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October 24-25, 2016
Bodrum, MUĞLA / TURKEY

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Assoc. Prof. Dr. Gökhan KARA
Assoc. Prof. Dr. Selçuk NAS
Asst. Prof. Dr. E.Gül EMECEN KARA
Asst. Prof. Dr. Murat YILDIZ

THE SECOND GLOBAL CONFERENCE ON INNOVATION IN MARINE TECHNOLOGY AND THE FUTURE OF MARITIME TRANSPORTATION

- *Conference Proceedings Book* –

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FOREWORD

The Istanbul University, Faculty of Engineering, Maritime Transportation Management Engineering Department and Turkish Chamber of Marine Engineers (UCTEA) have embarked upon the organising of an ambitious international conference.

The Second Global Conference on Innovation in Marine Technology and the Future of Maritime Transportations aims to bring a number of leading academics, researchers, industrial members and individuals from maritime sectors to discuss new topics of researches, developments and innovative ideas and to disseminate their findings and deliberations to a much wider audience. The conference would provide positive contributions on global research agenda.

The main topics of the conference are Maritime Transportation Management and Technologies, Port Cargo Handling and Shipping Technologies, Navigation, Risk Asssesment and Management, Maritime Safety & Security, Sustainability of Maritime Transportation, Marine Environment Science and Technology, Maritime Meteorology, Climatic Change, Maritime Logistics, Maritime Education and Training Technologies, Maritime Law and Conventions, Advanced Technologies in Marine Engineering, Fuels and Combustion, Energy Conversion and Management, Control & Automation Techonologies, Economics Aspect Of Maritime Tech. & Innovations, Naval Architecture and Offshore Technologies, Marine Materials & Equipment and Marine Structural Materials. During the two days of conference more than 90 invaluable papers have been presented in these topics.

We would express special thanks to all the financial supporters, delegates of maritime sector and participants and deeply indebted to all the committee members whose voluntary efforts brought such a great success to conference.

Prof. Dr. Güler ALKAN
İstanbul University, Faculty of Engineering
Head of Maritime Transportation Management
Engineering Dept.

C/Eng. Feramuz AŞKIN
The Chamber of Marine
Engineers of Turkey (GEMIMO)
Chairman

October 24

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	Başaran Bayrak / Chairman of the Ship and Yacht Exporters AssociationShipping
	Metin Kalkavan / Chairman of the Executive Committee of The Turkish Chamber of Shipping
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ORAL PRESENTATIONS

FULLY PARAMETRIC HULL FORM MODELING FOR FURTHER SYSTEMATIC INVESTIGATIONS

Sadık ÖZÜM[1], Bekir ŞENER[2], Hüseyin YILMAZ[3]

ABSTRACT

The paper presents a surface deformation and systematic variation methodology of a chine hull. The methodology is based on fully parametric surface modeling related to parameters. This technique provides to investigate the effects of parameters, which were determined according to the objective function, in conceptual design stage. In this paper it will be focused on how we can create a parametric model for further optimization studies. After creating a fully parametric parent hull, hundreds of alternative hulls was created by changing the parameters systematically.

Keywords – Hull form generation, parametric model, systematic variation, optimization

INTRODUCTION

To optimize a hull, the surface geometry should be deformed manually or with different methods. Before an optimization process, one of the most important thing is to define parameters that will be changed. In addition, constants should be determined to create boundary condition. Constants could be related with dimensions, stability, seakeeping, hydrostatic limits etc. To find the effect of a parameter or realize a hull form optimization, it has to be realized systematic analyzes and change the surface geometry according to change of parameters. Because of this situation, parametric modelling is a key issue, especially for multi-objective optimization.

Generally, a hull optimization algorithm use hull form variation methods to generate solution space. Every variant hull is compared with the previous one and it is graded according to objective function.

There are different methods for hull form modeling and deformation:

- Manipulate control points, which are belong to NURB surface. (Traditional Modelling)
- Combine two or more hull. (Partial Parametric Modeling)
- Deform parent hull by using linear and non-linear transformation technique (Partial Parametric Modeling)
- Model parent hull with completely numeric parameters (Completely Parametric Modeling)

Control Point Manipulating Method

Although this method is common computer - aided design, it is not suitable for automatic optimization because of many independent variable. Hendrix et al. [1] used a 5x9 matrix type mesh network to optimize Wigley hull in terms of resistance. The system have 135 degrees of freedom because every point have three coordinates. This value was reduced to 61 with making some points fixed but any constraint was applied to provide the

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surface fairness. Hence, change of position of some points can cause bump or hallow on the surface. Because of the complexity of hull shape and request for fair surfaces, this method is not proper for automatic optimization.

Merging / Morphing Method

Neu [2] use a method, which is based on weighted average. He tried to combine different hulls by using optimization procedure to create final hull. This method can be defined below;

$$Final\ Hull\ Forn = \sum c_n Parent\ Hull_n$$

$$c_n = mix\ coefficent; \tag{1}$$

$$and \quad 0 \leq c_n \leq 1;\ \ n = 1,2,3, \dots, N; \qquad \sum c_n = 1$$

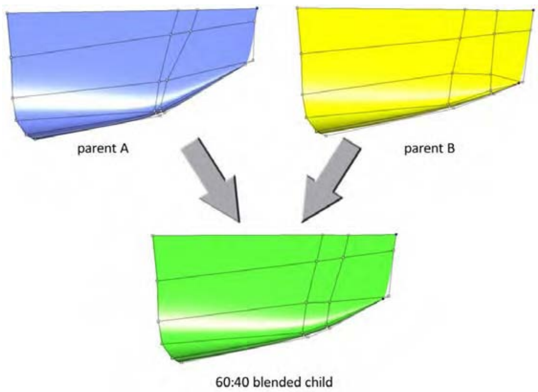

Figure 1. Example of Combining Two Hull

Figure 1 shows a new hull is that combined two different hull in the ratio of 60:40. Control points of new surface are obtained as fallows;

$$NewKN_{i,j} = 0.6\ ParentA\ KN_{i,j} + 0.6\ ParentB\ KN_{i,j} \tag{2}$$

This procedure is convenient to obtain new hulls if the properties of variants are known. If surfaces of parent hulls are faired, the surface of variants will be faired. Disadvantages of this method is that boundary of design space is limited.

Parametric Transformation Method

Simple linear transformations techniques cannot obtain enough variants for optimizations. Because of this situation non-linear transformation techniques are investigated. It is a common technique to derive an alternative design with the same main dimensions but different prismatic coefficient or LCB by changing the location of stations at which the offsets are given [3]. The shape of sections remain the same as in the parent hull, but they are moved forward or aft in some manner so that the curve of sectional area changes. Disadvantages of this method is limited solution space, because sections of hulls stay pretty much the same.

There were also developed different parametric transformation methods in further works but none of them was for optimization [2].

Parametric Modeling

Taylor, Thieme, Kwik and Nowacki has lead the modeling hull form according to specific parameters and it was developed by several researchers. Harries has developed a new method for parametric modeling and using CAD and CFD integrated [4]. In this method, determined parameters can be main dimensions (L, B, T, etc.), hydrostatic values (∇, c_B, c_P) or different things as coordinate, gradient, angle etc. for modelling hull form. Hull forms are created related to these parameters. As a result, when the parameters change systematically, many different variant can be generated.

