans are subject to a well-known economic effect known as the "tragedy of the commons" [12]. In such a case, shared finite resources (such as fisheries in the high seas and oceans) become depleted and diminished when rational individuals who have rights to the commons exploit the resource out of self-interest rather than to benefit the common [13]. It is particularly difficult to manage or regulate such situations. However, just as behaviors are what create a "tragedy of the commons," it is quite possible that solutions may be found by examining how to change those behaviors.

This paper will examine previous studies of conservation efforts, models of advocacy, and present a model to test various approaches to ocean advocacy that NGOs might consider employing.

Conservation Efforts and Behavior Change

Only several decades ago, global concern for the environment varied by geo/demography – concern was higher among people in developed nations than in developing nations. More recently, at the turn of the millennium, global concern for environmental issues and support for environmental protection was at a high level uniformly across geo/demography [14]. In 2013, again based on an international survey, global concern for the environment waned to a 20-year low [15]. On the surface, you might expect environmental conservation behaviors to vary as awareness and concern increased or decreased. However, conservation behaviors did not change dramatically during fluctuations in awareness of and concern for environmental issues [16], [17]. This provides some evidence that awareness alone does not alter behavior sufficiently to impact the environmental concern. In a global survey of experts' evaluation of progress toward achieving the seventeen UN sustainable

development goals, the goal for protecting our high seas and oceans ranked second from the bottom [18].

Schultz [7] suggests four reasons why behavior change is difficult when it comes to conservation efforts. First, education (or awareness) alone does not alter behavior [19], [20], [21]. Second, our thinking is biased and short-sighted. For example, one international study [22] indicated that people believe environmental problems are worse elsewhere (i.e., local better than global) and will get worse over time (i.e., better now than in future). As a result, environmental issues are viewed as lower priority [23]. Third, we often perceive ourselves as separate (or unconnected) from nature and as a result, have less incentive to engage in conservation behaviors [24]. Finally, our social norms guide our behavior. For example, when there is widespread concern for environmental issues, the underlying assumption is that conservation is not the norm, which serves to exacerbate the problem [25]. By examining these rationale for the lack of behavior change, Shultz goes on to offer several strategies for altering conservation behaviors, such as the use of motivational messages, behavioral prioritization using a targeted approach rather than a one-size-fits-all approach, and multi-disciplinary approaches.

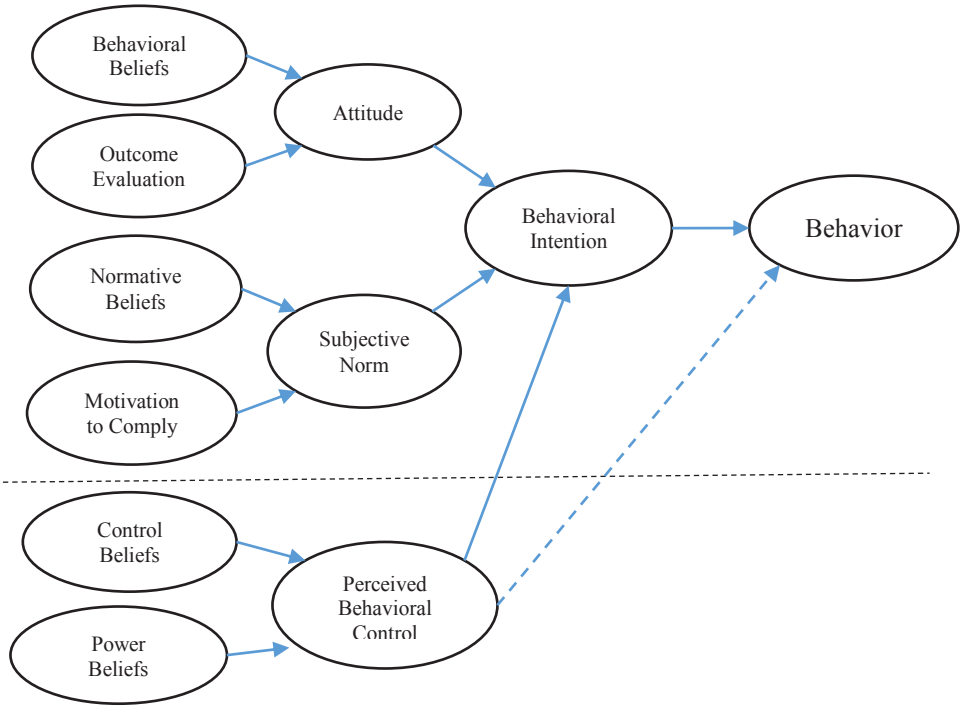

Figure 1: Theories of Reasoned Action and Planned Behavior

Looking at the specific example of biodiversity loss (which is driven in part by the resource use of a growing human population), St. John et al. [26] reviewed social-psychology theories

of behavior and how they were used in the context of conservation and natural-resource management. Using the theories of reasoned action and of planned behavior [27] as a framework (Figure 1), they reviewed the relatively few examples in conservation science where social-psychological models were used explicitly.

All things held equal, the more positive a person's attitude, subjective norm, and perceived behavioral control are, the greater the behavioral intention and, thus, the likelihood that they perform the behavior [28].

They also examined examples where these models were used implicitly based upon specific predictors of behavior. For example, one group of studies examined attitude and its implicit impact on pro-conservation behaviors; the results were mixed – only about one quarter of the studies demonstrated a relatively significant link between attitude and pro-conservation behavior, half demonstrated a mismatched link, and the remainder were inconclusive. An important finding was that general attitudes toward the environment are of limited use in predicting behavior. Rather, in order for attitudes to be useful toward motivating behavioral change, they must be specific to the targeted conservation focus (e.g., poaching behaviors, habitat conversion). In general, there was a dearth of investigation and studies that focused on these theories. It was suggested that conservation interventions might be more successful by expanding our knowledge and approach toward understanding human decision processes and behavior change. Specifically, when developing conservation programs and interventions, a more comprehensive model of behavior change that includes beliefs, attitudes, norms, controls, and intentions should be used. These conclusions of the St. John et al. investigation have also previously and independently been put forth [29].

Advocacy Framework

Ultimately, pro-conservation behavior changes likely will not happen on their own. Rather external groups or membership groups, like non-governmental organizations (NGOs) play a role in promoting and promoting behavior change. There are many models of how NGOs advocate for their particular areas of concern. To understand the nature of this advocacy work, Szarka [30] proposes a framework for NGO advocacy functions that focused specifically on environmental issues (e.g., climate change). The advocacy functions identified by Szarka include: issue framing, knowledge generation/dissemination, attribution of responsibility, lobbying, public mobilization, and agenda setting. Each of these six functions are based upon theory and then validated through a field study of NGOs in France, Germany,

and the UK. However, this framework is *descriptive* rather than *prescriptive* in that it illustrates what is being done rather than what should be done.

You might think that a primal set of advocacy functions would have evolved through time (i.e., those functions that best advanced the NGO mission would survive and thrive and spread, and those that were ineffective would wither and disappear). However, based upon the conservation psychology literature, there is mounting evidence that this is not the case. For example, education, which has been a traditional advocacy function of NGOs, has been shown to be ineffective because it does not, by itself, motivate behavior change [19], [20], [21]. Education has been proven less than effective because it is a weak motivator of the behavioral change, much weaker than is needed to change behaviors and address environmental concerns.

Therefore, to exploit this advocacy framework to motivate behavioral changes, it might be beneficial to overlay this advocacy framework [30] onto the theories of reasoned action and planned behavior [26]. The issue framing function of advocacy (which often takes the form of economy, social justice, or environment) could be viewed as "action-oriented sets of beliefs and meanings that inspire" and motivate action in movement organizations [31]. As such, issue framing might best be used to a belief-shaping function. Similarly, knowledge construction would as be useful in shaping beliefs. Attribution of responsibility as an advocacy function comes from the Quaker-inspired tradition of "bearing witness" [32]. Often in the form of on-the-ground presence, front-line involvement, and the intention to enlighten the public, attribution of responsibility appears to invoke norms and attitudes as a behavior change strategy. The remaining three advocacy functions (i.e., lobbying, public mobilization, and agenda setting) all involve behavioral intention and ultimately active behavior change to impart upon the NGO goals. As such, with some admittedly-awkward manipulation, the advocacy framework can be mapped to fit within the frame of the theories of reasoned action and planned behavior. That said, a behavior-theory-informed extension of Szarka's framework might be prove useful in identifying which NGO functions and practices prove to lead to the actual intended behavior change.

Community-Based Social Marketing Framework

As previously noted, environmental advocacy campaigns are frequently information intensive [21], [33] based upon the assumption that if recipients knew and cared more, they would do more. While well-meaning, many such initiatives are ineffective and instilling behavioral change [19], [33]. Realizing that "achieving a sustainable future will require that

people do things differently" (i.e., change behaviors), McKenzie-Mohr and Schultz [34] call upon yet another framework known as community-based social marketing (CBSM) in efforts to foster sustainable behavior. CBSM involves a five-step process of behavioral change:

1. Select behaviors – This involves a two-part approach. First, develop a mutually-exclusive list of end state behaviors. Then, evaluate the list to determine which behaviors are high-likelihood and high-impact.
2. Identify barriers and benefits – Barriers and benefits may (and likely will) vary between different behaviors and also among different individuals. However, in order to create sustainable behavioral change, barriers must be minimized and benefits maximized.
3. Develop strategies – Carefully select from among the behavioral change tools (e.g., commitment, prompts, norms, goal setting, convenience, etc.).
4. Pilot the strategy – Test the strategy on a small scale before widespread implementation to ensure efficacy and effectiveness. Also, different strategies may be competed against one another to determine the most cost-effective option.
5. Broad-scale implementation and evaluation – Once the pilot has proven successful, apply it to a wide-scale implementation and continue to evaluate efficacy and effectiveness.

In short, CBSM would be a specific approach to developing advocacy functions and strategies. For example, if an NGO decided that knowledge generation and dissemination (e.g., education) were an important advocacy function for its particular mission, it would first identify the specific behavioral changes necessary to address the environmental concerns. Then, they would analyze the barriers and benefits and create educational strategies to motivate the specific behavior changes. This is fundamentally different from the typical educational campaigns which are primarily cognitive in nature to those that influence affect and emotions in addition to behaviors. The NGO would then pilot test the strategies and ultimately, if successful, it would launch a full-scale campaign.

Proposed Experimental Framework

Using the previously referenced studies and research as a foundation, a theoretical framework will now be put forth. This framework as described in Figure 2 simplifies the theories of reasoned action and planned behavior into a single composite construct, which will be called *determinants* of behavior and labeled as D. The determinants of planned behavior, the independent variables in this case, will include values, beliefs, norms, attitude,

intentions, and decisions. Actual conservation behavior is the dependent variable and will be labeled as B.

This basic relationship previously demonstrated in the psychological literature provides the first hypothesis,

H1: There is a positive relationship between the determinants of behavior (D) and the actual conservation behaviors (B).

The inserted chart in Figure 2 illustrates this positive relationship with the positively sloping solid line.

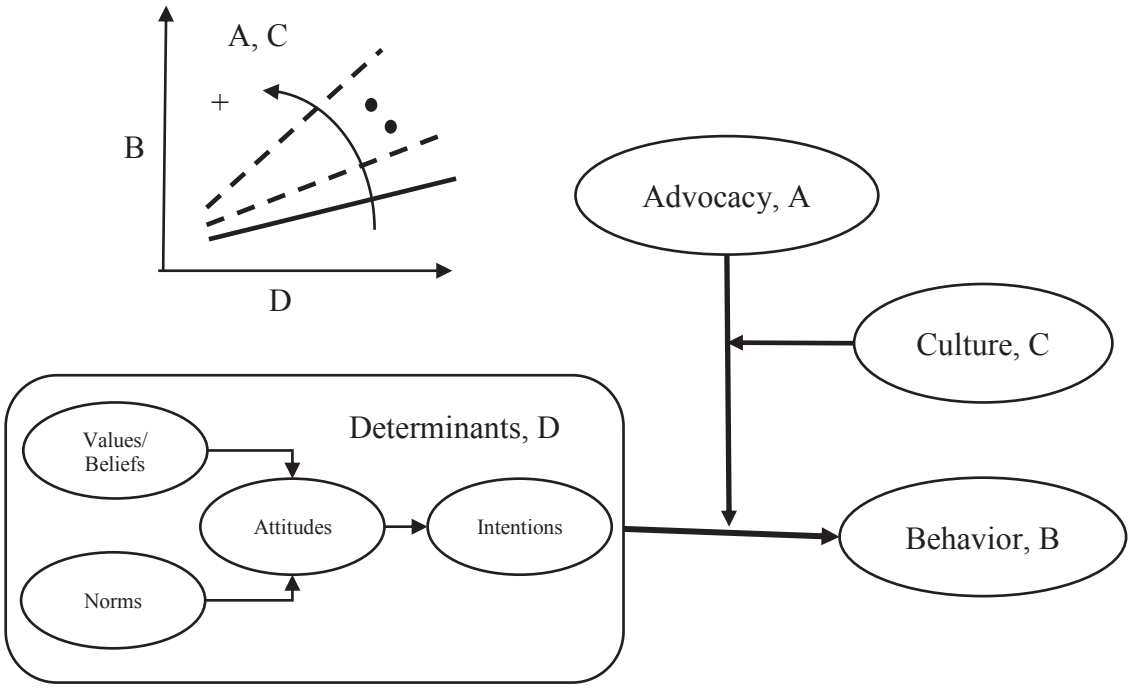

Figure 2: Theoretical Framework

Additionally, advocacy roles and strategies, labeled as A will serve to moderate the relationship between the determinants of behavior, D, and actual conservation behaviors, B. For example, advocacy strategies (A) such as community-based social marketing will enhance the relationship between the determinants (D) and the behaviors (B). From the conservation literature, we have our second hypothesis:

H2: As increasingly effective advocacy strategies (A) are applied, the relationship between determinants of behavior (D) and conservation behaviors (B) also increases.

The inserted chart in Figure 2 illustrates this moderator effect with the addition of a series of increasingly positively sloped dashed lines.

Finally, since culture (C) is an extremely important context variable and also an important dimension of the determinants of behavior, it is expected that culture will mediate the relationship between the advocacy strategies (A) and its effect of the determinant-behavior relationship. In other words, the efficacy of advocacy (A) on behavior (B) is influenced by the cultural context (C) within which the advocacy is taking place. From the culture literature, this provides our final hypothesis:

H3: Advocacy (A) influence on behavior (B) varies with culture (C).

In order to test the above theoretical framework and the proposed hypotheses, a experimental framework will be put forth. The framework will be based upon a quasi-experimental non-equivalent group design [3], [4] as shown in Figure 3.

N1	L	X	A
N2	L		A

Figure 3: Non-Equivalent Group Design

In the non-equivalent group design, there are two groups (N1 and N2). These will either be intact groups (e.g., from the Maritime Environmental Protection Associations) and thus non-randomly assigned or assembled groups randomly assigned (particularly where an equivalent group is needed). N1 will be the treatment group and N2 will be the control group (that receives no treatment between the pre- and post-testing). Both groups will be subject to the same pre-testing. In this case, since we are examining ocean advocacy and action, we will be interested in assessing their ocean literacy (as a potential addiional modifier variable) labeld as L [5], [6]. Likewise, since these groups are being drawn from a global population, we will also want to assess contextual factors [35] such as culture [36], [37]. Treatments are advocacy strategies and will vary, but could include CBSM strategies, or any of those described in the behavior conservation literature. Once the treatment, noted as X, has been applied to the treatment group, then after prescribed periods of time, both groups will be subject to post-testing to measure behavioral intent and ultimately behavior changes, labeled as A.