Harries and Abt has created a software, which is called FRENDSHIP-Modeler [5]. The software can provide to model parametric hull form and generate many variant easily. Nowadays FRENDSHIP-Modeler can provide many optimization algorithm options. In addition to this, other analysis programs can be integrated with FRENDSHIP-Modeler with simple codes.

F-Spline, which is a new type curve, is the major innovation for parametric model. Advantage of this curve is that it is always an optimized B-Spline curve in terms of fairness criteria. In consequence, parametric modeling could be realized with FRENDSHIP-Modeler simply and user-friendly.

Abt and Harries [6] use definitions as below for comparing geometric modelling methods and they try to explain areas of usage.

- **Flexibility**: the ability to adapt to different circumstances, here to cope with any possible shape.
- **Know-how:** The procedural knowledge of how to perform a specific task, here for instance to change geometry.
- **Effectiveness:** The capability of producing a desired effect, here quality of the design, i.e., the success in achieving a given goal independent of resources spent (doing the right thing).
- **Cost:** The value resources that have been used up to produce something.
- **Efficiency:** The swiftness with which information, here geometry, is generated and changed (getting things done).

Figure 2 gives the result of comparison in terms of abovementioned properties of subjects. Fully parametric modeling methods is generally high efficient but poor in terms of flexibility. It has high degree of influence and low cost for per unit. Conventional methods have most flexibility but needs high technical knowledge. Partially parametric modeling methods have averaged features in comparison with fully parametric and conventional techniques. Advantage of this method is that they need less know-how and therefore easier to apply. The most important advantage of fully parametric methods is to ensure a high quality surface and eliminate the complexity of conventional modeling process. Hence, a fully parametric modeling technique was used in this work.

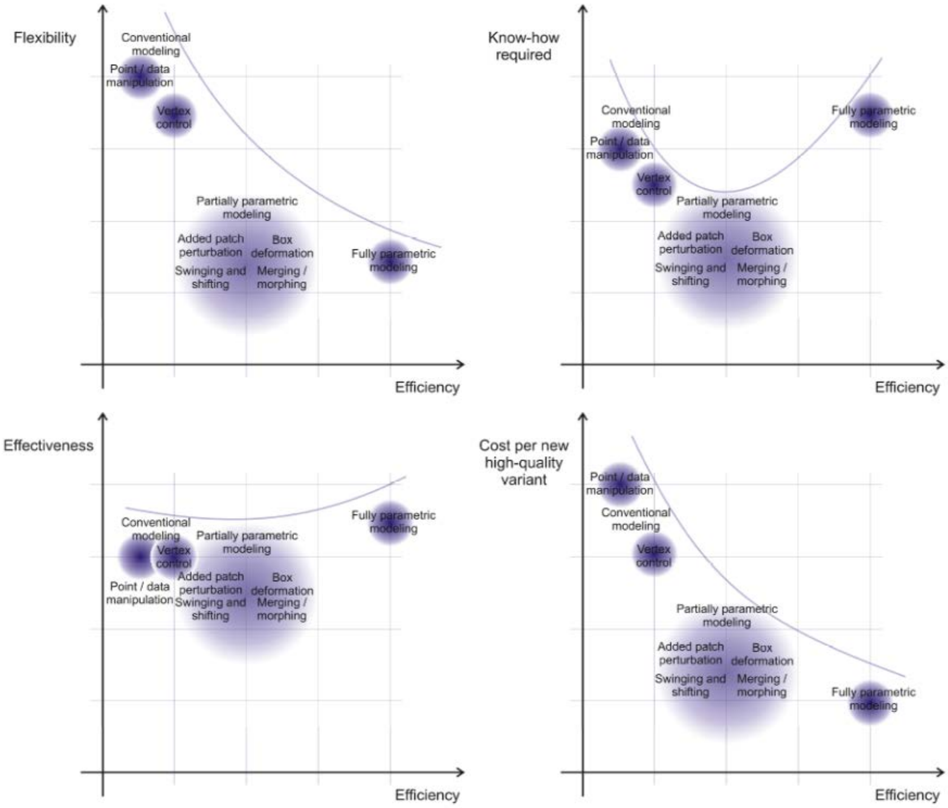

Figure 2. Qualitative Assessment of Available Geometric Modeling Techniques [6]

HULL FORM GENERATION WITH PARAMETRIC MODELLING

In this paper, it is just focused on how full parametric hull form could be generated and how the variants are created from parent hull. This is important stage for the optimization works. Because the optimization stage needs a database to compare variants and choose the best one, FRENDSHIP-Modeler was used for geometric modeling. This process can be separated 3 major groups as shown Figure 3.

- Preliminary Design: Hull type, length range, speed etc. should be defined according to objective function on this stage. It is useful to collect data of existing boats which are similar to investigated hull.
- Parametric Modelling: Global and local parameters will be defined in this step. Parametric points and curves will be created to generate the parametric surface of hull. Parameters can be changed numerically also connected points, curves and surfaces will be deformed relatively.
- Systematic Variation: After parametric modeling, constants and design variables should be determined. In this step, lots of variants will be generated with changing design variables systematically.

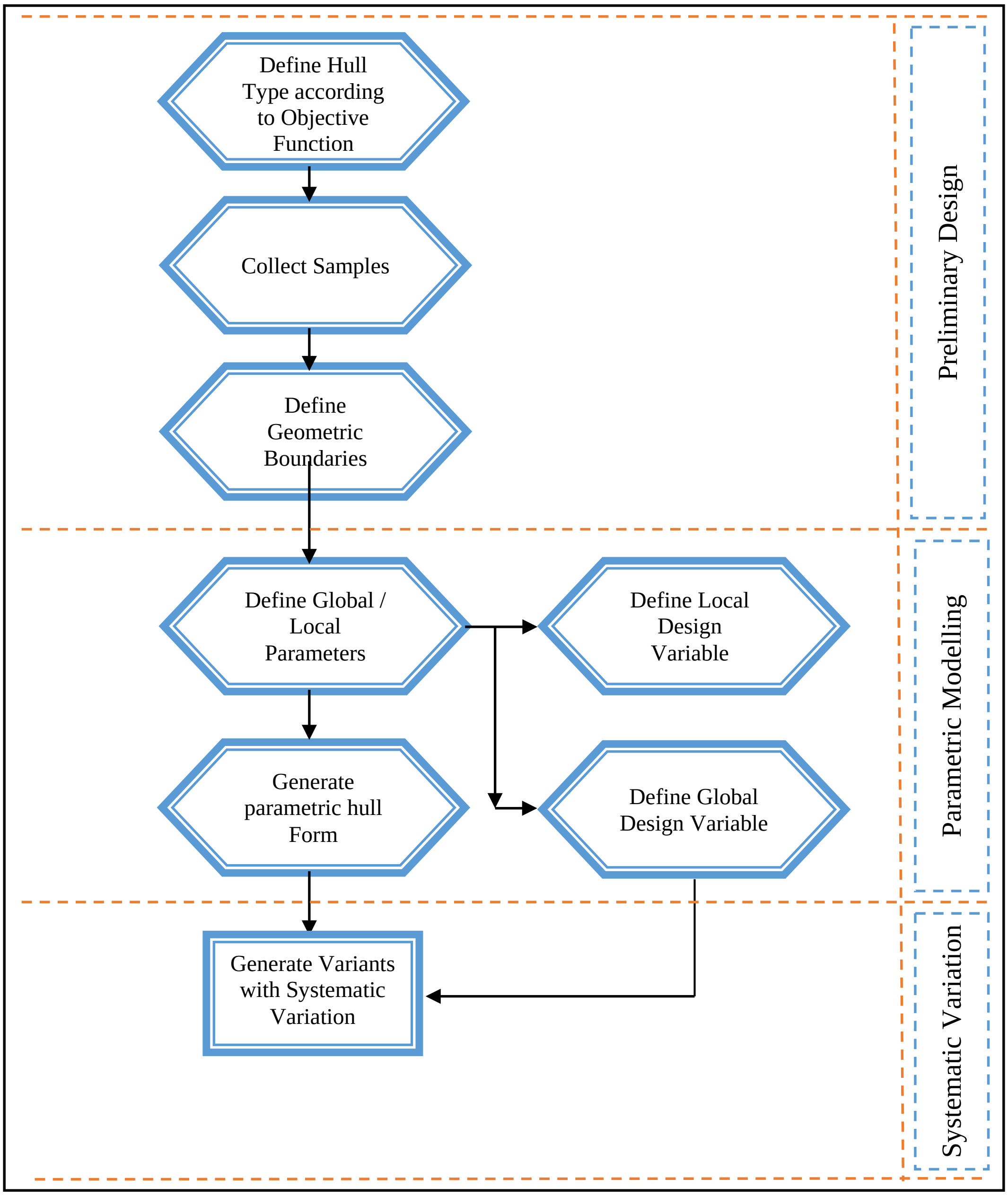

Figure 3. Flowchart of Hull Generation Methodology

Preliminary Design

Figure 4 shows sample hulls, which have length from 37m to 50m, and their L/B ratios. L/B and $L/\nabla^{1/3}$ ratios can be seen from Figure 5. Figure 6 gives speed range of boats. When examined these data, dimensions of parent hull can be chosen as Table 1.

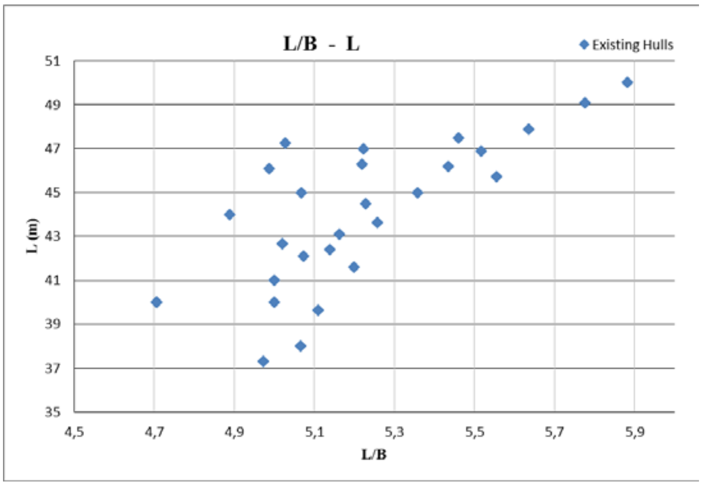

Figure 4. L and L/B Range of Existing Hulls

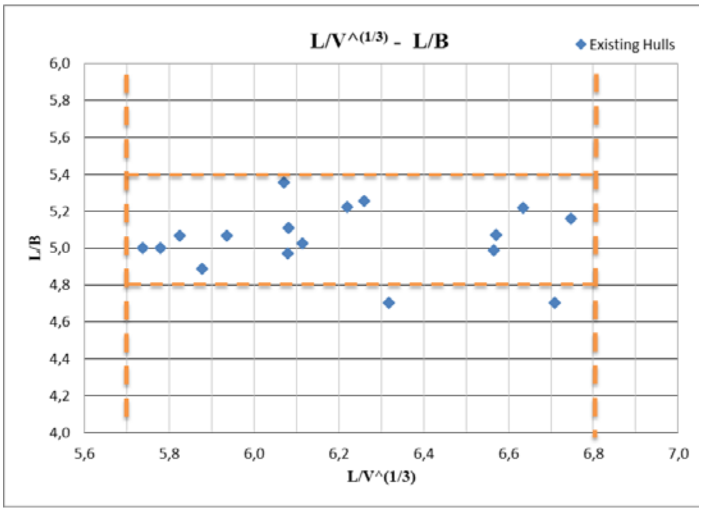

Figure 5. L/B and L/$\nabla^{1/3}$ Range of Existing Hulls

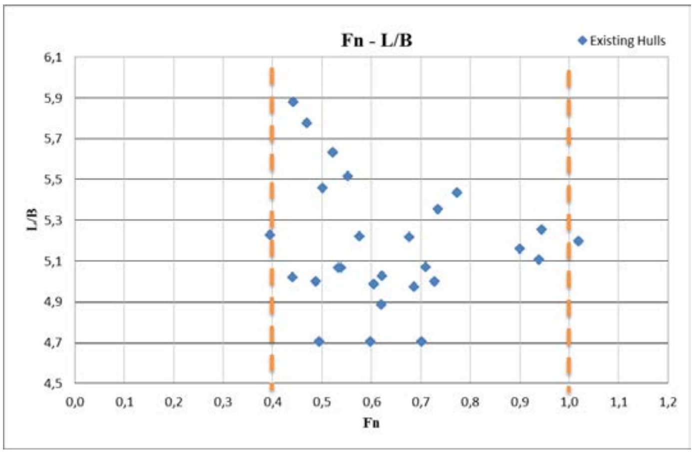

Figure 6. L/B and Fn Range of Existing Hulls

Table 1. Main Dimension and Non-dimensional Coefficients of Initial Hull Form

Length over all, L_{OA}	45 m	**L/B**	4.8
Length over all, L_{WL}	39.56 m	**$L/\nabla^{1/3}$**	6.3
Breadth, B_{MAX}	9.4 m		
Breadth on WL, B_{WL}	8.5 m		
Depth, D	5.5 m		

Parametric Modeling of Parent Hull

Parametric surfaces need some curves and that curves need characteristic points as it is seen from Figure 7. These curves and points will connect to parameters, which are defined before according to objective function. In this way surface of hull is responsive to changing parameters. Besides, design variables should be defined to alternate parameters systematically.