In conclusion, by conducting such exeriments, we exppect to identify those NGO advocacy strategies and techniques that work best in changing public behavior when it comes to ocean advocacy and concern for environmental issues. This is important because in order to effect change more deliberate efforts need to be made to change behaviors that will result in improvements to conservation efforts.

References:

[1] United Nations, "Goal 14: Conserve and sustainably use our oceans, seas, and marine resources," [Online]. Available: http://www.un.org/sustainabledevelopment/sustainable-development-goals/. [Accessed 29 December 2015].

[2] International Associatioin of Maritime Universities, "Tasmanian Statement 2014," 2014. [Online]. Available: http://iamu-edu.org/?page_id=2995. [Accessed 12 March 2016].

[3] J. Shaughnessy, Zechmeister, E and Zechmeister, J, Research methods in psychology 10th edition, New York: McGraw-Hill, 2014.

[4] C. Reichardt, "Nonequivalent group design," in *Encyclopedia of statistics in behavior science*, New York, Wiley & Sons, 2014.

[5] M. Umuhire and Q. Fang, "Method and application of ocean environmental awareness measurement" Lessons learnt from university students of China," *Marine Pollution Bulletin,* vol. 102, no. 2, pp. 289-294, 2016.

[6] Ocean Literacy Project, "Principles of the Scope and Sequence," 12 January 2015. [Online]. Available: http://oceanliteracy.wp2.coexploration.org/ocean-literacy-framework/principles-and-concepts/. [Accessed 22 March 2017].

[7] P. W. Schultz, "Conservation means behavior," *Conservation biology,* vol. 25, no. 6, pp. 1080-1083, 2011.

[8] B. S. Halpern, C. Longo, D. Hardy, K. L. McLeaod, J. F. Samhouri and S. K. Katona, "An index to assess the health and benefits of the global ocean," *Nature,* vol. 488, no. 7413, pp. 615-620, 2012.

[9] V. J. Cole, L. M. Parker, S. J. O'Connor, W. A. O'Connor, E. Scanes, M. Byrne and P. M. Ross, "Effects of multiple climate change stressors: Ocean acidification interacts with warning, hyposalinity, and low food supply on the larvae of the brooding flat oyster Ostrea angasi," *Marine biology,* vol. 163, no. 5, pp. 1-17, 2016.

[10] E. S. Poloczanska, M. T. Burrows, C. J. Brown, J. García Molinos, B. S. Halpern and O. Hoegh-Guldberg, "Responses of marine organisms to climate change across oceans," *Frontiers in marine science,* vol. 3, no. 62, 2016.

[11] A. Masello and O. Defeo, "The deep-sea red crab Chanceon notialis (Geryonidae) in the southwestern Atlantic Ocean: Spatial patterns and long-term effects of fishing," *Fisheries research,* vol. 183, pp. 254-262, 2016.

[12] G. Hardin, "The tragedy of the commons," *Science,* vol. 162, no. 3859, pp. 1243-1248, 1968.

[13] E. Ostrom, "Tragedy of the commons," in *The new palgrave dictionary of economics*, 2008, pp. 2573-3576.

[14] A. A. Leiserowitz, R. W. Kates and T. M. Parris, "Do global attituides and behaviors support sustainable development?," *Environment: Science and Policy for Sustainable Development,* vol. 47, no. 9, pp. 22-38, 2005.

[15] A. Vaughan, "Public concern for environment lowest in 20 years," *Guardian,* 28 02 2013.

[16] D. W. Moore, "Public leans toward conservation approach to environmental policy," *Gallup Poll Monthly,* vol. 438, no. March, pp. 35-38, 2002.

[17] T. Crompton, "Weathercocks and signposts: The environmental movement at the crossroads," World Wildlife Fund, Godalming, UK, 2008.

[18] SustainAbility and GlobeScan, "Evaluating progress toward the sustainable development goals," GlobeScan & SustainAbility, London, 2017.

[19] P. W. Schultz, "Knowledge, education, and household recycling: Examing the knowledge-deficit model of behavior change," in *New tools for environmental protection*, Washington, DC, National Academy of Sciences, 2002, pp. 67-82.

[20] J. D. Fisher, W. A. Fisher and P. Shuper, "The information motivation-behavioral skills model in HIV prevention behavior," in *Emerging theories in health promotion practice and research*, San Francisco, Wiley, 2009, pp. 21-65.

[21] D. N. McKenzie-Mohr, P. W. Lee, W. Schultz and P. Kotler, Social marketing to protect the environment: What works, Thousand Oaks, CA: Sage, 2012.

[22] R. Gifford, L. Scannell, C. Kormos, L. Smolova, A. Biel and S. Boncu, "Temporal pessimism and spatial optimism in environmental assessments," *Journal of Environmental Psychology,* vol. 29, no. 1, pp. 1-12, 2009.

[23] D. L. Ussell, "The psycho-spatial dimension of global environmental problems," *Journal of Environmental Psychology,* vol. 20, pp. 307-318, 2000.

[24] E. Gosling and K. Williams, "Connectedness to nature, place attachment and conservation behavior: Testing connectedness theory among farmers," *Journal of Environmental Psychology,* vol. 30, pp. 298-304, 2010.

[25] R. B. Cialdini, L. J. Demaine, B. J. Sagarin, D. W. Barrett, K. Rhoads and P. L. Winter, "Managing social norms for persuasive impact," *Social Influence,* vol. 1, pp. 3-15, 2006.

[26] F. A. V. St John, G. Edwards-Jones and J. P. G. Jones, "Conservation and human behavior: Lessons from social psychology," *Wildlife Research,* vol. 37, pp. 658-667, 2010.

[27] I. Ajzen, "The theory of planned behavior," *Organizational Behavior and Human Decision Processes,* vol. 50, pp. 179-211, 1991.

[28] R. J. Vallerand, P. Deshaies, J. P. Cuerrier, L. G. Pellitier and C. Moganeau, "Ajzen and Fishbein's theory of reasoned action as applied to moral behaviour: A confirmatory analysis," *Journal of Personality and Social Psychology,* vol. 62, pp. 98-109, 1992.

[29] C. D. Saunders, A. T. Brook and O. E. Myers, "using psychology to save biodiversity and human well-being," *Conservation Biology,* vol. 20, no. 3, pp. 702-705, 2006.

[30] J. Szarka, "From climate advocacy to public engagement: An exploration of the roles of environmental non-governmental organisations," *Climate,* vol. 1, pp. 12-27, 2013.

[31] R. D. Benford and D. A. Snow, "Framing processes and social movements: An overview and assessment," *Annual Review of Sociology,* vol. 26, pp. 611-639, 2000.

[32] S. R. Susanto, "The transformation of Greenpeace strategy in the 1990s: From civil disobedience to modern movement," *Global Strategy,* vol. 1, pp. 186-205, 2007.

[33] P. W. Schultz and F. G. Kaiser, "Promoting proenvironmental behavior," in *Handbook of environmental and conservation psychology*, New York, Oxford University Press, 2012, pp. 556-580.

[34] D. McKenzie-Mohr and P. W. Schultz, "Choosing effective behavior change tools,"

Social Quarterly Marketing, vol. 20, no. 1, pp. 35-46, 2014.

[35] P. Bansal and K. Roth, "Why companies go green: A model of ecological responsiveness," *Academy of Management Journal,* vol. 43, no. 4, pp. 717-736, 1000.

[36] T. L. Milfont and P. W. Schultz, "Culture and natural environment," *Current Opinion in Psychology,* vol. 8, pp. 194-199, 2016.

[37] S. M. C. Loureiro and D.-M. Koo, "The role of affective commitment in driving environmental efforts: A cross-cultural study," in *Global Marketing Conference Proceedings*, Singapore, 2014.

[38] M. A. Wolfson and N. Madjar, "Advocacy, gender and reputation: A motivational framework for creativity in negotiations," *Academy of Management Proceedings,* vol. 2014, no. 1, p. 13002, 2014.

PAY AS A DETERMINATE OF VOLUNTARY TURNOVER AMONG U.S. OFFSHORE COMMERCIAL MARINERS

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Abstract: Due to intense competition for employees with maritime expertise across multiple transportation-related industries, efforts to retain qualified seafarers in positions that require long-term travel at sea are a primary strategic concern for unions, shipping firms, and crewing service agencies. Pay represents the largest investment that these stakeholders make in their efforts at retention. Yet the relationship between pay and voluntary turnover is not well understood. Research in the maritime industry is sparse. Research across the management literature provides ambiguous or conflicting findings and their transferability to the maritime industry is questionable. In this paper, the authors attempt to better understand the relationship between pay and turnover in the maritime industry. The authors take a unique approach by surveying mariners who have actually left the industry. Findings of the study do not suggest a strong link between pay and turnover. Results indicate that other components like the employee's benefits package, or factors relating to job satisfaction other than pay may play a larger role in offshore mariners' decision to quit or stay.

Keywords: Mariner retention, pay satisfaction, voluntary turnover

Introduction

In organizations, managers use pay as a tool to attract qualified applicants, to maximize the performance of employees, and to retain high performers in the face of competing economic opportunities (Heneman & Judge, 2000). This effort represents one of the largest investments that employers make. Employee pay makes up as much as 57% of the total value of all U.S. production of goods and services (Williams, McDaniel & Nguyen, 2006). In this paper, we

report findings on a survey of mariners who left positions that required long, repeated, uninterrupted voyages at sea (who we term offshore mariners) for positions that do not require long-term travel at sea. The goal of our research is to better understand how employees' feelings about their pay influence their decision to quit or remain in offshore mariner positions.

Several aspects of this project are unique. Because of the particularly hazardous challenges of retaining seafarers who must be away from friends and family for long periods of time, we focus our analysis exclusively on offshore mariners. Moreover, our survey is limited to people who have already left positions as offshore mariners. This allows us to inquire about the positions they took after leaving and to ascertain their feelings about their time as an offshore mariner in retrospect. Additionally, this approach enables us to operationalize turnover as occurring when one actually leaves an offshore mariner position, rather than as their quit intention, the latter being a much less precise, but frequently used variable. Lastly, when operationalizing turnover, we focus on offshore mariners who leave the occupation (*i.e.,* occupational commitment) rather than on movement between firms (*i.e.,* organizational commitment). Prior research on turnover tends to focus on organizational commitment, which is a construct that is not particularly relevant in the U.S. maritime industry where commitment to a single firm is not a widespread norm, especially among unionized employees.

We begin our analysis by introducing prior research in the management literature about the relationship between pay and voluntary turnover. We then focus on turnover research that is specific to the maritime industry. Our methodological approach is outlined next, followed by a summary of the results of our survey. We close by discussing some of the implications of our research findings.

The relationship between pay and voluntary turnover

The relationship between pay and voluntary employee turnover is a complex one and research findings are somewhat ambiguous. Scholars who explore this link generally find that higher satisfaction with pay leads to lower turnover (*e.g.,* Currall, *et al.,* 2005; Cotton & Tuttle, 1986; DeConinck & Stilwell, 2004; Lum *et al.,* 1998; Vandenberghe & Tremblay, 2008; Williams, McDaniel & Nguyen, 2006). Yet some scholars report a relatively strong or important connection (*e.g.,* Cotton & Tuttle, 1986; Currall, *et al.,* 2005; DeConinck & Stilwell, 2004; Lum *et al.,* 1998), while others find a relatively weak relationship (*e.g.,* Singh & Loncar, 2010;

Williams, McDaniel & Nguyen, 2006; Vandenberghe & Tremblay, 2008). Leonard (1987) finds that, while pay increases may have a negative effect on turnover, the effect is too small to justify the cost of the increased pay.

Prior research on job satisfaction also has implications that conflict with scholarly work that suggests a strong link between pay satisfaction and turnover. Aside from self-reported quit intentions, satisfaction is the employee cognition that is thought to be the strongest predictor of voluntary turnover (Tett & Meyer, 1993). Yet among the five types of satisfaction thought to primarily contribute to an employee's overall sense of job satisfaction (pay, promotion, supervisor, coworker, and the work itself), pay has been found to have the weakest influence (Ironson *et al.,* 1989; Russell *et al.,* 2004).

Pay and turnover in the maritime industry

Given the ambiguous findings of prior research on the pay-turnover link and the particularly unique characteristics of the maritime industry, managers and other stakeholders in the industry receive little guidance from the management literature when trying to determine how increases in pay may influence mariners' decision to quit or stay. But because of their high level of skill and the significant challenges associated with retaining them, efforts to extend the tenure of offshore mariners are critical to the competitive advantage of shipping firms and to the vitality of the U.S. shipping industry as a whole (Lewis, Rao & Kamdar, 2015).

These efforts are complicated by the fact that among mariners there is generally not a professional norm of high organizational commitment. Seafarers tend to shift employment among shipping firms at a comparatively high rate (Fei, Chen & Chen, 2009). This is partly due to the fact that many U.S. mariners are unionized and even though they may have a preference for a particular shipping firm, they often have a relatively narrow range of assignments available through their union.

A culture of high occupational commitment is also not a norm among U.S. offshore mariners. One of the primary challenges that shipping firms and maritime unions face in retaining qualified mariners is the availability and attractiveness of shore positions (Caesar, Cahoon & Fei, 2013; Fei, Chen & Chen, 2009). Movement to shore side positions is thought to be one of the main contributing factors driving the worldwide shortage of seafarers (Caesar, Cahoon & Fei, 2015). Research suggests that the availability of desirable economic alternatives may moderate the negative relationship between pay satisfaction and turnover (*e.g.,* Shore & Martin, 1989) such

that as offshore mariners perceive a greater market demand for their skills, satisfaction with pay in their current position may be less likely to cause them to stay.

Yet shipping firms and maritime unions invest enormous sums of money in the hopes of attracting and retaining qualified mariners. A 2017 study of mid-career degree holders found that the average income of graduates of the State University of New York (SUNY) Maritime, whose 2017 student body was comprised of 70% license-track cadets (students training to work aboard a merchant marine vessel), was $144,000, besting both M.I.T. and Princeton University (Stern, 2017). Based on survey responses from mariners, it seems reasonable to conclude that these investments pay off in longer tenures. 62% of respondents to the 2012 Shiptalk Life at Sea Survey[1] said that increased pay would be likely to keep them at sea for longer. But while increased mariner pay may lead to greater occupational commitment, the positive effect on commitment to a particular shipping firm may be short-lived (Hult & Snoberg, 2013).

Method

The focus of this research is to determine if any insights can be gained about voluntary turnover among offshore mariners in the U.S. commercial shipping industry by surveying seafarers who have moved into positions that do not require long-term travel at sea. Hence, we limited survey respondents to people who met the following criteria:

- Were employed with a commercial shipping firm in a job that required long-term travel at sea (travel for most of the year where each trip averaged more than a week in length)
- Worked for at least one year in a position that required long-term travel aboard a U.S. flagged vessel
- Left a position that required long-term sea travel for a position that does not.

To conduct our survey, we emailed an online survey to 1,110 cadets who graduated from the California State University Maritime Academy with degrees in either maritime transportation or marine engineering technology between the years 1995-2015. We received 70 responses to our survey. Respondents' level of agreement with statements presented in the survey was determined using a 5-point Likert scale. 1 indicated strongly agree, 2 agree, 3 disagree, 4 strongly disagree, and 5 undecided.

[1] The Life At Sea survey is a multinational assessment of registered user of Shiptalk Recruitment about their experiences as seafarers. The 2012 survey had 488 respondents, making it one of the most comprehensive maritime employee surveys. Respondents from English-speaking countries are disproportionately represented (40%).

When assessing the link between pay and turnover, scholars frequently use self-reported quit intentions as the dependent variable, rather than actual turnover (*e.g.,* DeConinck & Stilwell, 2004; Lum *et al.,* 1998; Singh & Loncar, 2010; Vandenberghe & Tremblay, 2008). The advantage of this is that quit intentions can be more easily ascertained through survey data than can actual turnover. Gathering data from employees who have left an organization can be challenging. Despite the data gathering advantages of operationalizing turnover as quit intention, there are significant methodological concerns. While self-reported quit intentions are the strongest known predictor of actual turnover, the two are only correlated at a 0.38 level (Griffeth, Hom & Gaertner, 2000). To increase the validity of their turnover measure, some scholars instead use the variable tenure (*e.g.,* Bedeian & Ferris, 1992; Motowidlo, 1983).

When management scholars assess turnover, they tend focus on movement between firms. However, in the U.S. maritime industry, it is often erroneous to conceptualize turnover at the organizational level (*i.e.,* how long a mariner remained with a particular shipping firm). Because many offshore mariners in the U.S. are unionized, they tend to move fluidly between shipping firms based on availability of union job postings. Hence, we calculate tenure as the number years respondents report having worked as offshore mariners. We refer to our dependent variable as occupational tenure.

We also asked survey respondents a range of questions relating to the five facets of satisfaction that Ironson *et al.* (1989) claim primarily contribute to overall job satisfaction (pay, promotion, coworker, supervisor, and the work itself). Given its strong link to turnover (Allen, Shore & Griffeth, 2003; Eisenberger, Stinglhamber & Vandenberghie, 2002), we also asked a range of questions relating to former offshore mariners' sense of perceived organizational support including: availability of training opportunities; access to communications equipment to stay in touch with loved ones; availability of rest time; safety concerns; the attractiveness of the benefits package; and living conditions aboard ship. Lastly, we asked respondents how their income, and income growth potential, in the position they took after leaving their career as an offshore mariner compared with the pay they received in their prior seafaring position.

To test the significance of observed statistical differences in occupational tenure compared to levels of agreement to questions about job satisfaction, we performed the one-way ANOVA test. Thus, if the ANOVA test resulted in a statistically significant p-value, respondents in each category (strongly agree, agree, etc.) demonstrated appreciable statistical differences in mean

occupational tenure. We also used the two-sample, one-tailed t-test to determine whether there were statistical differences between genders and crewing service experience.

Results

Respondents were overwhelmingly satisfied with the amount they were paid while working as an offshore mariner: 32% strongly agreed that they were satisfied; 56% agreed; only 8% disagreed; and no respondents reported that they strongly disagreed. Women were significantly more satisfied with pay than their male counterparts (p=0.034). When asked what factors most strongly contributed to their decision to leave a career as an offshore mariner, only 19% of respondents cited the amount of pay. More frequently cited contributors included; personal factors unrelated to the position aboard ship (60%)[2], poor communications with friends and family on shore (34%), and availability of promotion opportunities (24%). The nature of the work itself came in just behind the amount of pay with slightly under 19% reporting it as one of the factors that most contributed to their decision to leave. It is interesting that 57% of respondents who cited pay as a factor that most strongly contributed to their decision to leave also either agreed or strongly agreed that they were satisfied with the amount they were paid.

The average occupational tenure of mariners in our sample was 6.7 years. When asked how long they planned to remain in their offshore mariner position when they started their seafaring career, the average response was 17 years. 28.6% of our sample spent more years training to sail than they spent in a career as an offshore mariner.[3] We performed a one-sided ANOVA test of all survey response categories (strongly agree, agree, etc.) with our dependent variable, occupational tenure. Satisfaction with pay was not significantly associated with occupational tenure. Satisfaction with benefits was significantly associated with occupational tenure (p=0.045) such that the more satisfied an offshore mariner was with their benefits package, the longer their occupational tenure tended to be. Consistent with prior research on the link between turnover and job satisfaction, three of the five facets thought to contribute to overall satisfaction had at least a moderately significant association with occupational tenure. Satisfaction with the nature of the work itself (p=0.059), satisfaction with the likability of managers (p=0.067), and

[2] The percentage of respondents who cite personal factors as a primary factor contributing to their decision to leave may be an underestimate. We allowed respondents to choose an open-ended "other" response to this question and many wrote in responses that would fit this category.

[3] This number is likely an underestimate. All respondents were graduates of California State University Maritime Academy. We asked respondents to tell us how many years they spent in training to be a mariner. Some said zero, or less than three, indicating that they did not perceive their time at university as training.

satisfaction with the availability of promotion opportunities (p=0.099) were all positively associated with occupational tenure.

With regard to the position respondents took after leaving their career as an offshore mariner, pay did not appear to be a strong motivator. 47% of respondents strongly disagreed, and 25% disagreed, that the pay they received in the first job they accepted after leaving a career as an offshore mariner was higher than their previous income. Respondents were a bit more optimistic about future income growth in the position they took after leaving. 17% strongly agreed, and 34% agreed that the prospects for income growth were better in the position they took after leaving their career as an offshore mariner. Still, 27% disagreed and 14% strongly disagreed.

20% of respondents agreed that that there was bias with regard to decisions about the amount they and their colleagues were paid. No one strongly agreed, 31% disagreed, 15% strongly disagreed, and 31% were undecided. Mariners who worked for crewing service agencies were significantly more likely to perceive bias than mariners who did not (p=0.043).

Discussion and conclusion

Prior research on the relationship between pay and turnover in the maritime industry is thin and consists mainly of currently employed mariners' self-reported projections about the effect that changes in pay might have on their likelihood of quitting or staying. We take a different approach. This may explain why our findings about how much pay may contribute to offshore mariners' decisions to quit are partly inconsistent with previous scholarly work. Only 19% of our survey respondents cited pay as a primary factor contributing to their decision to leave. Yet 62% of respondents to the 2012 Shiptalk Life at Sea Survey cited pay as a factor that would likely keep them on the job longer. We see two possible explanations for this disparity. First, many of the 2012 Shiptalk Life at Sea Survey respondents may be advocating for better pay. The lower percentage of mariners in our survey who cited pay as a retention issue may be in part a result of the decreased motivation to advocate for better pay since they have already quit. The large proportion of our respondents who cited pay as a primary reason for leaving, but also said that they were satisfied with pay may provide additional evidence for our advocacy hypothesis.

A second possible explanation for the disparity in results about the effect of pay on turnover is that mariners projecting into the future may fail to account for the diminishing returns that Worley, Bowen, and Lawler III (1992) find may occur when equivalent percentage increases in pay become relatively less attractive as the recipient's existing level of pay increases. Thus,

mariners imagining pay raises in the future may overestimate the positive effect that these will have on their overall well-being. Mariners who have actually received the pay raises that others are imagining may have adjusted for the diminishing returns described by Worley, Bowen, and Lawler III (1992) and may therefore give less weight to increases in pay as a motivator to stay.

Even if we assume that a negative relationship between pay and turnover exists, the decision to use pay to decrease turnover is a complex one. Managers must ask themselves if resources aimed at turnover reduction are better spent elsewhere (*e.g.,* training, benefits, encouraging interpersonal ties among coworkers, improved working conditions). Our findings suggest that investing in employees' benefits package may have a significant negative effect on turnover, while we see no significance associated with pay increases. We speculate that the reason for this difference is because when employers invest in meaningful benefits, it improves employees' sense of perceived organizational support (POS). While improvements to employees' benefits packages advantages them financially, it also demonstrates that managers understand employees' needs and care enough to respond to them, a central prerequisite to facilitating POS. This view is supported by the findings of Vandenberghe & Tremblay (2008) who suggest that the negative relationship between pay satisfaction and turnover may be moderated by affective commitment (an employee's positive emotional attachment to a company). After controlling for affective commitment, the relationship between pay satisfaction and turnover significantly weakens (Vandenberghe & Tremblay, 2008), suggesting that the negative effect that pay can have on turnover may be largely explained by what pay communicates to the employee about how much company managers understand employees' needs and care about fulfilling them.

An employees' sense POS may be more efficiently and meaningfully communicated using methods other than pay (Rhoades & Eisenberger, 2002). In addition to providing benefits, there are some other ways in which shipping firms and maritime unions can improve employees' sense of POS. A particularly attractive piece of low-hanging fruit would be to invest in modern communications equipment. We interviewed Jeremy Hope, an agent with Pacific Ports, a major U.S. mariner union. He estimates that only slightly over half of U.S. flagged offshore vessels have modern communications equipment that would allow mariners to reliably stay in contact with friends and family at home (Jeremy Hope, personal communication, July 26, 2017). We find this astounding given the consistency with which separation from loved ones is reported as the main challenge of a life at sea (*e.g.,* Kantharia, 2017; Shiptalk Recruitment, 2012). 44% of

respondents to our survey said that they either disagreed or strongly disagreed that they were satisfied with company efforts to keep them in touch with loved ones while they were at sea. Lewis, Rao & Kamdar (2015) find that a negligible decrease in the turnover rate of no more than 3% would more than pay for the installation and operating costs of a VSAT system that would reliably keep mariners connected to the internet.

Other uncertainties about using pay to decrease turnover make this a complex decision. For example, some mariners may actually leave earlier as a result of having reached their financial goals. Also, increasing labor costs relative to competitors may result in decreased turnover costs on one hand, but may lead to other significant cost disadvantages on the other. Additionally, pay satisfaction is a complex term with a wide range of contributing factors, including: personal and job inputs; monetary and non-monetary outcomes; pay policies and administration; and feelings of equity (or lack thereof) when referencing one's own pay with that of comparison others (Lum *et al.,* 1998). Hence, among other potential problems, an increase in pay for one employee or class of employees may result in equity distress in others, thereby causing a decrease in overall job satisfaction and potentially increasing the likelihood that some employees will quit.

The fact that mariners employed with crewing service agencies were more likely to perceive bias relating to the amount they were paid is consistent with research suggesting that employees' perception of fairness about pay may be significantly affected by the existence of procedural justice (belief that the process of determining pay is open and fair) and distributive justice (belief that the actual awarding of pay is equitable) (*e.g.,* Folger & Konovsky, 1989). Mariners who work for U.S. crewing service agencies are highly unlikely to be unionized (Jeremy Hope, personal communication, July 26, 2017). The difference in perceptions about bias relating to pay between crewing agency employees and those who do not work for crewing agencies suggests that the openness of the union collective bargaining system and the bureaucratized process of awarding raises may significantly contribute to employees' perceptions of fairness. Shipping firms who manage non-union labor may benefit from following the union approach to making and communicating decisions about pay.

Our findings that women are more satisfied with pay than men raise some concern since it is unlikely that women are being paid more than men, or working less. Our results are consistent with the findings of numerous previous scholars who have looked at gender differences in pay satisfaction (*e.g.,* Clark, 1997; Lambert, Hogan & Barton, 2001; Williams, McDaniel & Nguyen,

2006). Two main explanations have been put forward for this discrepancy. The first is that women may be more satisfied with their jobs in general due to having lower expectations than men about the utility they are likely to gain from employment (Clark, 1997; Williams, McDaniel & Nguyen, 2006). This argument supposes that, relative to men, women have disproportionately high exposure to negative experiences in the workplace, and therefore, tend to have lower expectations with regard to future job satisfaction. Clark (1997) supports this argument by demonstrating that this effect significantly diminishes when women have less cause to underestimate expected employment utility (*e.g.,* when employees are generally young or highly skilled). We see some evidence that this effect may be happening in that men in our sample are more optimistic about their opportunities for future income growth after leaving their position as an offshore mariner than are women, but the significance of this effect is weak ($p=0.089$).

The second possible explanation for the differential rates in male and female pay satisfaction we observe may have to do with the different ways in which men and women are socialized. Specifically, men may be more inclined to stay in a job that gives them low satisfaction because they are more likely to be socialized to view themselves as the primary breadwinner (Lambert, Hogan & Barton, 2001). Conversely, women are more likely to be socialized to prioritize family issues other than income generation (Lambert, Hogan & Barton, 2001).

Being an offshore mariner is a challenging career. While shipping firms and unions could always do more to improve working conditions, there are certain aspects that many mariners may find undesirable that are simply inherent in the field, like separation from loved ones. This leads many industry experts focused on improving retention to emphasize the reward structure (*i.e.,* adding carrots as opposed to removing sticks). Our research suggests that in some ways, this mentality may have merit. However, we also find that the type of reward matters.

Lastly, it is important to note that, while the effect of pay on retention may be overestimated, competitive pay is, of course, an important part of human resource management strategy in the U.S. maritime industry. For example, pay does appear to be important to attracting talented people to start careers as mariners. Certain reward structures may also be useful to motivate higher performance. For example, many U.S. shipping firms provide bonuses to encourage adherence to important safety standards. While competitive pay rates likely play an important role in fulfilling some important human resource management goals, our research suggests that other factors may play a more important role in improving retention. We also caution human

resource management professionals in the U.S. shipping industry against a disproportionate focus on rewards. Respondents to our survey cited issues with the work itself as frequently as they did pay as a factor that primarily contributed to their decision to leave. We find that, with regard to responding to these concerns, there may be some low-hanging fruit yet to be plucked.

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References

Allen, D.G., Shore, L.M. & Griffeth, R.W. (2003). The role of perceived organizational support and supportive human resource practices in the turnover process. *Journal of Management,* 29: 99-118.

Bedeian, A. & Ferris, G. (1992). Age, tenure, and job satisfaction: A tale of two perspectives. *Journal of Vocational Behavior,* 40: 33-48.

Caesar, L., Cahoon, S. & Fei, J. (2013). Breaking the psychological contract and managing expectation: Developing solutions for the shortage of ship officers. *Proceedings of the IAME,* Marseille, Paris: 1-18.

Caesar, L., Cahoon, S. & Fei, J. (2015). Exploring the range of retention issues for seafarers in global shipping: Opportunities for further research. *WMU Journal of Maritime Affairs,* 14: 141-157.

Clark, A. (1997). Job satisfaction and gender: Why are women so happy at work? *Labour Economics,* 4: 341-372.

Cotton, J. & Tuttle, J. (1986). Employee turnover: A meta-analysis and review with implications for research. *The Academy of Management Review,* 11: 55-70.

Currall, S., Towler, A., Judge, T. & Kohn, L. (2005). Pay satisfaction and organizational outcomes. *Personnel Psychology*, 58: 613-640.

DeConinck, B. & Stilwell, C. (2004). Incorporating organizational justice, role states, pay satisfaction and supervisor satisfaction in a model of turnover intentions. *Journal of Business Research*, 57: 225-231.

Eisenberger, R., Stinglhamber, F. & Vandenberghie, C. (2002). Perceived supervisor support: Contributions to perceived organizational support and employee retention. *Journal of Applied Psychology*, 87: 565-573.

Fei, J., Chen, S. & Chen, S.L. (2009). Organizational knowledge base and knowledge transfer in the shipping industry. *Electronic Journal of Knowledge Management*, 7: 325-340.

Folger, R & Konovsky, M. (1989). Effects of procedural and distributive justice on reactions to pay raise decisions. *Academy of Management Journal,* 32: 115-130.

Griffeth, R., Hom, P. & Gaertner, S. (2000). A meta-analysis of antecedents and correlates of employee turnover: Update, moderator tests, and research implications for the next millennium. *Journal of Management,* 26: 463-488.

Hult, C. & Snoberg, J. (2013). *Wasted time and flag state worries: Impediments for recruitment and retention of Swedish seafarers.* Leiden: CRC Press

Heneman, H. & Judge, T. (2000). *Incentives and motivation. In S. Rynes & B Gerhart (Eds.), Compensation in organizations: Progress and prospects* (pp. 61-103). San Francisco, CA: New Lexington Press.

Ironson, G., Brannick, M., Smith, P., Gibson, W. & Paul, K. (1989). Construction of a job in general scale: A comparison of global, composite, and specific measures. *Journal of Applied Psychology,* 74: 193-200.