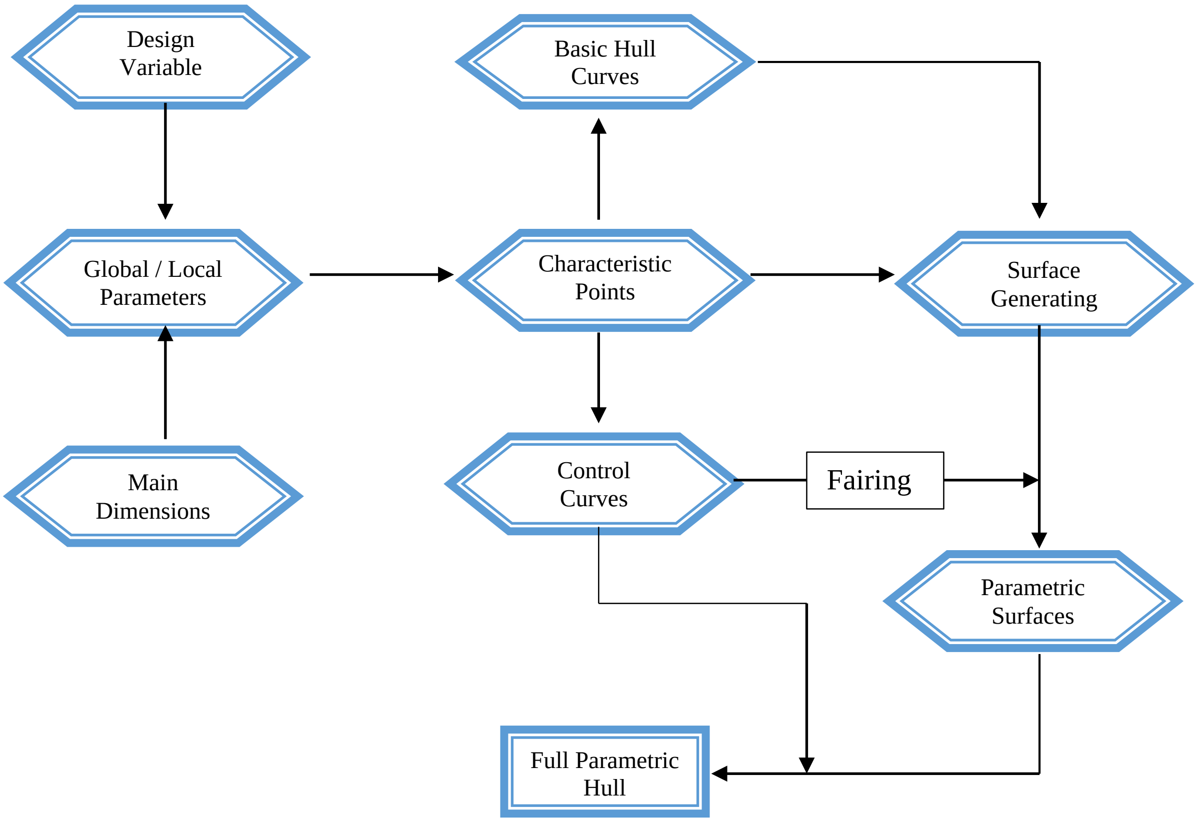

Figure 7. Parametric Flowchart

During the modeling, positional, differential (tangent angles) and integral (areas) parameters are used. This parameters can be separated in two groups as global and local. Main dimensions and characteristic features of hull are assumed as global parameters. Parameters are used for specific curves or surface can be presumed as local parameters. For instance, length of hull is a global parameter but height of propeller tunnel is a local parameter.

At first stage, it is necessary to create basic longitudinal curves for outline of hull, shown in Figure 8.

Table 2. Basic Form Curves

Name of Parametric Curves	Abbreviation
Keel curve	Keel
Deck curve	DECK
Inner spray rail curve	ISR
Outer spray rail curve	OSR
Knuckle curve	KC

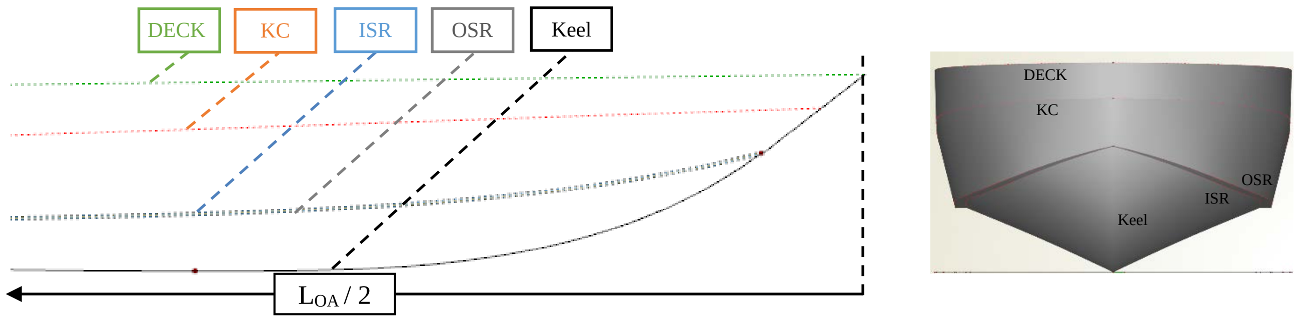

Figure 8. Basic Form Curves

RESULTS AND DISCUSSION

Geometric boundaries which are investigated on preliminary design is important for this step. Constant and variable parameters were defined according to boundaries as shown in Table 3-4. Variable parameters were changed systematically and constant parameters were fixed during variation. As result of process, 120 variants were generated with 45m fixed length and different beam, displacement and deadrise angle, shown Figure 9.

Table 3. Variable Parameters

L_{OA} / B	4.8, 5.0, 5.2, 5.4
L_{WL} / $\nabla^{1/3}$	5.7, 5.9, 6.1, 6.3, 6.5, 6.8
DA (Deadrise Angle)	10.0, 12.5, 15.0, 17.5,20.0

Table 4. Constant Parameters

Fn	0.75
Loa	45 m
Cp	0.80
T_{stern}	0.35 m
Deadrise angle in the direction of X	75^0
Propeller tunnel height	0 m
Fullness of stem	77