Kantharia, R. (2017, May 30). 12 main reasons seafarers quit sea jobs. *Marine Insight,* Retrieved from http://www.marineinsight.com/life-at-sea/12-main-reasons-seafarers-quit-sea-jobs/ on

Lambert, E., Hogan, N. & Barton, S. (2001). The impact of job satisfaction on turnover intent: A test of a structural measurement using a national sample of workers. *The Social Science Journal,* 38: 233-250.

Lewis, T., Rao, A. & Kamdar, N. (2015). Employee retention in the maritime industry: A review and analysis. *IAMU 2015 Annual General Assembly Conference Proceedings.*

Lum, L., Kervin, J., Clark, K., Reid, F., & Sirola, W. (1998). Explaining nursing turnover intent: Job satisfaction, pay satisfaction, or organizational commitment? *Journal of Organizational Behavior,* 19: 305-320.

Motowidlo, S. (1983). Predicting sales turnover from pay satisfaction and expectation. *Journal of Applied Psychology,* 68: 484-489.

Rhoades, L. & Eisenberger, R. (2002). Perceived organizational support: A review of the literature. *Journal of Applied Psychology,* 87: 698-714.

Russell, S., Spitzmuller, C., Lin, L., Stanton, J., Smith, P., Ironson, G. (2004). Shorter can also be better: The abridged job in general scale. *Educational and Psychological Measurement,* 64: 878-893.

Shiptalk Recruitment. (2012). *Life at Sea Survey, Seafarer Attraction & Retention.* Shiptalk Publishing.

Shore, L & Martin, H. (1989). Job satisfaction and organizational commitment in relation to work performance and turnover intentions. *Human Relations,* 42: 625-638.

Singh, P. & Loncar, N. (2010). Pay satisfaction, job satisfaction and turnover intent. *Industrial Relations,* 65: 470-490.

Stern, G. (2017, March 16). The Young Mariners of Throgs Neck. *The New York Times,* Retrieved from https://www.nytimes.com/2017/03/16/nyregion/suny-maritime-college.html?_r=0

Tett, R. & Meyer, J. (1993). Job satisfaction, organizational commitment, turnover intention, and turnover: Path analyses based on meta-analytic findings. *Personnel Psychology,* 46: 259-293.

Vandenberghe, C. & Tremblay, M. (2008). The role of pay satisfaction and organizational commitment in turnover intentions: A two-sample study. *Journal of Business and Psychology,* 22: 275-286.

Williams, M., McDaniel, M & Nguyen, N. (2006). A meta-analysis of the antecedents and consequences of pay level satisfaction. *Journal of Applied Psychology,* 91: 392-413.

Worley, C., Bowen, D. & Lawler III, D. (1992). On the relationship between objective increases in pay and employee's subjective reactions. *Journal of Organizational Behavior,* 13: 559-571.

IDENTIFICATION OF FACTORS THAT CONTRIBUTE TO UNDERUTILIZE OF LIFEJACKET BY FISHERMEN OF EAST COAST OF PENINSULAR MALAYSIA

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Abstract. The rate of fisherman drowns and missing in Malaysia every year are worrying. The drown and missing cases are believed due to not using the lifejacket carried on-board. The objective of this study is to identify factors that contribute to the underutilise of lifejacket by fishermen in Malaysia. This research was conducted in four steps. The first step was to conduct the literature review of factors that contributed to underutilisation of lifejackets. The second step was to develop the survey questionnaire based on the identified factors. The third step was data analysis, which comprised of variance and factor analysis. The fourth step was the result of the analysis. Literature review had identified four factors as follows: too hot, uncomfortable, bulky, and faith in swimming abilities. These factors were then used to develop 21 questionnaires by deriving the sub-factor and items for each factor. The Principle Axis Factor Analysis was used to analyse the result of the survey and had identified and renamed the four factors as follows: condition of lifejacket, awareness on using lifejacket, faith on swim ability and uncomfortable. As for the conclusion, the features that caused the under utilize of lifejackets by fishermen are the condition of lifejacket, awareness on using lifejacket, faith on swim ability and uncomfortable.

Keywords*:* lifejacket, under utilise, safety

Background

Commercial fishing has been one of the most dangerous occupations due to the uncertainty of weather, work far from shore, and hard to get any assistance during emergency. They risk related to this job are many such as man overboard, vessel's technical problem, and heavy weather.

According to finder.com.au, the commercial fisherman is at top of the list of the most dangerous job in Australia in 2013 (Chris Ison Rockfishing, 2013; Elizabeth Barry, 2017). The job is also 17 times more dangerous than the miner. In Malaysia, search and rescue cases conducted by the Malaysian Maritime Enforcement Agency (MMEA) involving lost of lives at sea from 2006 to 2015 is 553 cases, which comprise of 34% of the total 1636 cases (MMEA, 2015). Most of the lost of lives at sea cases are believe related to fishing activities. Other cases are medical evacuation, distress call from ships, and ship and boat incidents. The local fishermen that involves with incident from 2006 to 2015 is 132 persons, which 111 saved, 13 drown and 8 lost (MMEA, 2015). The comparison of cases between ships, tug boats, ferries, and boats (fishing boats and recreational boats) from 2006 to 2015 shows that the local fishing boat is the main contributor in the ships and boat incidents category with 21 cases, which is 61% followed by tug boats (27%) and sand mining vessel (12%) (MMEA, 2013, 2014, 2015). The aforementioned statistics related to commercial fishing is quite alarming. One of the factors that believed contributed to the drown and lost at sea statistic is the underutilisation of lifejacket by fishermen. Therefore, the objective of this research is to investigate and identify factors that cause lifejacket to be underutilized by fishermen in Malaysia and to propose the features of lifejackets that would address the issue.

Methodology

The overall research activities are shown in Figure 1. The detail explanation of each step is given in the following paragraphs.

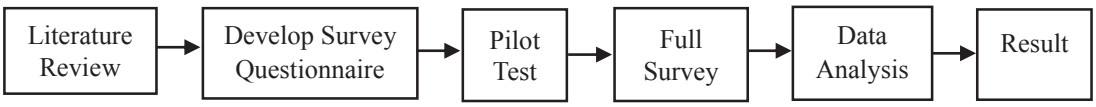

Figure 1: The flow chart of the research activities

The first step is to conduct a literature review to identify factors that contribute to underutilize of lifejacket by fishermen. Then the identified factors are filtered by referring it to the local fishermen. This is because, the identified factors may come from another country, which have a different climate and culture and may not applicable in Malaysia. The second step is to develop the survey questionnaire based on the identified factors. Sub-factors and item (question) for each sub-factor is developed. The minimum of two questions for each sub-factor. Five-point Likert-scale is used as the standard response of the survey (Likert, 1932). In the third step, pilot test was conducted to test the reliability of the questions. Upon received satisfying result, the step 4 full survey is conducted. Step 5 is the data analysis on the response of the survey. Step 6 is the final result.

Result and Discussion

Prior to the full survey, pilot test was conducted to 10 fishermen in district Kuala Terengganu to test the reliability of the questions prepared. The result of Cronbach's Alpha gained from the test was 0.622, which is within the acceptable range of reliability (Piaw, 2012). After that, full survey was conducted to fishermen community in Duyong Island and Ketam Island of district Kuala Terengganu . The population of the registered coastal fishing vessel (Class A) at the place was 113 persons. Therefore, the sample size of the survey is 86 (Ahmad Fuad, Abd Kader, Ahmad, & Abdul Malik, 2014). However, the number of response received was 87. This is because during the period of the survey, some of the vessel went out for fishing and it was hard to meet each listed vessel. The result of all 21 questions are shown below. 100% of respondent agree and strongly agree with the statement number 6 "wearing lifejacket limits movement". 100% respondent agree and strongly agree with the statement Statement number 7, "I feel uncomfortable wearing lifejacket". 83% of the respondent agree and strongly agree with statement number 8, which "lifejackets are heavy and not streamline with the body, thus limiting movement". Statement 6, 7 and 8 are related to wearing thick lifejacket that limits the movement of user. For the statements number 10, 11 and 12, 100% of the respondent agree and strongly agree that user refuse to use a bad condition lifejacket. Therefore, lifejackets should be properly maintained to encourage its usage. 87% of the respondent agree and strongly agree with statement number 14, which "People think that wearing lifejacket would tarnish the masculine and manhood image". This relates to the attitude of user, which give more priority to image and ego rather than safety. 82% of the respondent choose agree and strongly agree to statement number 1, which "Thick lifejacket may cause user to sweat heavily". This is highly relevant with user from tropical climate country such as Malaysia would sweat heavily by wearing lifejacket. 79% of the respondent agree and strongly agree with statement number 15 "High confidence in swim-ability would cause user reluctant to wear lifejacket".

Table 1: Response for question no. 1 "Thick lifejacket may cause user to sweat heavily"

Scale	Frequency	Percent	Cumulative Percent
Disagree	3	3.4	3.4
Undecided	11	12.6	16.1
Agree	56	64.4	80.5
Strongly Agree	17	19.5	100.0
Total	87	100.0	

Table 2: Response for question no. 2 “Lifejacket to suitable to wear during noon time”

Scale	Frequency	Percent	Cumulative Percent
Undecided	9	10.3	10.3
Agree	48	55.2	65.5
Strongly Agree	30	34.5	100.0
Total	87	100.0	

Table 3: Frequency table for question no. 3 “Type of material used to construct lifejacket cause heat to be trapped between body and lifejacket.”

Scale	Frequency	Percent	Cumulative Percent
Undecided	15	17.2	17.2
Agree	61	70.1	87.4
Strongly Agree	11	12.6	100.0
Total	87	100.0	

Table 4: Frequency table for question no. 4 “Using vest type lifejacket that is tight may cause the user hard to breath”

Scale	Frequency	Percent	Cumulative Percent
Disagree	11	12.6	12.6
Undecided	41	47.1	59.8
Agree	35	40.2	100.0
Total	87	100.0	

Table 5: Frequency table for question no. 5 “Using lifejacket may cause difficulty to user to move freely on boat or ship”

Scale	Frequency	Percent	Cumulative Percent
Undecided	5	5.7	5.7
Agree	65	74.7	80.5
Strongly Agree	17	19.5	100.0
Total	87	100.0	

Table 6: Frequency table for question no. 6 “wearing lifejacket limits movement”

Scale	Frequency	Percent	Cumulative Percent
Agree	57	65.5	65.5
Strongly Agree	30	34.5	100.0
Total	87	100.0	

Table 7: Frequency table for question no. 7 “I feel uncomfortable wearing lifejacket”

Scale	Frequency	Percent	Cumulative Percent
Agree	65	74.7	74.7
Strongly Agree	22	25.3	100.0
Total	87	100.0	

Table 8: Frequency table for question no. 8 “lifejackets are heavy and not streamline with body, thus limiting movement”

Scale	Frequency	Percent	Cumulative Percent
Undecided	14	16.1	16.1
Agree	68	78.2	94.3
Strongly Agree	5	5.7	100.0
Total	87	100.0	

Table 9: Frequency table for question no. 9 “It is uncomfortable wearing vest/dress type lifejacket on boat”

Scale	Frequency	Percent	Cumulative Percent
Disagree	7	8.0	8.0
Undecided	40	46.0	54.0
Agree	40	46.0	100.0
Total	87	100.0	

Table 10: Frequency table for question no. 10 “People do not like to use worn-out lifejacket”

Scale	Frequency	Percent	Cumulative Percent
Undecided	10	11.5	11.5
Agree	56	64.4	75.9
Strongly Agree	21	24.1	100.0
Total	87	100.0	

Table 11: Frequency table for question no. 11 “People do not like to use molded lifejacket”

Scale	Frequency	Percent	Cumulative Percent
Agree	42	48.3	48.3
Strongly Agree	45	51.7	100.0
Total	87	100.0	

Table 12: Frequency table for question no. 12 “People do not like to wear smelly lifejacket”

Scale	Frequency	Percent	Cumulative Percent
Agree	47	54.0	54.0
Strongly Agree	40	46.0	100.0
Total	87	100.0	

Table 13: Frequency table for question no. 13 “Lifejacket should be wear only by persons who do not know how to swim”

Scale	Frequency	Percent	Cumulative Percent
Disagree	9	10.3	10.3
Undecided	31	35.6	46.0
Agree	35	40.2	86.2
Strongly Agree	12	13.8	100.0
Total	87	100.0	

Table 14: Frequency table for question no. 14 “People think that wearing lifejacket would drop the masculine and manhood image.”

Scale	Frequency	Percent	Cumulative Percent
Disagree	4	4.6	4.6
Undecided	7	8.0	12.6
Agree	60	69.0	81.6
Strongly Agree	16	18.4	100.0
Total	87	100.0	

Table 15: Frequency table for question no. 15 “High confident in swim-ability would cause user reluctant to wear lifejacket”

Scale	Frequency	Percent	Cumulative Percent
Undecided	18	20.7	20.7
Agree	56	64.4	85.1
Strongly Agree	13	14.9	100.0
Total	87	100.0	

Table 16: Frequency table for question no. 16 “The price of quality lifejacket is expensive”

Scale	Frequency	Percent	Cumulative Percent
Undecided	8	9.2	9.2
Agree	47	54.0	63.2
Strongly Agree	32	36.8	100.0
Total	87	100.0	

Table 17: Frequency table for question no. 17 “I can’t afford to buy the quality lifejacket”

Scale	Frequency	Percent	Cumulative Percent
Disagree	1	1.1	1.1
Undecided	17	19.5	20.7
Agree	68	78.2	98.9
Strongly Agree	1	1.1	100.0
Total	87	100.0	

Table 18: Frequency table for question no. 18 “My unstable income not permit to buy lifejacket”

Scale	Frequency	Percent	Cumulative Percent
Undecided	1	1.1	1.1
Agree	47	54.0	55.2
Strongly Agree	39	44.8	100.0
Total	87	100.0	

Table 19: Frequency table for question no. 19 “Lack of awareness on the importance of using lifejacket had caused people do not prefer to use it”

Scale	Frequency	Percent	Cumulative Percent
Undecided	32	36.8	36.8
Agree	53	60.9	97.7
Strongly Agree	2	2.3	100.0
Total	87	100.0	

Table 20: Frequency table for question no. 20 “I only wear lifejacket during emergency and rough sea”

Scale	Frequency	Percent	Cumulative Percent
Undecided	1	1.1	1.1
Agree	64	73.6	74.7
Strongly Agree	22	25.3	100.0
Total	87	100.0	

Table 21: Frequency table for question no. 21 “Lack of enforcement by the authority on the usage of lifejacket”

Scale	Frequency	Percent	Cumulative Percent
Disagree	6	6.9	6.9
Undecided	11	12.6	19.5
Agree	55	63.2	82.8
Strongly Agree	15	17.2	100.0
Total	87	100.0	

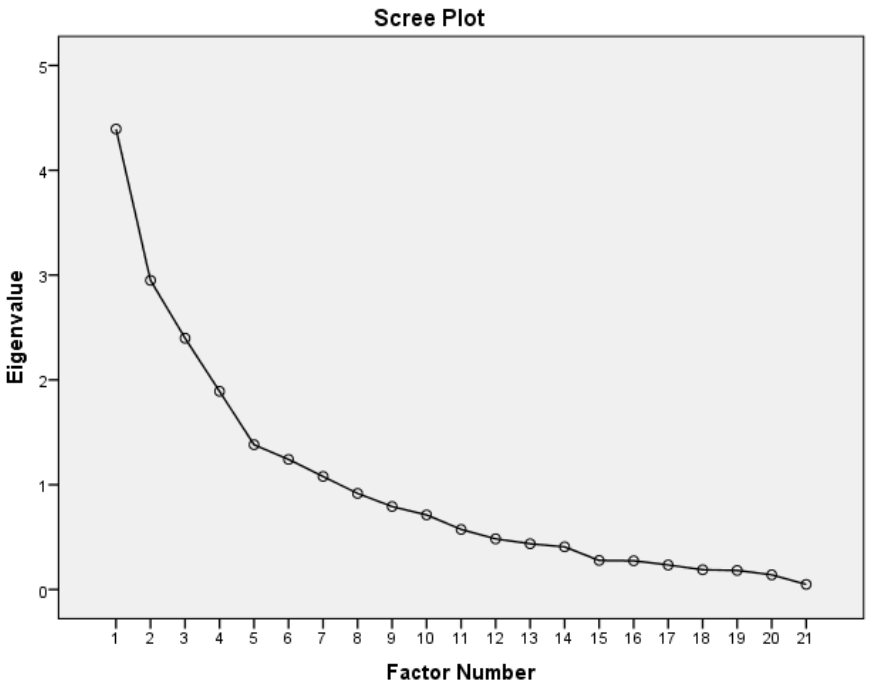

Figure 2: Scree plot graph

A scree plot is a plot of the eigenvalues against the number of factors in order of extraction (Kothari, 2012; Piaw, 2011). The scree plot above shows the first four columns that depicts four factors. Starting from the fifth factor, the line is almost flat, depicts that each successive factor is accounting for decreasing amounts of the total variance. Therefore, the number of factors identified in this analysis is four.

Table 22 shows the result of factor analysis performed to all 21 statements. These statements were grouped into four factors. Table 22 contains the rotated factor loadings (factor pattern matrix), which represent both how the variables are weighted for each factor but also the correlation between the variables and the factor. During the analysis, values 0.3 and lower were filtered blank to remove the variable with low correlations and not meaningful.

Table 22: Factor Analysis of the response received

Rotated Factor Matrix[a]				
Statements	**Factor**			
	1	**2**	**3**	**4**
No. 11: People do not like to use molded lifejacket	0.908			
No. 12: People do not like to wear smelly lifejacket	0.822			
No. 7: I feel uncomfortable wearing lifejacket	0.651			
No. 5: Using lifejacket may cause difficulty to user to move freely on boat or ship.	0.509			
No. 10: People do not like to use worn-out lifejacket	0.466			
No. 1: Thick lifejacket may cause user to sweat heavily				
No. 19: Lack of awareness on the importance of using lifejacket had caused people do not prefer to use it		0.793		
No. 21: Lack of enforcement by the authority on the usage of lifejacket.		0.753		
No. 14: People think that wearing lifejacket would drop the macho and manhood image.		0.625		
No. 18: My unstable income not permit to buy lifejacket.				
No. 16: The price of the quality lifejacket is expensive.		0.555		
No. 4: Using vest type lifejacket that is tight may cause the user hard to breath.				
No. 17: I can't afford to buy the quality lifejacket.				
No. 15: High confident in swim-ability would cause user reluctant to wear lifejacket.			-0.892	
No. 13: "Lifejacket should be wear only by persons who do not know how to swim"			0.506	
No. x: I only wear lifejacket during emergency and rough sea.			0.453	
No. x: Difficult to seat comfortably on boat when wearing vest type lifejacket				
No. 8: lifejackets are heavy and not streamline with body, thus limiting movement"				0.767
No. 2: Lifejacket not suitable to wear during noon time				0.576
No. 6: wearing lifejacket limits movement				0.417
No. 3: Type of material used to construct lifejacket cause heat to be trapped between body and lifejacket.				

The four factors identified in Table 22 are named as shown in Table 23 according to group of related variable/category.

Table 23: Factor Analysis of the response received

Factor 1: Condition of Lifejacket.	Moldy; smelly; restless; and worn-out
Factor 2: Awareness on wearing lifejacket.	Lack of awareness campaign; lack of enforcement; not masculine /macho; and expensive
Factor 3: Swim-ability	high confidence in swim ability; wear during emergency; and wear by non-competence swimmer
Factor 4: Uncomfortable	limits movement; noon-time; and movement difficulties

Conclusion

The respondents agree that lifejacket limits movement, uncomfortable to wear, hot to wear in the hot and humid climate and drop the masculine image. The respondents also agree on refuse to wear the bad condition lifejacket. There are four factors verified by the factor analysis, which related to under utilize of lifejacket as follows: condition of lifejacket, awareness on using lifejacket, swim-ability and uncomfortable.

References

Ahmad Fuad, A. F., Abd Kader, A. S., Ahmad, M. Z., & Abdul Malik, A. (2014). The Study to Propose Life Jacket Provision Index Static Model for the Assessment of the Provision of Life Jacket On Board Coastal Passenger Vessel. *Journal of Applied Science and Agriculture*, *9*(18), 185–189.

Chris Ison Rockfishing. (2013, September 16). Fishermen have one of the most dangerous jobs in Australia. *Capricornia Newspapers Pty Ltd*. Sydney. Retrieved from https://www.themorningbulletin.com.au

Elizabeth Barry. (2017). Australia's 10 most dangerous jobs. Retrieved July 11, 2017, from https://www.finder.com.au/dangerous-jobs

Kothari, C. R. (2012). *Research Methodology: An introduction*. *Research Methodology: Methods and Techniques* (Vol. IX). http://doi.org/Goddard, W. & Melville, S.

Likert, R. (1932). *A technique for the measurement of Attitudes*. New York: Columbia University Press.

MMEA. (2013). *MMEA Laporan Tahunan 2013*. Putrajaya.

MMEA. (2014). *MMEA Laporan Tahunan 2014*. Putrajaya.

MMEA. (2015). *MMEA Laporan Tahunan 2015*. Putrajaya.

Piaw, C. Y. (2011). *Kaedah Penyelidikan Buku 1* (2nd ed.). Kuala Lumpur: McGraw-Hill.

Piaw, C. Y. (2012). *Asas Statistik Penyelidikan Buku 2* (2nd ed.). Kuala Lumpur: McGraw-Hill.

OPERATIONAL AUTOMATIC VOLTAGE REGULATOR OF SHIP SYNCHRONOUS GENERATORS

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Abstract

The paper presents a design of an automatic electronic voltage regulator of ship synchronous generators. It is intended to replace transistor regulators, which have low performance and accuracy parameters and their accuracy of voltage maintenance reaches 3 - 5 %. But this precision does not match the requirements.

The modeling of the valid regulator has a voluminous form. This creates lots of parasite capacitances and inductances, which affect its work speed. The old transistors often get out of order which reduces the reliability of the generator. In order to eliminate these disadvantages an automatic voltage regulator with operational amplifier was designed. Its main work principle is based on the comparison between the generator's voltage and the reference one. This difference is amplified and affects the control coil. If the generator's voltage differs from the standard, the quick impact on the coil restores it. The elements used in the regulator's production are modern with wide temperature range, high fidelity and fast operation. All this contributes to the elimination of the above mentioned defects.

Keywords: proportional-integral-differential controller, pulse-width modulation scheme, automatic voltage regulator, AVR, comparator

Introduction

Ship generators with automatic systems of excitation have to produce electricity in the needed quantity and relevant quality (Hebner 2005; Prousalidis 2008). It requires voltage and frequency

maintenance in the given parameters. According to the requirements of the ship registers the power system has to have the following characteristics.

In steady state the AVR must be able to keep the voltage within ±2,5% of the rated voltage under all steady load conditions. The limit can be increased to ±3,5% for emergency generator sets.

When specifying the requirements for voltage regulation in load changes, a definition of sudden load is used. The sudden load is defined to be more than 60% of the full load current at power factor of 0,4 lagging or less. When switching on the sudden load the instantaneous voltage drop must not exceed 15% of the rated voltage. When the load is switched off the voltage rise must not exceed 20%. In both cases the voltage regulation must restore the voltage within ±3% of the rated voltage within 1,5 s. For emergency generator sets not in parallel operation, the limits can be increased to ±4% and 5 s.
(Zalewska 2009) presents a comparative analysis of different types of voltage controllers for synchronous generators. For voltage regulation of generator control AVR employing conventional, fixed parameter compensators is able to provide good steady state voltage regulation and fast dynamic response to disturbances. Marine compound system is a typical example of a compound type of automatic voltage regulator of ship synchronous generator (Djagarov 1997).

Scheme of automatic voltage regulator

The basic AVR has to provide close-loop control of the synchronous generator (SG) terminal voltage by acting upon the exciter winding with a voltage, U. It may have 1,2,3 stabilization loops and additional inputs, besides the reference voltage U_{rvf} of SG and its measured value with load compensation U_c:

$$U_c = \left|U_g + (r_c + jX_c).I_g\right|.\frac{1}{1+s\tau_s} \qquad (1)$$

The load compensator introduces the compensation of generator voltage variation due to load and also the delay τ, due to the voltage sensor. Other than that, a major field-winding voltage U_f loop is introduced. The voltage regulator may be of many types (a lead-lag compensator, for example) with various limiters.

Block scheme of automatic voltage regulator is shown in fig. 1

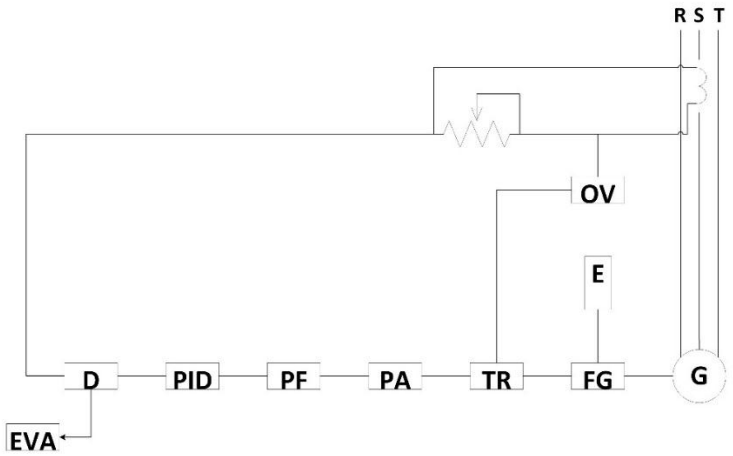

Fig. 1. Block Scheme of Automatic Voltage Regulator

Where: G – generator; FG – generator`s excitation coil; E – initial excitation; TR – thyristor; OV – Overvoltage protection; PA – pulse amplifier; PF – pulse phase; PID – proportional-integral-differential controller; D – measuring unit ΔU; EVA – setting voltage reostat

An electrical scheme has been designed in order to meet the requirements of the Bulgarian Ship Register (fig. 2).

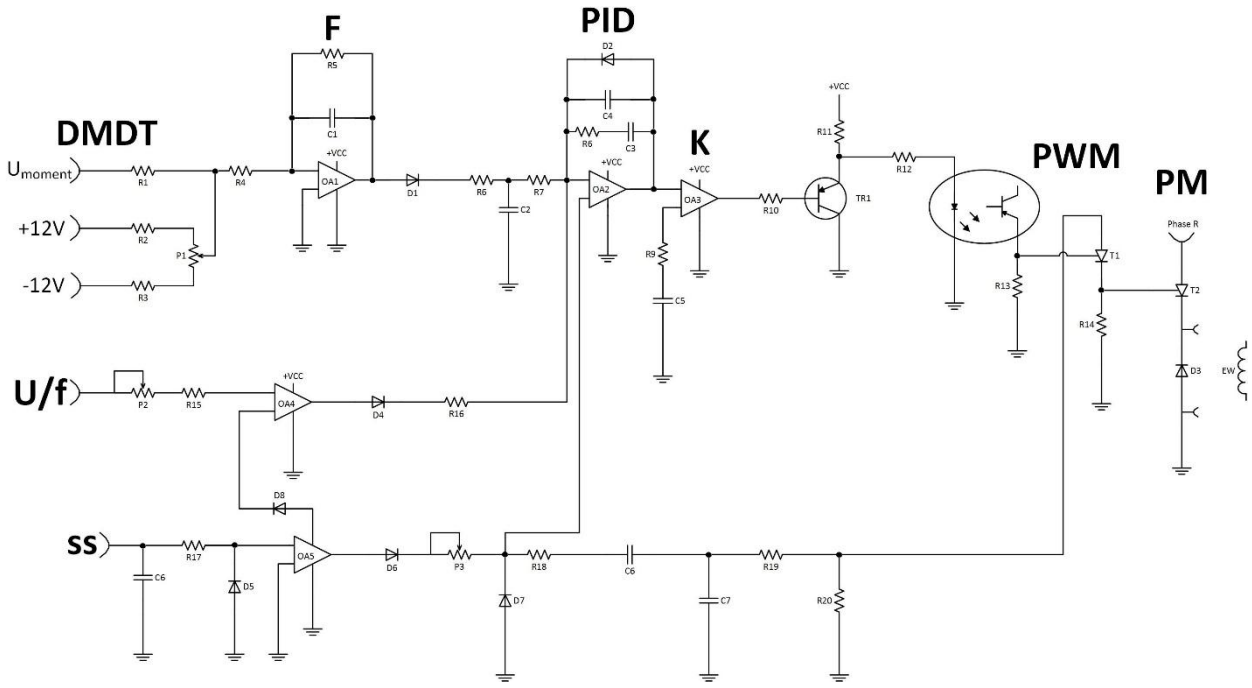

Fig. 2. Operational automatic voltage regulator of ship synchronous

On this scheme the following indications are shown:
DMDT – Device for measurement and droop tune; F - filter alerts; SS – synchronization scheme; PM – power module; PID – proportional-integral-differential controller; K – comparator; PWM – pulse-width modulation scheme operating the power module

Automatic voltage regulator measures the voltage of the generator and the change of the reactive current and regulates the voltage of excitation in a such way that the generator's voltage is maintained in a state which is at least ±2% accurate as it ensures the static character at the reactive loading within the above-mentioned 2%. The automatic voltage regulator influences the generator's voltage as it controls the generator's excitation current. The regulator works on the base of the width-impulse principle as it regulates the width of the impulses towards the excitation coil and thus regulates the amount of the rotor current. The amount of the basic stabilized voltage, which is compared to the generator's voltage, is changed by the means of the potentiometer P1 of DMDT.

In the device for measurement and droop tune (DMDT) the generator's voltage U_g enters the automatic regulator and thus the unnecessary disturbances are filtered. The difference between the generator's voltage U_g and the pilot voltage U_{ref}:

$$\Delta U = \pm (U_g - U_{ref}) \qquad (2)$$

is sent to the PID controller.

It is processed in the PID controller and at the output a signal is produced, which controls PWM. At the other end, a voltage, which is proportional to the pilot voltage U_{ref} influences the rotor's excitation coil.

Fig. 3 shows the dependence of the pilot voltage Uref from the change of the generator's voltage U_g.

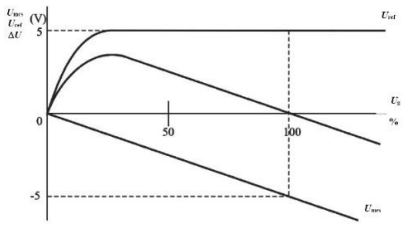

Fig.3. Graphic of the relations of the voltages

The three-phase voltage of the generator is transformed by a transformer and is stabilized by the power module, which ensures the supply of all modules of the automatic voltage regulator.

The comparator is an electronic scheme with analogue input and impulse output, i.e. the PID controller sends impulses with certain length and amplitude based on the input voltage to it. The output impulse indicates whether the input voltage U_g is bigger than the pilot voltage U_{ref} or not. This impulse operates the thyristors of the power module, which is shown in fig. 4.

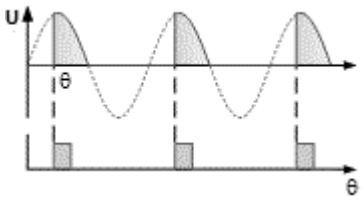

Fig. 4 Operation of the thyristor by the deviation of the voltage from the nominal one.