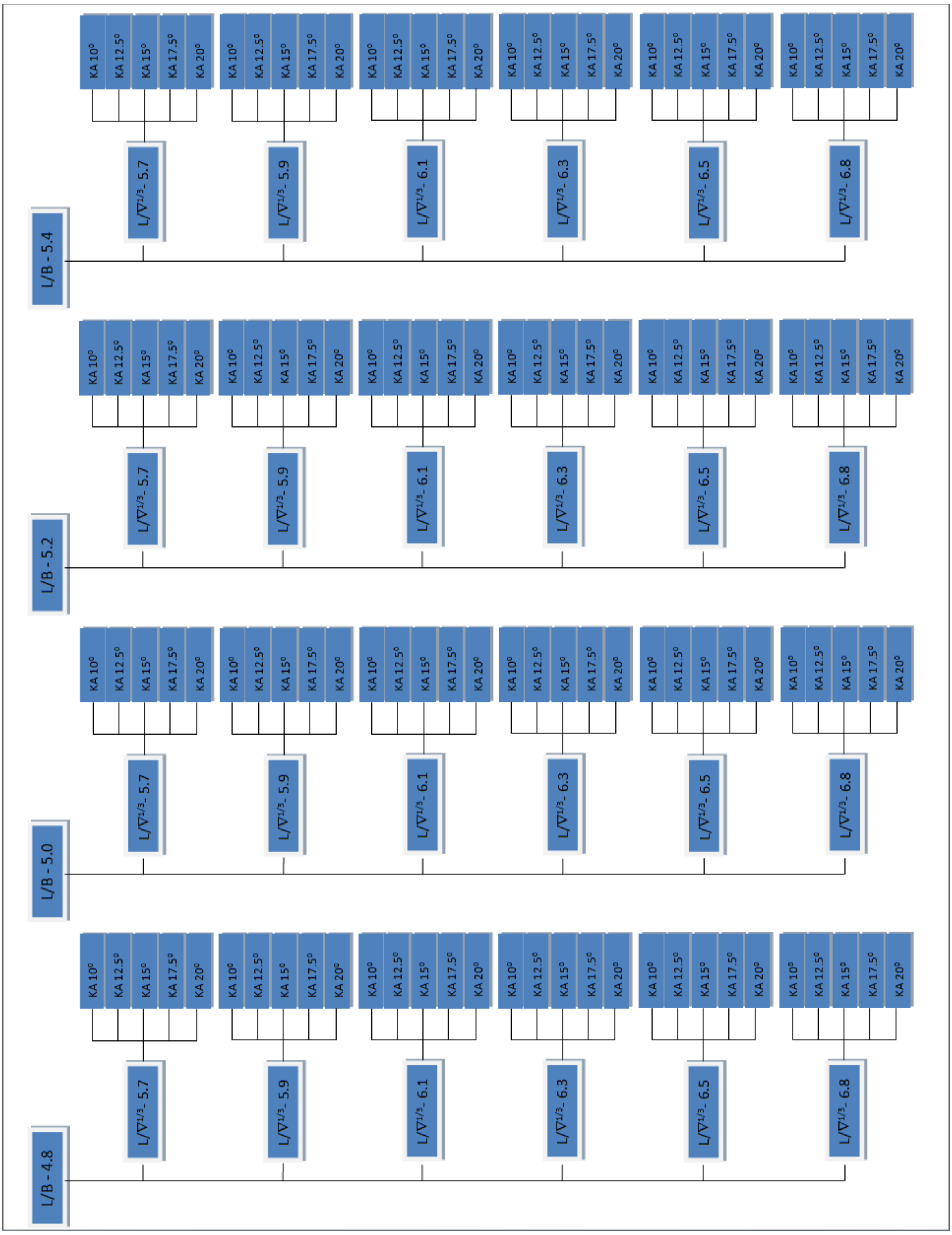

Figure 9. All Variants

In this work, the advantages of fully parametric modeling was mentioned and a fully parametric modeling method was used to create a parent form to generate alternative hull forms. In further studies, all alternatives will be used in a multi-objective optimization process in terms of seakeping, stability and resistance. In line with this target, different software will be integrated to whole process to realize the analyzes simultaneously for all alternative hull forms.

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CFD ANALYSIS OF FLETTNER ROTOR SHIPS AND PERFORMANCE DETERMINATION BASED ON SIMULATION ENVIRONMENT

H. İ. Çopuroğlu[1], E. Peşman[2], M. Özkök[3]

ABSTRACT

Flettner Rotors are spinning cylinders which produce lift force by utilizing wind power. This phenomenon is called as Magnus Effect. The Flettner Rotor system was firstly used for vessels in the 1920's by Flettner. But, today, due to global warming and necessity of reducing emissions, renewable energy resources such as wind energy become more significant than ever before. So, Flettner rotor systems have been re-awakened. This study presents a comparison between two multipurpose container ships which have same features and forms but one of the ships has four Flettner Rotors and the other doesn't. Revolutions per minute of the propellers are fixed for each ship. Therefore, the effect of rotors clearly can be investigated without being dependent on propellers' propulsion forces. The main purpose of this comparison is to observe the effect of Flettner Rotors on navigation duration. With this aim, a simulation model is built up for these two container ships to observe cruising velocity and arrival times on same route and weather condition by a simulation. The route has variable wind forces and directions and the cruising velocity of the rotor ship varies depending on the wind directions and wind forces of the route. The lift forces acting on the rotors are detected by using X-Flow CFD program and based on this power variable cruising velocities are calculated. According to data that are obtained from the simulation, the efficiency of rotors is investigated.

Keywords–*flettner rotors, route simulation, spinning cylinders, X-flow*

INTRODUCTION

Flettner Rotors are spinning cylinders which produce lift force by utilizing wind power. This phenomenon is called as Magnus Effect. The Magnus effect is the observed effect in which a spinning cylinder (or ball) curves away from its principal flight path. German physicist Heinrich Gustav Magnus described the effect in 1852. The Flettner Rotor system was firstly used for vessels in the 1920's by Flettner. Flettner Rotors are used for modern ships. Nowadays there are two ships which have Flettner Rotors. One of them is E-Ship1 built by Enercon Company in 2010, and the other one is Estraden which is a modified ship. E-Ship1 is shown in Fig. 1.

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Figure 1. E-Ship1, a ro-ro cargo ship, which is launched by Enercon

There are many studies about rotating cylinder behaviours. Those studies can be on different Reynolds numbers and spin ratios. The spin ratio is the ratio of the surface speed to the free-stream flow speed [1].

One of those studies is a research by Aoki and Ito [2] studied on characteristics of lift and drag forces, strouhal number, flow patterns behind of a rotating cylinder in terms of the spin rate ratio by numerical and experimental analyses. In this study, the spin rate ratio is varied from 0 to 1.0 for Reynolds number, Re=60000 and 140000. Some of these ports from the study were that the drag coefficient C_D tends to increase as the spin rate ratio increases. The lift coefficient C_L increases within creasing spin rate ratio.

Mittal and Kumar [3] also studied on characteristics of lift and drag forces but they form their studies on *Re=200* between Re=1000. Their paper showed that on low Re numbers, between the spin ratio of 0 and 2, C_L has a sinusoidal relation with flow time. And with increasing of spin ratio except between 4.2 and 4.8 the C_L is the constant value. C_L values between 4.2 and 4.8 are irregular. They compared their CFD studies with Chen et al. [4] experimental studies. Mittal and Kumar's Results are shown in Fig. 2.

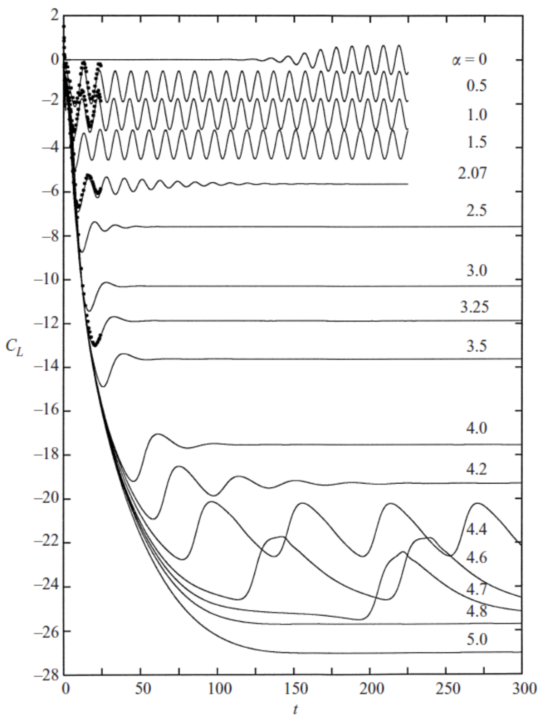


Figure 2. Re=200 flowpast a rotatingcylinder: time histories of Cl forvariousvalues of α from Mittal & Kumar (2002). Solid symbols (.) are the results from Chen et al. (1993).