The main part is the operation amplifier, which ensures the work of the proportional-integral-differential (PID) controller. The deviation of the generator's voltage ΔU is amplified and this amplified difference ΔU is proportional to the integral of the entry voltage and it enters the comparator. PID controller and the pulse-width modulation scheme form the law of PID controlling according to which the voltage regulator functions and is presented by the formula:

$$U = k_p.U_{mes} + \frac{1}{T_i}.\int U_{mes}dt + T_d.\frac{dU_{mes}}{dt} \qquad (3)$$

Synchronization scheme (SS) is a functional generator, which sends impulses by the means of the comparator, which operates the pulse-width modulation scheme.

The electrical protection module U/f transfers impulses, which lock the power module at lower frequency of rotation of the generator up to 30 Hz, which results in the lower voltage supply to the excitation coil.

Investigation of the work of the automatic voltage regulator

The work of the designed automatic voltage regulator was investigated in Matlab environment. The system consists of synchronous generator with active-inductive load. The rated parameters of the generator are: S = 5 *kVA*; f = 50 *Hz*; U = 390/235 *V*; I = 7,4/4,5 *A*; n = 3000 *rpm*; U_f = 90 *V*; I_f =

3,8 *A*; R_a = 1,5 *Ω*; R_f = 18,2 *Ω*; X_a = 8,5 *mH*; X_f = 518 *mH*; x_d' = 0,17 *p.u.*; x_d" = 0,12 *p.u.* .A short-circuit in the system is simulated at t=4s and excluded by protection at t=4.4s.

The graphics look like:

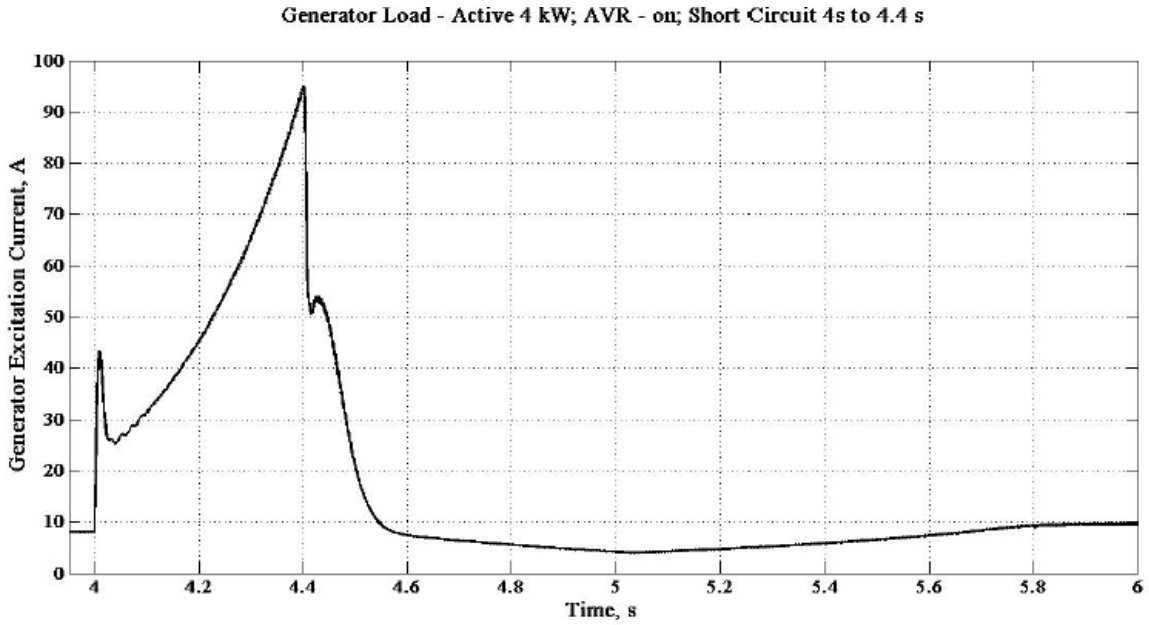

Fig. 5. Excitation current of the synchronous generator

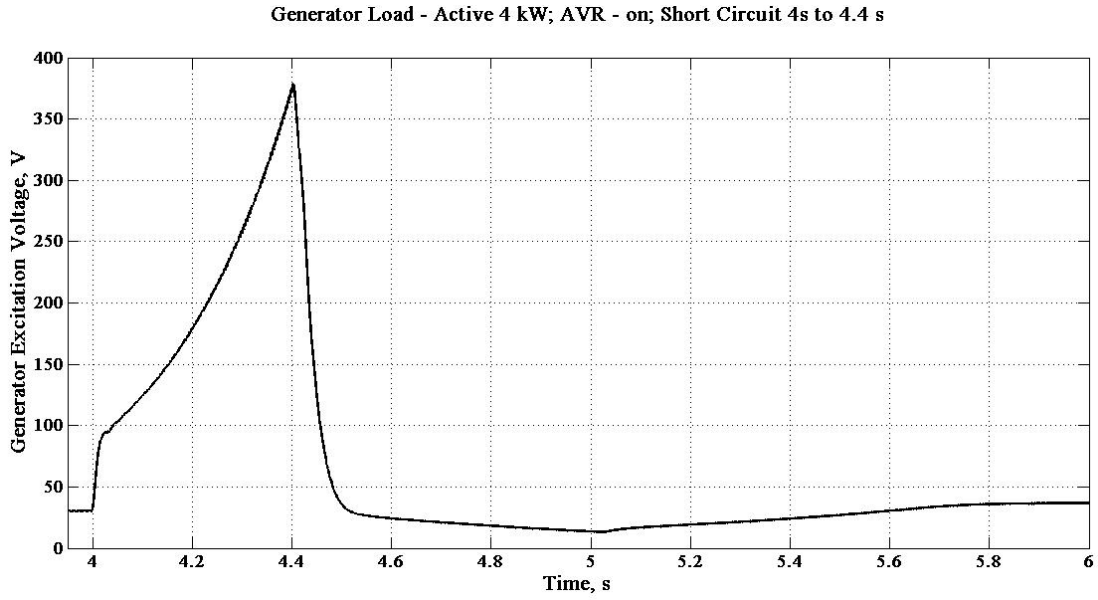

Fig. 6. Excitation voltage of the synchronous generator

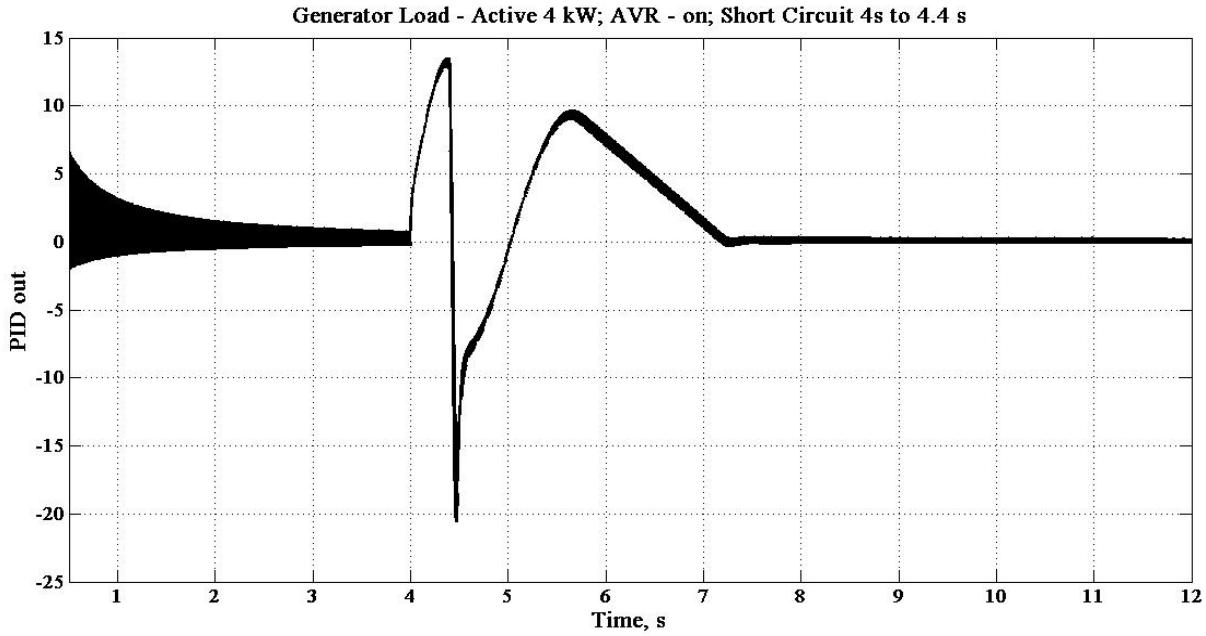

Fig. 7. Output signal from the PID controller

It can be seen from the graphs that the excitation current (Fig. 5) increases sharply, as a result, the excitation voltage is also increased (Fig.6). Fig. 7 shows that the generator's voltage drops, but due to the influence of the AVR on the generator excitation voltage, it is restored to the relevant parameters.

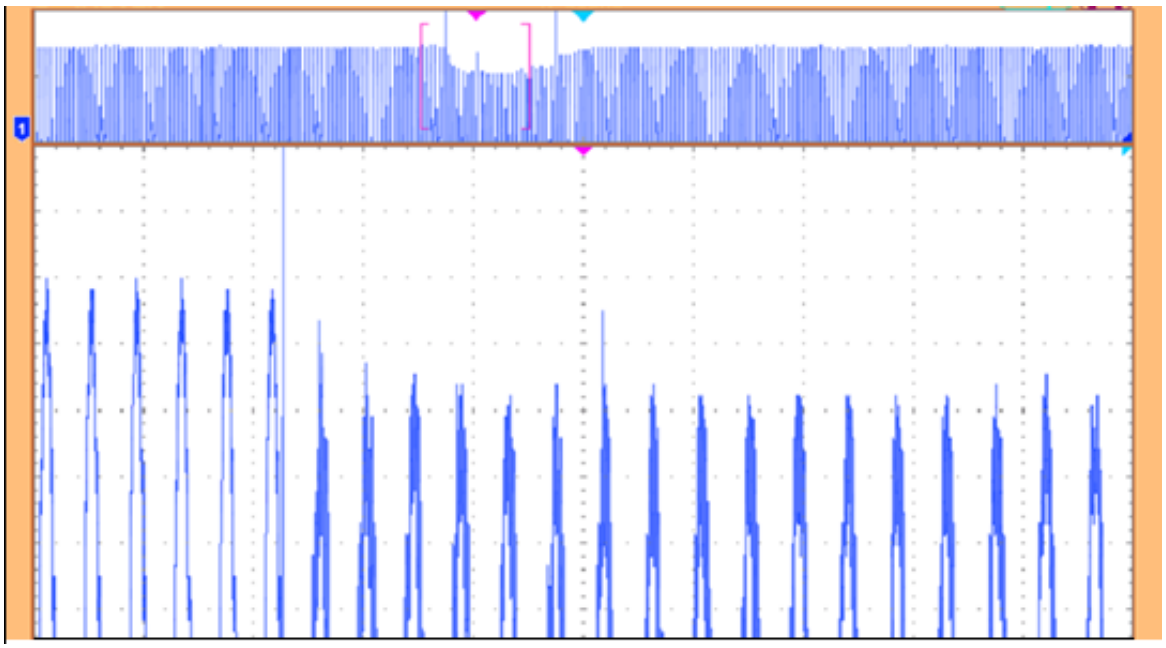

Fig. 8. Transient stator voltage of SG without AVR

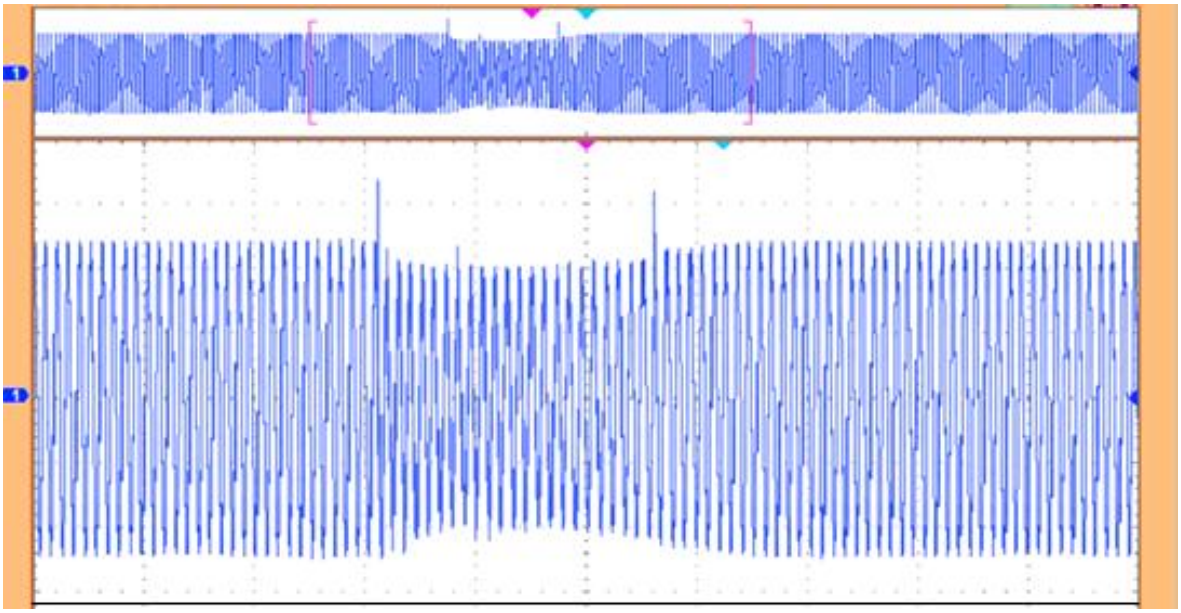

Fig. 9. Transient stator voltage of SG with AVR

On figures 8 and 9 is shown the transient stator voltage of the generator with and without AVR. It can be clearly seen that the stator voltage drop of the generator and the transient process duration in the simulation without AVR is much bigger than the same in the simulation with AVR.

Conclusion

The electronic automatic voltage regulator of ship's synchronous generators is used because of its high reliability and very good dynamic characteristics. The article describes the developed electronic automatic voltage regulator. The proportional-integral-differential regulator, which was developed, improves the static and dynamic characteristics of the generator. Graphics of simulation results of AVR are presented. They demonstrate the high accuracy of regulation of voltage of the ship's synchronous generator and the very good dynamic characteristics at various problematic circumstances.

References

HEBNER R. E., 2005. Electric Ship Power System – Research at the University of Texas at Austin, *IEEE Electric Ship Technologies Symposium IEEE ESTS 2005, 25-27 July 2005, Philadelphia, PA USA*.

J. PROUSALIDIS, E. STYVAKTAKIS, I.K. HATZILAU, F. KANELLOS, S. PERROS, E. SOFRAS, 2008. Electric power supply quality in ship systems: an overview, *International Journal Ocean Systems Management, Vol.1, No.1, pp.68-83.*

K. ZALEWSKA, W. REBIZANT AND R. KAWECKI, 2009. Comparative Analysis of Different Types of Generator Voltage Controllers, in *Proc. of the IEEE 44th Int. Universities Power Eng. Conf.*, UPEC, Sept. 1–4, pp. 1–4.

N. F. DJAGAROV, 1997. Korabni elektroenergiini sistemi [Ship's Electrical Power Systems], Technical University of Varna, pp. 42-47. [in Bulgarian].