Jensen et al. [5] investigated characteristic of flow past around a stationary and a rotating cylinder for Reynolds numbers below 200. They found that on most of the variable spin rates on Computational Fluid Dynamics (CFD) and Experimental Fluid Dynamics (EFD) are matched for C_D and C_L values, but above 2,489 there is some inconsistency. Also, the Strouhal numbers from the simulations and an experiment were compared. The values were obtained in the simulations are higher than the experiment. Furthermore, the lift coefficient obtained from the CFD simulations was compared with experiments and by comparing these values to the corresponding rotation ratios; it was clear from the study that these matched quite well.

Jie et al.[6] analyzed the Magnus effect by on the CFD method. The aerodynamic characteristics of the cylinder and dumbbell shaped cylinder and Magnus effect was analyzed by CFD software, FLUENT. From the comparison analysis of the cylinder and the dumbbell, it can be seen that the Magnus force of the dumbbell is bigger than the cylinder at the same wind speed and rotation speed.

Cayzac et al. [7] focused on comparing two numerical analyses method of Magnus effect. First of them was RANS and second of them was RANS/LES hybrid prediction method. As a conclusion, RANS/LES hybrid predictions were better than RANS predictions, but with an increase of, at least, one order of magnitude in computational time.

The study of Karabelas [8], uniform flow past a rotating cylinder at Re = 140,000 was computed based on Large Eddy Simulation (LES). Uniform flow past a rotating cylinder was investigated with LES for spin ratios up to a = 2 and Re = 140,000. Finally, the flow patterns were strongly affected by spin ratio. As a increases, the downstream vortices were shifted to lower azimuthal angles.

Those studies which are given above are all about CFD studies on a rotating cylinder. There are also some papers about rotor using on the marine field. One of those studies is De Marco et al. [9] studied on variation geometric factor of Flettner Rotors such as length and diameter. They tried to propose a systematic approach to identifying the effectiveness and industrial usefulness of Flettner Rotors.

In this paper a comparison is made between two multipurpose container ships which have same features and forms but one of the ships has two Flettner Rotors and the other doesn't. The main purpose of this comparison is to observe the effect of Flettner Rotors on navigation duration. The lift forces acting on the rotors are detected by using X-Flow CFD program.

METHOD

Numerical Study

The lift forces acting on the rotors are detected by using XFlow CFD program and based on this power variable cruising velocities are calculated. The program is 14.0 release and the calculations are run with 4 logical processors. Turbulence model is smagorinsky.

Only one rotor is calculated. So the rotor's flow characteristic is used for results. The rotor has 4 m diameter and 28 m length. Also, the rotor has a Thom disc which is a disc to be used for making flow regular and eliminate the end effect of the object. Thom disc has 8 m diameter and 30 cm length. Details of the rotor are shown in Fig. 3.

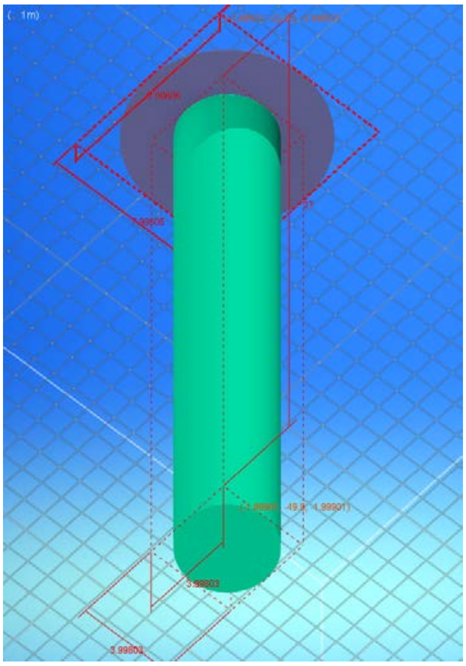


Figure 3. Detail of the rotor which is used at X-Flow calculations.

The calculations are run by different wind velocities and different angles. The angular velocity of the rotor is variable from 250 rpm to 350 rpm. The angular velocity is 250 rpm while the flow velocity is between 3 m/s to 9 m/s, 300 rpm while flow velocity is between 9 m/s to 11 m/s and 350 rpm while the flow velocity between 12 m/s to 20 m/s.

Features of the Ship

The ship body which is used for comparison has 190.65 m of length (LBP=190.65 m), 32.2 m of the beam (B=32.2 m), 10.66 m of the draft (T=10.66 m). Also, the displacement volume of the ship is 35958.164$m^3$and her prismatic coefficient is 0.58 (Cp=0.58). The basic body of the ship is shown in Fig. 4.

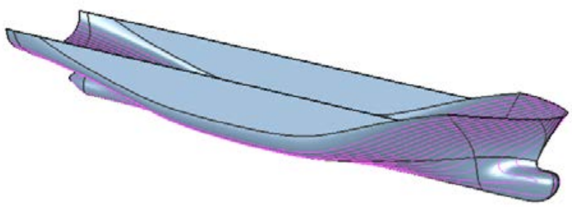


Figure 4. Basic body model of the ship

2 rotors are used at the ship. The distance between two rotors is 60 m. So the lift calculations from 1 rotor at X-Flow are taken as doubled. The basic general arrangement of rotors on the ship is shown in Fig. 8. Revolutions per minute of the propellers are fixed for each ship. Therefore, the effect of rotors clearly can be investigated without being dependent on propellers' propulsion forces. The velocity of the ship is also constant and 12 knots.

Figure 5. Basic general arrangement of rotors on the ship

One of the important parameters is the resistance of the ship. The resistance of the ship is calculated by standard software. The resistance is calculated by using Compton method. With this resistance, the force which is required to reach 12 knots is calculated. The required thrust force is 588 kN. After finding rotors' lift forces, those forces are added to required force and new velocity is calculated. After this step, from distance-velocity relation, the cruising duration is calculated and it is compared with the non-rotor ship. Non-rotor ship has 12 knots of velocity. The relation between the velocity of the ship and the resistance is shown in Fig. 6 with a graphic. The apparent wind velocities encounter angles are calculated for depending on the ship velocity, wind directions and wind velocities. XFlow analyzes were performed for different angles and velocities. Depending on the apparent wind velocities and angles, the lift forces are determined by using interpolation.

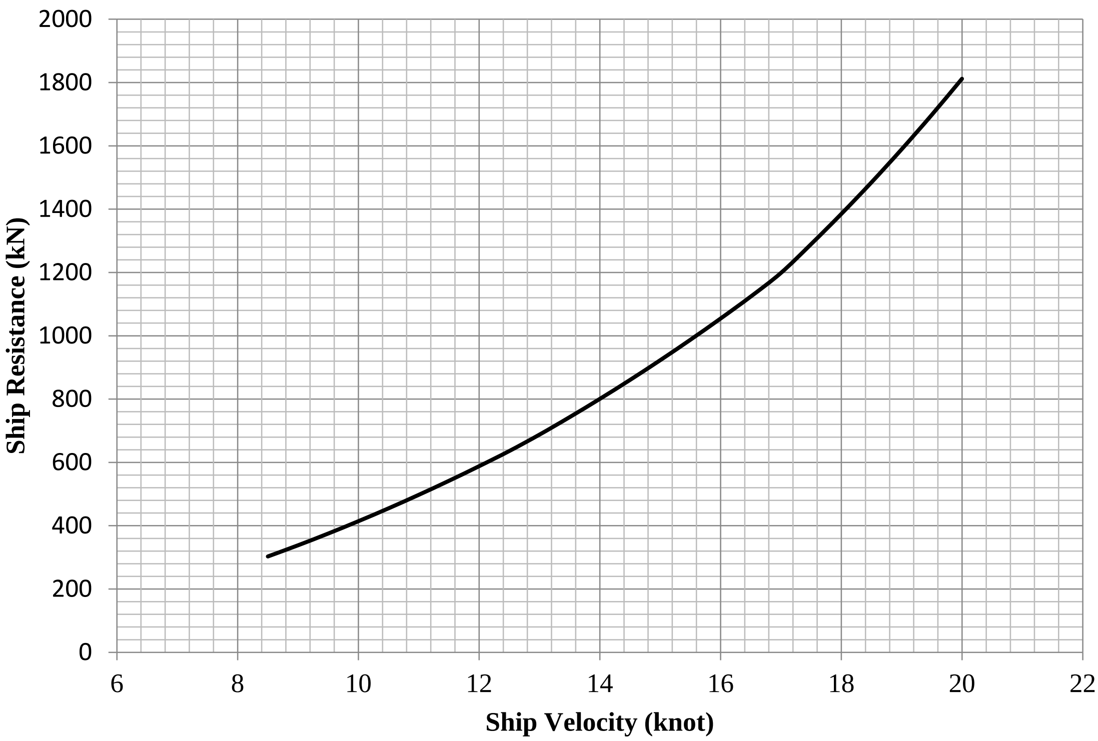


Figure 6.The relation between the velocity of the ship and the resistance.

Route Planning

The route must has variable wind forces and directions and the cruising velocity of the rotor ship varies depending on the wind directions and wind forces of the route. So, all possibilities can be made for natural conditions. With this aim, the route is chosen as Barcelona to Trabzon. This route has many winds with different force and directions. The route which is chosen is shown in Fig. 7.

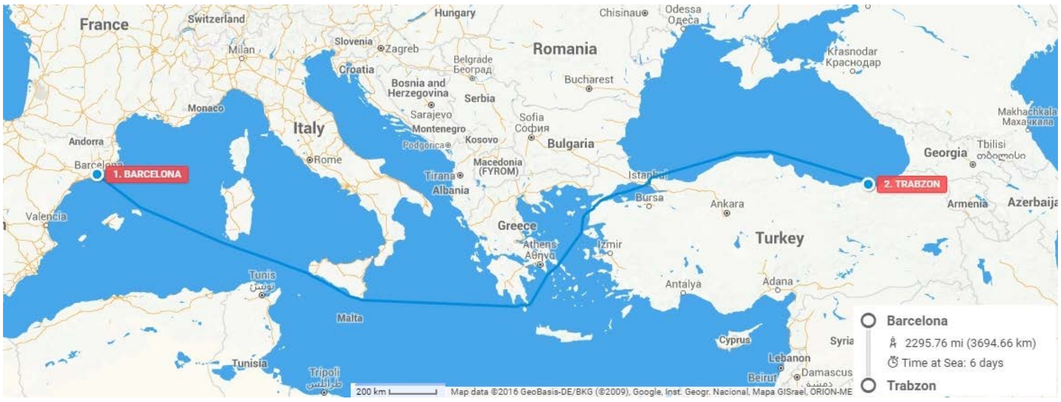


Figure 7. The route between Barcelona and Trabzon

Also, one of the important parameters is the dates of cruising. Because, wind parameters change by dates and seasons of the year. So the dates of cruising are chosen as summer and the wind characteristics are determined. Basic map of summer wind characteristic of the Mediterranean Sea is shown in Fig. 8.

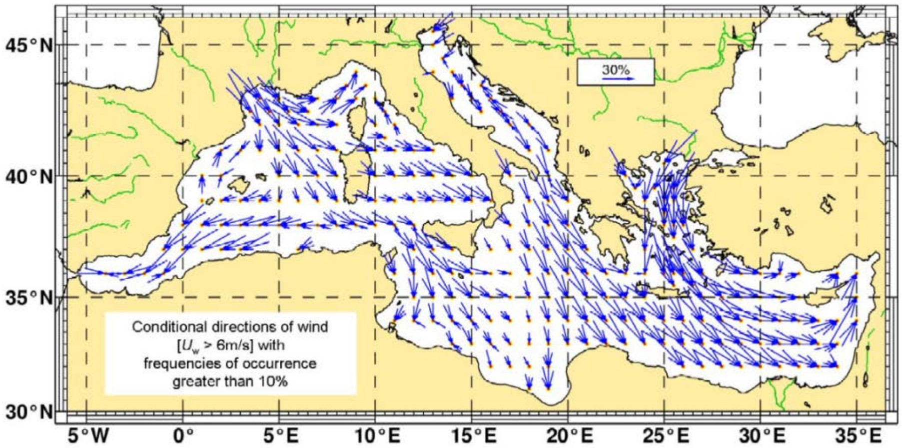


Figure 8. Spatial distribution of wind directionality , Summer according to Western European Armaments Organisation[10]

According to summer wind forces and directions, a table is created (Table1). The table has wind directions according to vessel body (the bow is 0° and the stern is 180°) and forces. This table is used to find distant relations of wind characteristics.

Table 1. Relations between wind directions, angle, force and distance

Distance (km)	Windvelocity (m/s)	Directionaccordingto body	Angleaccordingto body
0-50	4	starboard	90
50-150	6	starboardstern	115
150-200	3	stern	180
200-250	10	port stern	160
250-350	8	port	90
350-400	10	port	90
400-500	10	port stern	135
500-600	8	port stern	150
600-700	12	port stern	165
700-900	6	port stern	170
900-1000	8	stern	180
1000-1200	6	stern	180
1200-1300	3	port stern	160
1300-1400	3	port stern	125
1400-1500	4	port	90
1500-1700	10	port	90
1700-1800	12	port stern	110
1800-1900	14	port stern	135
1900-2050	6	port stern	160
2050-2200	3	port bow	70
2200-2250	4	port bow	80
2250-2300	8	port	90
2300-2400	10	port bow	40
2400-2500	8	bow	0
2500-2650	6	port bow	45
2650-2800	10	port	90
2800-3200	8	port	90
3200-3600	6	port	90
3600-3700	4	port bow	70

Route Simulation

Simulation is a tool that can model the real world on computer environment. By doing this, the real event and its conclusions can be seen before performing the real things. Therefore, simulation helps the managers make decisions on what the company should do. In this section, the route that the ship will keep track will be modelled by utilizing simulation software.