DECISION MAKING IN CARGO TANK COATINGS FOR CHEMICAL TANKER COMPANIES

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Abstract: To choose the most effective tank coating is critical issue prior to ship construction for chemical tanker companies. Several criterias according to goals of companies are considered. First application as cost and difficulty, cargo compatibility, cargo tank cleaning, maintenance, durability, freight income and usage life time of cargo tank coating are the criterias to decide the tank coating which is one of epoxy, zinc, stainless steel and MarineLine. In this context, the aim of this study is to decide which tank is most effective as price-performance. According to this aim, the ratings of alternatives for tank coating have been researched and scored among these tank coatings in comparison with their specifications by three tank coating experts. And the importance weights of these criterias to choose a tank coating prior to ship construction have been asked to 15 operation managers of chemical tanker companies that these companies consist eighty percent of whole chemical tanker market in Turkey. 15 decision makers have scored the importance weights of the criterias with linguistic expressions. The ratings of alternatives and the average of importance weights of 7 criterias have been evaluated by fuzzy TOPSIS method. In results of the calculations, coefficients of 4 cargo tank coatings are 0.27 (epoxy), 0.22 (zinc), 0.38 (stainless steel), 0.35 (MarineLine). According to calculated coefficients, stainless steel cargo tank coating is the most effective tank coating when the 7 criterias are considered together. Although the stainless steel cargo tank coating has highest value, the difference between stainless steel and MarineLine is so less in comparison with the other cargo tank coatings. The reason of nuance is the fact that the first application cost of MarineLine cargo tank coating is much less than stainless steel cargo tank coating and MarineLine cargo tank coating is as well as stainless steel in terms of cargo compatibility.

Keywords: tank coating, chemical tanker, stainless steel, MarineLine, fuzzy TOPSIS.

Introduction

A chemical tanker is a type of tanker, which carries liquid cargoes except crude oil and cargoes requiring no significant cooling or pressure tanks. The chemical tankers carry not only chemical products but, commodities such as vegetable oils, molasses, wine, animal fats, solvents and some clean petroleum products and lubricants. Additionally chemical tankers can carry inorganic substances like phosphoric acid, sulphuric acid and caustic soda.

The chemical tanker is a very special type of ship due to the complexity and the particularity of the cargo. Chemical tankers can carry extremely corrosive cargos like sulphuric acid, caustic soda, acetic acid and virgin naphtha. Therefore, much attention is mostly given to the cargo tanks and to their ability to ensure the integrity and the purity of the cargo.

Chemical tanker owners have usually invested large amounts of money on their new building chemical tankers. In general, stainless steel is considered to be the ideal material of construction, being non corrosive and easy to clean. However, first application cost of APC MarineLine is one fourth of the stainless steel cost, so APC MarineLine is decided as a cargo tank coating type by the Turkish chemical tanker companies before constructions of their chemical tankers (Gündoğan, 2017).

Cargo tank coatings can be mainly categorized into four groups:

- Inorganic coating; zinc silicates and ethyl silicate types
- Organic coatings; epoxy and modified epoxy systems
- Advanced polymer coating (MarineLine 784)
- Stainless steel coating

In this context, the ratings of alternatives for tank coating have been researched and scored among these tank coatings in comparison with their specifications by three tank coating experts with respect to following criterias (Table 1). These criterias have sub-criterias and the average of sub-criterias give the rating of related criteria.

Table 1. Tank coating criterias.

C1	*C2*	*C3*	*C4*	*C5*	*C6*	*C7*
First application * C1a; Cost * C1b; Difficulty and duration of application	Cargo compatibility	Cargo tank cleaning * C3a; Cost * C3b; Difficulty and duration of cleaning	Maintenance * C4a; Cost * C4b; Period * C4c; Difficulty	Durability	Freight income	Life time (average)

Then, to determine weights of criterias, 15 decision makers have scored the importance weights of the criterias with linguistic expressions. The ratings of alternatives and the average of importance weights of 7 criterias have been evaluated by fuzzy TOPSIS method.

Cargo tank coatings

During the last 30 years, several types of coating have been used for tank lining service in the sea trades. Being used of some coating materials have stopped and new more reliable and flexible coating materials have been developed. Today's typical coatings (Figure 1) can be categorized as follows:

(a) (b) (c) (d)

Figure 1. Tank coatings; epoxy (a), zinc silicates (b), stainless steel (c), MarineLine (d).

Epoxy (*A1*)

Epoxy cargo tank coatings contain curing agents in order to cure fast and they are 75-90 % solids by volume. They have limited chemical resistance and their first application consist of two or three layers. First application of epoxy cargo tank coating is so difficult because of that all epoxy coatings need well surface preparation. Also, epoxy coatings do not clink on sharpen surfaces. Corrosion occurs rapidly on these surfaces (*C1b., C2.* and *C5.*) (Gündoğan, 2017).

Epoxy cargo tank coatings are suitable to pick up slight trades of the product carried, especially the chemicals which have only a limited suitability. Alcohols, esters, ketones cause to soften the coating and the coating is more likely to absorb small amounts of cargo. The tank, coated with epoxy coating, should be vented thoroughly before tank cleaning when these types of cargoes are carried (*C2.* and *C3b.*) (Salem, 1996).

Epoxy coatings have compatibility with the carriage of alkalis, glycols, seawater, animal fats and vegetable oils but, they have limited resistance to carriage of aromatics such as benzene and toluene, alcohols which are especially ethanol and methanol. These coatings are also suitable for the carriage of animal and vegetable oils provided the acid value does not exceed 10 (i.e. free fatty acid content of 5%). However, oils or fats with acid value between 10 and 20 acceptable for limited time of carriage. The cargo which is molasses should provide pH above 4 to carriage in epoxy coated cargo tanks, although dilute solutions may become acidic

and attack the epoxy coatings. This problem is remedied by adding an alkali to keep pH in acceptable level (*C2.*) (Corkhill, 1981).

Epoxy coating is one of the cheapest coating types. Its initial cost is the second cheapest and it requires small amount of time for application (*C1a.* and *C1b.*) But it provides lower performance than MarineLine (*C5.*) (Gündoğan, 2017). It can't resist enough to corrosive liquids even first 3 months from application to tanks, no aggressive cargoes are allowed (*C2.*).

Zinc silicates (*A2*)

Zinc silicates are generally applied as one coat which acts as a weak barrier between steel and corrosives. This means that zinc silicates are not resistant to strong acids, bases, alkalis and even seawater which has slow deteriorating effect. Zinc silicates are suitable for carriage of cargoes have pH range of 5.5-10, aromatic hydrocarbons, such as benzene and toluene, alcohols and ketones. Also carriage of vegetable and animal fats are unsuitable since carriage of halogenated compounds are suitable if the tanks' surfaces are free of moisture (*C2.*) (Gündoğan, 2017).

Although the physical properties (i.e. hardness and abrasion resistance) vary according to the type of silicate used, chemical resistance and cargo compatibility are very similar. These coatings are normally applied as a single coat of 75-125 microns to a blast clean metal surface. They show unequable features because of the quality of surface preparation and blast cleaning for a white metal finish is necessary (*C4c.*) (Rogers, 1971).

In zinc-coated tanks, cleaning operation is costly and complex work when the cargo to be cleaned is a dyed gasoline, gasoil, or vegetable oil cargo and next cargo is to be methanol or MEG. Only special safe cleaning chemicals made for zinc can be used. It causes to increase the cost of cargo tank cleaning operation (*C3a.* and *C3b.*).

Zinc coating is the cheapest cargo tank coating type at first application (*C1a.*) Besides, it requires less amount of time for its construction than epoxy, MarineLine and stainless steel coatings (*C1b.*) (Çakmaz, 2017).

Stainless steel (*A3*)

Stainless steel is the general name given to the whole of chrome high alloyed corrosion resistant steels, and the main alloying element is chromium. Stainless steel coating is generally used for cargo tank coating, steam coils, ladders, supports, pump shell on chemical tankers. Stainless steel is impermeable and generally invisible under oxidizing conditions with a chromium content of 12%. The formation of self-healing and invisible oxide film on the surface serves as a barrier between the metal and the external environment. It provides effectively corrosion resistance (*C5.*) (Vadakayil, 2010).

Stainless steel coatings provides easy tank cleaning operation. With stainless steel, the cargo would not absorbed inside the coating (*C3a.*). Typically, washing is firstly carried out with sea water at a certain temperature to remove cargo residues, where possible followed by washing with freshwater to remove chlorides. For some cargoes only fresh water is used (*C3a.* and *C3b.*) (Çakıroğlu, 2017).

Stainless steel, which is the most resistant for heavy chemicals and it is the most expensive tank coating type *(C1a.* and *C2.*). The performance of a stainless steel coated cargo tank drops off dramatically when exposed to halogen salts, especially chlorides that penetrate the passivation and allow corrosive attack (*C2.* and *C5.*). But if the passivation maintained correctly, stainless steel tank coating is the most durable type for corrosion (*C5.* and *C7.*) (Gündoğan, 2017).

The chemical tanker which have stainless steel coated cargo tanks, have more freight income than the other cargo tank coating types even carrying same cargoes. Also obviously seen that the cargoes which can carried in only stainless steel coated cargo tanks, are more valuable cargoes than others (*C6.*) (Aydın, 2017).

Stainless steel cargo tank coating has less maintenance period than the other cargo tank coating types, if the required passivation is done. So the maintenance cost of stainless steel cargo tank coating is not much as others. General maintenance is required in only 5 years shipyard period (*C4a., C4b.* and *C4c.*) (Soykan, 2017).

APC MarineLine 784 (*A4*)

Advanced Polymer Coatings offers the unique MarineLine coating to the chemical tankers market in respect to carrying most of IBC- approved cargoes. MarineLine 784 provides high functionality by formulated with a polymer designed and engineered with 28 functional groups per molecule. When heat cured, MarineLine 784 coating forms 3-dimensional, screen-like structures with up to 784 cross-links which its maximum performance. This far surpasses Phenolic Epoxies which only deliver 2 functional groups with only 4 cross-links as showed in Figure. 2.

More densely cross-linked molecular structure provides; higher chemical resistance, higher temperature resistance, higher reactivity at lower temperature, more resistance to absorption, greater toughness, faster tank cleaning relative to epoxy and zinc cargo tank coatings. MarineLine 784 is resistance to; thermal Shock (-40 C to +200 C), flex stressing, wear and abrasion, product absorption, impact (*C2., C5.* and *C3b.*) (APC, 2002).

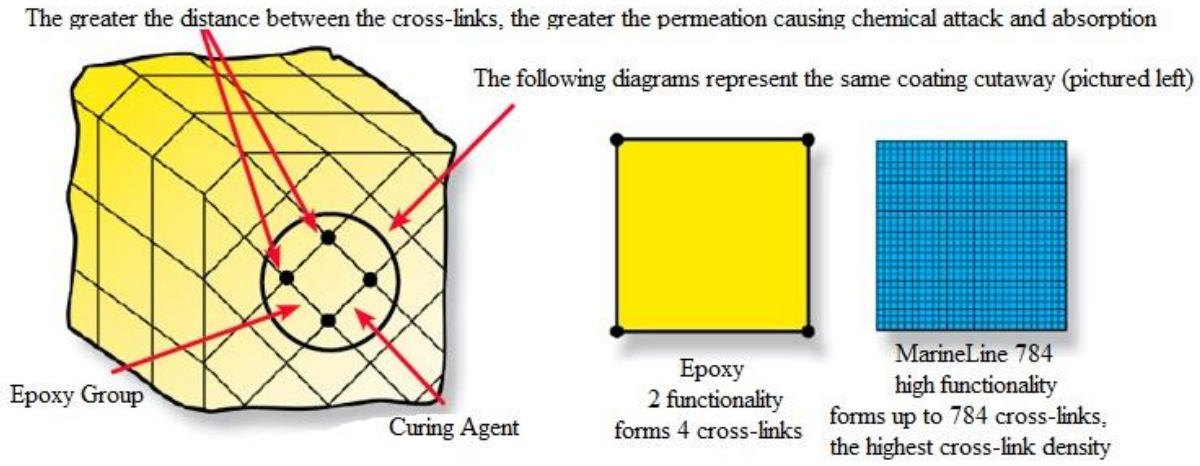

Figure. 2. Cutaway of Epoxy and MarineLine 784 coatings (APC, 2002).

MarineLine is much cheaper than stainless steel and more expensive than zinc silicate and epoxy coatings. Its initial cost is about 1/4 of stainless steel initial costs (*C1a.*). If the all costs are considered, the cost comparison makes MarineLine the best option. More time is required during first application than epoxy and zinc coatings but less than stainless steel (*C1b.*) (Erzurumlu, 2017).

MarinLine cargo tank coating provides easy tank cleaning between cargoes. MarineLine creates a protective barrier that is easily cleaned, eliminating long ventilation times and putting the ship back into service faster this means more number of voyage then slower ones. MarineLine coating has a much smoother surface than stainless steel and this superior 'slip' promotes significant savings in fuel, energy, time and in cleaning chemicals used, all of which have a positive impact on the environment (*C3a.* and *C3b.*) (Karagöz, 2012).

Periodic surveys of the tank and regular maintenance are needed to ensure a long service life (*C4b.*). The tanks coated with MarineLine do not require any passivation to deliver a long service. Key points of maintenance for MarineLine are to only carry approved chemicals, clean properly the tanks, and touch up any areas as needed with the MarineMend coating repair kit (*C4c.*) (Balta, 2017).

However, MarineLine tank coating has a much lower freight rate compared to stainless steel in chamical tanker market because of the fact that the cargo owners want their cargos carry in stainless steel tanks rather than MarineLine (*C6.*).

Methodology

The ratings of alternatives have been scored between them according to literature and 3 tank coating experts. There are the references about criterias in "Cargo tank coatings" section and they refer to ratings of alternatives. To model the tank coatings' ratings, fuzzy numbers have

been used rather than crisp numbered data for real approach on tank coatings. Therefore, the fuzzy TOPSIS methodology has been adopted to solve multi-criteria decision making problem on the issue. Wang and Elhag's (2006) linguistic expression (Table 2) has been used for ratings of the tank coatings.

Table 2. Linguistic variables and fuzzy ratings of the alternative (Wang and Elhag, 2006).

Linguistic expression	Fuzzy numbers
Very Poor (VP)	(0, 0, 1)
Poor (P)	(0, 1, 3)
Medium Poor (MP)	(1, 3, 5)
Fair (F)	(3, 5, 7)
Medium Good (MG)	(5, 7, 9)
Good (G)	(7, 9, 10)
Very Good (VG)	(9, 10, 10)

Same linguistic expression has been adopted for the importance weights of these criterias with very high (VH), high (H), medium high (MH), medium (M), medium low (ML), low (L) and very low (VL) terms. 15 decision makers have scored the importance weights of the criterias with these linguistic expressions.

Results

In fuzzy TOPSIS, the decision makers may use linguistic variables or fuzzy numbers to evaluate the ratings of alternatives with respect to criterias. In assumption of a decision group has K people, the ratings of alternatives belong to each criterion can be calculated as (Chen, 2000);

$$\tilde{x}_{ij} = \frac{1}{K}\left[\tilde{x}_{ij}^{\,1}(+)\,\tilde{x}_{ij}^{\,2}(+)\ldots(+)\tilde{x}_{ij}^{\,K}\right] \quad (1)$$

where $\tilde{x}_{ij}^{\,K}$ is the rating of the K^{th} decision maker for i^{th} alternative with respect to j^{th} criterion. With respect to equation, decision matrix has been obtained (Table 3).

Table 3. The fuzzy decision matrix for four alternatives.

	C1	*C2*	*C3*	*C4*	*C5*	*C6*	*C7*
A1	(6, 7.5, 8.5)	(3, 5, 7)	(1.5, 3, 5)	(2.3, 4.3, 6.3)	(0, 1, 3)	(3, 5, 7)	(0, 1, 3)
A2	(7, 8.5, 9.5)	(0, 0, 1)	(1, 3, 5)	(2.3, 4.3, 6.3)	(1, 3, 5)	(0, 0, 1)	(1, 3, 5)
A3	(0, 0.5, 2)	(9, 10, 10)	(9, 10, 10)	(7.7, 9.3, 10)	(7, 9, 10)	(9, 10, 10)	(9, 10, 10)
A4	(3, 5, 7)	(7, 9, 10)	(6, 8, 9.5)	(1.7, 3, 5)	(5, 7, 9)	(5, 7, 9)	(5, 7, 9)

Then, fuzzy decision matrix has been normalized by following formula (Chen, 2000) and results are shown in Table 5.

$$\tilde{r}_{ij} = \frac{xij}{xj*} \quad (2)$$

where x_j* is the highest value of that criteria. To determine the weights of each criteria, 15 decision makers have scored the importance weights of the criterias with these linguistic expressions (Table 4). Then, the average of these scores as the weights of each criteria has been stated in Table 4.

Table 4. The importance weights of the criterias

	D1	*D2*	*D3*	*D4*	*D5*	*D6*	*D7*	*D8*	*D9*	*D10*	*D11*	*D12*	*D13*	*D14*	*D15*
C1	VH	VH	VH	VH	M	VH	VH	VH	ML	VH	H	VH	VH	VH	VH
C2	M	M	H	ML	ML	H	H	M	VH	MH	VH	MH	H	VL	ML
C3	L	L	VL	MH	MH	MH	VL	H	L	M	MH	ML	MH	MH	M
C4	MH	MH	MH	L	H	ML	MH	MH	M	H	M	M	M	H	MH
C5	ML	ML	L	H	L	M	L	L	H	L	L	L	ML	ML	VL
C6	H	H	M	M	VH	L	M	ML	VL	ML	VL	H	L	L	L
C7	VL	VL	ML	VL	VL	VL	ML	VL	MH	VL	ML	VL	VL	M	H

The results of formula 2 and the average of importance weights, which are shown in Table 4, has been stated in Table 5.

Table 5. The fuzzy normalized decision matrix and the weights of the criterias

	C1	*C2*	*C3*	*C4*	*C5*	*C6*	*C7*
A1	(0.63, 0.79, 0.89)	(0.3, 0.5, 0.7)	(0.15, 0.3, 0.5)	(0.23, 0.43, 0.63)	(0, 0.1, 0.3)	(0.3, 0.5, 0.7)	(0, 0.1, 0.3)
A2	(0.74, 0.89, 1)	(0, 0, 0.1)	(0.1, 0.3, 0.5)	(0.23, 0.43, 0.63)	(0.1, 0.3, 0.5)	(0, 0, 0.1)	(0.1, 0.3, 0.5)
A3	(0, 0.05, 0.21)	(0.9, 1, 1)	(0.9, 1, 1)	(0.77, 0.93, 1)	(0.7, 0.9, 1)	(0.9, 1, 1)	(0.9, 1, 1)
A4	(0.32, 0.53, 0.74)	(0.7, 0.9, 1)	(0.6, 0.8, 0.95)	(0.17, 0.3, 0.5)	(0.5, 0.7, 0.9)	(0.5, 0.7, 0.9)	(0.5, 0.7, 0.9)
Weight	(0.79, 0.91, 0.95)	(0.45, 0.63, 0.77)	(0.29, 0.45, 0.63)	(0.43, 0.62, 0.8)	(0.14, 0.28, 0.46)	(0.27, 0.41, 0.57)	(0.12, 0.2, 0.33)

Considering the importance weights of each criterion, the weighted normalized fuzzy decision matrix has been constructed by following formula (Chen, 2000). The results of multiplication have been stated in Table 6.

$$\tilde{V} = [\tilde{v}_{ij}]_{mxn},\ i = 1, 2, \ldots, m, j = 1, 2, \ldots, n, \text{ where } \tilde{v}_{ij} = \tilde{r}_{ij}\,(\cdot)\,\tilde{w}_{j.} \quad (3)$$

Table 6. The fuzzy weighted normalized decision matrix

	C1	*C2*	*C3*	*C4*	*C5*	*C6*	*C7*
A1	(0.5, 0.72, 0.85)	(0.14, 0.32, 0.54)	(0.04, 0.14, 0.32)	(0.1, 0.27, 0.5)	(0, 0.03, 0.14)	(0.08, 0.21, 0.4)	(0, 0.02, 0.1)
A2	(0.58, 0.81, 0.95)	(0, 0, 0.08)	(0.03, 0.14, 0.32)	(0.1, 0.27, 0.5)	(0.01, 0.08, 0.23)	(0, 0, 0.06)	(0.01, 0.06, 0.17)
A3	(0, 0.04, 0.2)	(0.4, 0.63, 0.77)	(0.26, 0.45, 0.63)	(0.33, 0.58, 0.8)	(0.1, 0.25, 0.46)	(0.24, 0.41, 0.57)	(0.11, 0.2, 0.33)
A4	(0.25, 0.48, 0.7)	(0.32, 0.57, 0.77)	(0.17, 0.36, 0.6)	(0.07, 0.19, 0.4)	(0.07, 0.2, 0.41)	(0.14, 0.29, 0.51)	(0.06, 0.14, 0.3)

According to weighted normalized fuzzy decision matrix, it has been known that $\tilde{v}_{ij}$ values are normalized in the range of interval [0, 1]. Then, the fuzzy positive ideal solution (FPIS, A*) and the fuzzy negative ideal solution (FNIS, A^-) has been calculated as (Chen, 2000)

$$d_i^* = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^*),\ i = 1, 2, \ldots, m,\ d_i^- = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^-),\ i = 1, 2, \ldots, m. \quad (4)$$

where $\tilde{v}_j^* = (1, 1, 1)$, $\tilde{v}_j^- = (0, 0, 0)$, $j = 1, 2, \ldots, n$ and where $d(\cdot,\cdot)$ is the distance measurement between two fuzzy numbers. The results of equations have been stated in Table 7.

Table 7. The distance measurement

	A^*	A^-
A1	5.29	2.00
A2	5.62	1.64
A3	4.53	2.78
A4	4.80	2.58

A closeness coefficient is defined to determine the ranking order of all alternatives once the d_i^* and d_i^- of each alternative A_i ($i = 1, 2, \ldots, m$) has been calculated (Chen, 2000). The closeness coefficient of each alternative is calculated as,

$$CC_i = d_i^- / (d_i^- + d_i^*),\ i = 1, 2, \ldots, m. \quad (5)$$

The highest CC_i is the best one from among a set of feasible alternatives (Chen, 2000). According to equation, closeness coefficients of 4 tank coating alternatives have been calculated and stated below,

$$CC_1 = 0.27,\ CC_2 = 0.23,\ CC_3 = 0.38,\ CC_4 = 0.35.$$

It can be seen that stainless steel is the best alternative for tank coating type and the MarineLine is the second alternative. On the other hand, it is clear that there is no obvious difference between these two tank coating types.

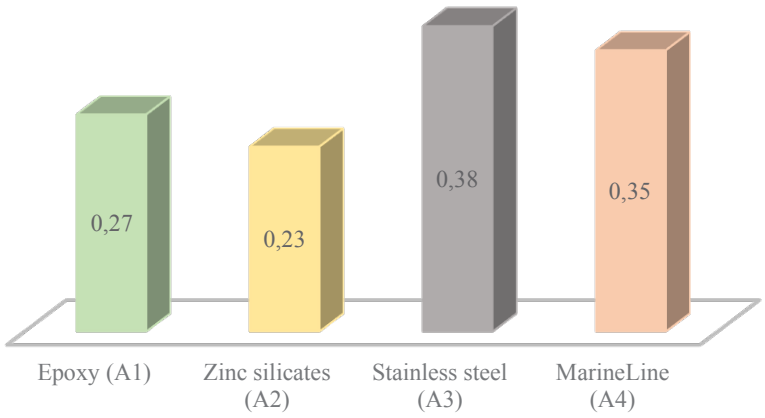

Figure. 3. Closeness coefficients of 4 tank coating alternatives.

Conclusion

To decide which tank coating can be most effective, several criterias according to goals of companies should be considered for chemical tankers. Generally four type tank coatings have been used for carriage of chemical substances in tankers. They are epoxy, zinc silicates, stainless steel and MarineLine. And chemical tanker companies have considered the performances of ships, freight income of carriage or maintenance costs etc. to choose one of them.

In this study, 7 main criterias and their sub-criterias have been determined and 4 tank coatings have been researched within these criterias. 3 tank coating experts evaluated the criterias for each tank coating with the information from literature and scored them with linguistic expressions of Fuzzy decision making method. Besides, 15 operation managers of chemical tanker companies that these companies consist eighty percent of whole chemical tanker market in Turkey, scored the importance weights of the criterias with similar linguistic expressions. With fuzzy ratings of these linguistic expressions, decision matrix was constructed and 4 tank was evaluated in fuzzy TOPSIS method to choose best alternative of tank coatings.

According to results of decision matrix, stainless steel cargo tank coating is the most effective tank coating when the 7 criterias are considered together. Although the stainless steel cargo tank coating has highest value, the difference between stainless steel and MarineLine is so less in comparison with the other cargo tank coatings. The reason of nuance is the fact that the first application cost of MarineLine cargo tank coating is much less than stainless steel cargo tank coating and MarineLine cargo tank coating is as well as stainless steel in terms of cargo compatibility. Indeed, MarineLine tank coating has been used in 93% of chemical tankers in Turkish chemical market. While stainless steel has been best one in decision, MarineLine has been decided for many years by Turkish chemical tanker companies due to mentioned nuance above. Consequently, stainless steel is what companies dream about, MarineLine is what they get by taking the risks of being in limited world chemical market.

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References

APC. 2002. *MarineLine 784* [Online]. Available: http://www.adv-polymer.com/Marine_Transportation_Protective_Coatings/pdfs/MarineLine784-protective-coatings.pdf [Accessed 02.03.2017].

AYDIN. 2017. Evaluation for the cargo tank coatings. *In:* EYÜPOĞLU, A. (ed.).

BALTA, Ö. 2017. Evaluation for the cargo tank coatings. *In:* KARABULUT, N. (ed.).

CHEN, C. T. 2000. Extensions of the TOPSIS for group decision-making under fuzzy environment. *Fuzzy sets and systems,* 114(1)**,** 1-9

CORKHILL, M. 1981. *Chemical tankers: the ships and their market,* London, Fairplay Publications.

ÇAKIROĞLU, H. 2017. Evaluation for the cargo tank coatings. *In:* EYÜPOĞLU, A. (ed.).

ÇAKMAZ, O. 2017. Evaluation for the cargo tank coatings. *In:* KARABULUT, N. (ed.).

ERZURUMLU, H. 2017. Evaluation for the cargo tank coatings. *In:* KARABULUT, N. (ed.).

GÜNDOĞAN, C. 2017. Evaluation for the cargo tank coatings. *In:* EYÜPOĞLU, A. (ed.).

KARAGÖZ, K. 2012. *Reviewing Coating Issues of Cracking and Detachment* [Online]. Available: http://www.marinelineturkiye.com/dosyaindir/Medya/Chem-Line/marinlinepaint_surface_artkim_ocak_2013.pdf [Accessed 10.04.2017].

ROGERS, J. 1971. Tank coatings for chemical cargoes. *Trans. I. Mar.,* 83**,** 139-147.

SALEM, L. S. 1996. Epoxy for Steel. *Journal of Protective Coatings & Linings,* 13**,** 77-98.

SOYKAN, G. 2017. Evaluation for the cargo tank coatings. *In:* KARABULUT, N. (ed.).

VADAKAYIL, A. 2010. *Stainless Steel Cargo Tanks* [Online]. Available: https://ajitvadakayil.blogspot.com.tr/2010/12/clad-stainless-steel-and-solid-ss-cargo.html.

WANG, Y. M. & ELHAG, T. M. 2006. Fuzzy TOPSIS method based on alpha level sets with an application to bridge risk assessment. *Expert systems with applications,* 31**,** 309-319.

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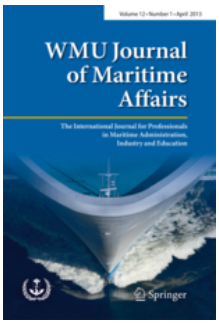

Background

The International Association of Maritime Universities (IAMU) and the World Maritime University (WMU) have an agreement for the inclusion of a dedicated IAMU Section, which focuses on Maritime Education and Training (MET), in the *WMU Journal of Maritime Affairs* (JoMA). This provides a great opportunity for everyone involved in MET (academic staff at IAMU member universities) to not only publish high-quality peer reviewed articles based on research but also to have their articles abstracted/indexed in SCOPUS, Google Scholar, EBSCO Discovery Service, OCLC, SCImago, Summon by ProQuest, Transport Research International Documentation (TRID).

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The *WMU Journal of Maritime Affairs* (JoMA) is an international peer reviewed journal that covers the subject areas of maritime safety, marine environment protection and shipping operations and gives, in this context, special attention to human factors and the impact of technology, and maritime education and training. JoMA is for scientists, academics and professionals in maritime administration, industry and education. It aims to serve the international maritime community by presenting fresh ideas and current thinking on subjects of topical interest, reporting on relevant research findings and addressing interrelationships between safety, environment protection and efficiency of maritime transport. The journal accepts Articles as well as Book Reviews for publication.

Scope of the IAMU Section

JoMA has a section dedicated to the activities of IAMU. The focus of the IAMU Section is on Maritime Education and Training (MET). The IAMU Section follows a similar editorial review procedure as JoMA and accepts a range of papers for publication including: Articles, Issues of Contemporary Interest, Reports and Comments, and Book Reviews.
Articles, in principle, should present genuine research findings. However, overview articles summarising the status of knowledge in a specific research area may be considered for publication.
Issues of Contemporary Interest are not always covered by traditional research and valuable lessons can be learnt through reports on best practice or critical discussions from the practitioner's point of view. This is why IAMU encourages experts to express their views on issues of contemporary interest.
Reports and Comments can be published to facilitate research activities within the scope of the IAMU section. This allows members to voice their reasoned opinions on published manuscripts and also to stimulate discussions on areas that require further research.
Book reviews relevant to the scope of the IAMU Section can also be considered.

Focus of the IAMU Section

The focus for papers submitted for publication in the IAMU Section of JoMA is Maritime Education and Training (MET). In this context MET is considered to include the wide range of issues associated with all forms of education and training which are related to maritime activities carried out by persons both at sea and onshore. This could include, but not be limited to:

- Systems of maritime education and training e.g. international, national, higher education, vocational training;

- Impacts on maritime education and training e.g. international conventions, maritime industry needs, government regulation;
- Curriculum development e.g. processes, review, innovations, balancing conflicting requirements, objectives;
- Course delivery e.g. classroom based learning, competency based training, e-learning, flexible learning, blended learning, flipped classroom approach;
- Teaching practise e.g. teacher centred, student centred, education and training technologies, multi-cultural students, teaching exemplars;
- Assessment e.g. linking objectives and assessment, methods, evaluation of results, assessment exemplars;
- Quality e.g. standards, measuring outcomes and effectiveness, teacher training, teaching competence; and
- Issues impacting MET e.g. life-long learning, changing educational environment, attractiveness of the teaching profession and recruitment.

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If you are interested in becoming a reviewer please:
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sblewarn@amc.edu.au or Barrie.Lewarn@utas.edu.au

BY PUBLISHING USEFUL, WELL RESEARCHED MANUSCRIPTS WHICH CAN ENHANCE THE QUALITY OF MET, YOUR CONTRIBUTIONS BENEFIT YOU, THE RESEARCHER, AND WILL ASSIST IN INCREASING THE REPUTATION AND STANDING OF *IAMU* AS AN ORGANISATION DEDICATED TO THE CONTINUOUS IMPROVEMENT OF MET.