Along with route between Barcelona and Trabzon, the speed of ship will be different. In simulation environment, these speed diversities will be shown in the form of basic nodes. Each basic node alters the speed of ship by using some simulation steps as shown in Fig. 9. These simulation steps are called as Decide and Assign. In Decide step, condition is determined. Fig. 10 depicts the Decide condition that defines if the ship is rotor ship or non-rotor ship. Assign steps (Assign 1 and 2) in Fig. 11 and 12 define the speed of rotor and non-rotor ships.

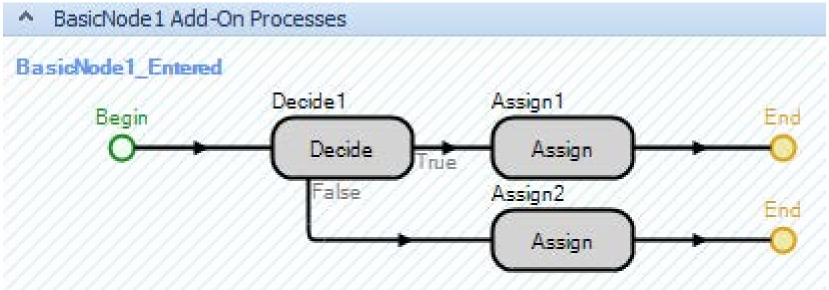


Figure 9.Simulation steps used in route simulation.

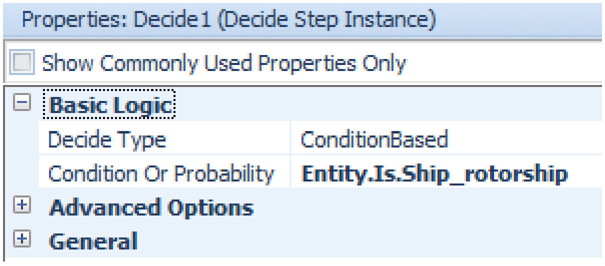


Figure 10. Decide step and condition.

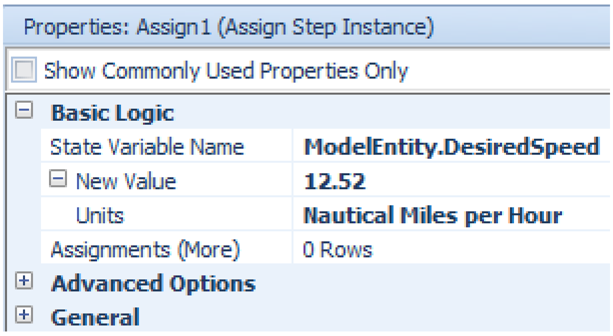


Figure 11. Assign1 step and rotor ship speed.

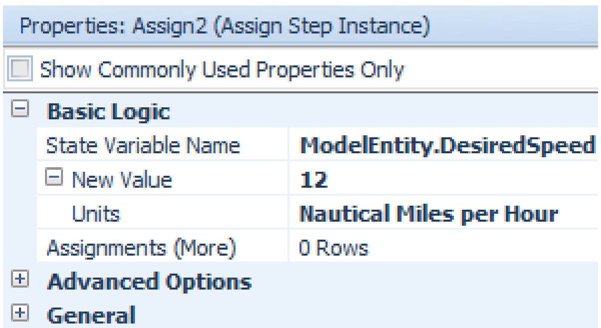


Figure 12. Assign2 step and non-rotor ship speed.

RESULTS AND DISCUSSIONS

The rotor is run by different wind velocities and different angles. The angular velocity of the rotor variable from 250 rpm to 350 rpm. The calculations are run between 3 m/s and 20 m/s of velocity. Some of the flow characteristics around the rotor are shown in Fig. 13.

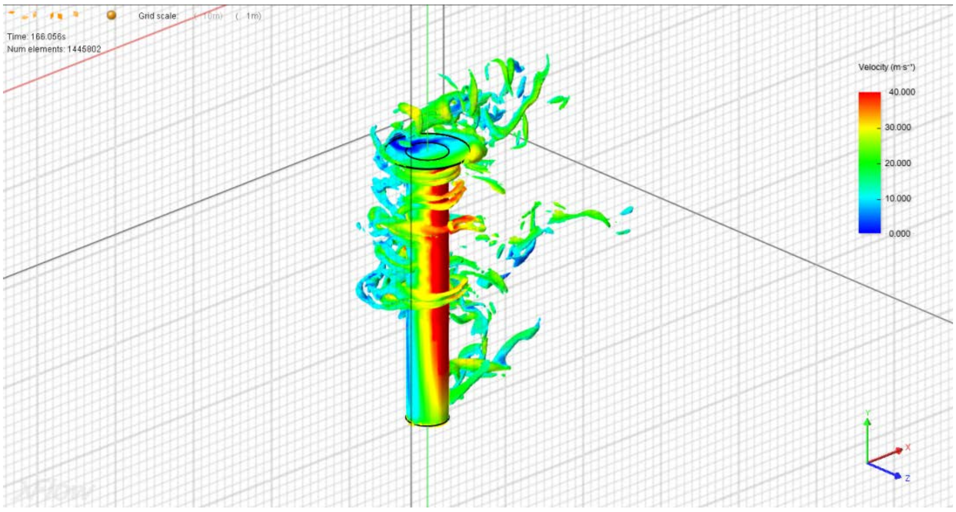


Figure 13. Velocity fields around of the rotor. (350 rpm of angular velocity and 14m/s flow velocity.)

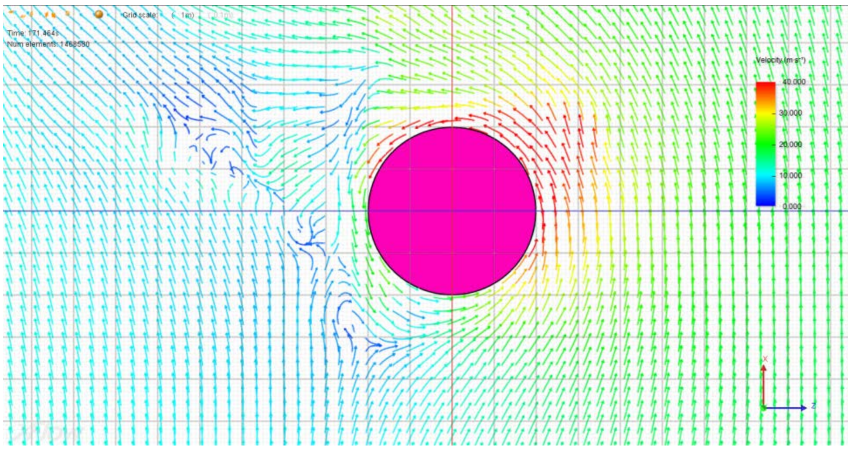


Figure 14.Vector velocity magnitude of the rotor with perspective from above. (350 rpm of angular velocity and 14m/s flow velocity.)

There are also some data from vector velocity magnitudes. Those data can be seen from Fig 14. After those calculations, lift forces are calculated. The most important parameter in this paper is the relation lift forces, velocity and angle of the wind. According to those data, lift forces are added to required force and new velocity is calculated. Firstly the calculations are made for true wind. The ship cruising velocity is presumed as 0 by calculating with the true wind. The lift force, true wind velocity and true wind angle of the rotor are given as a graphic at Fig.15.

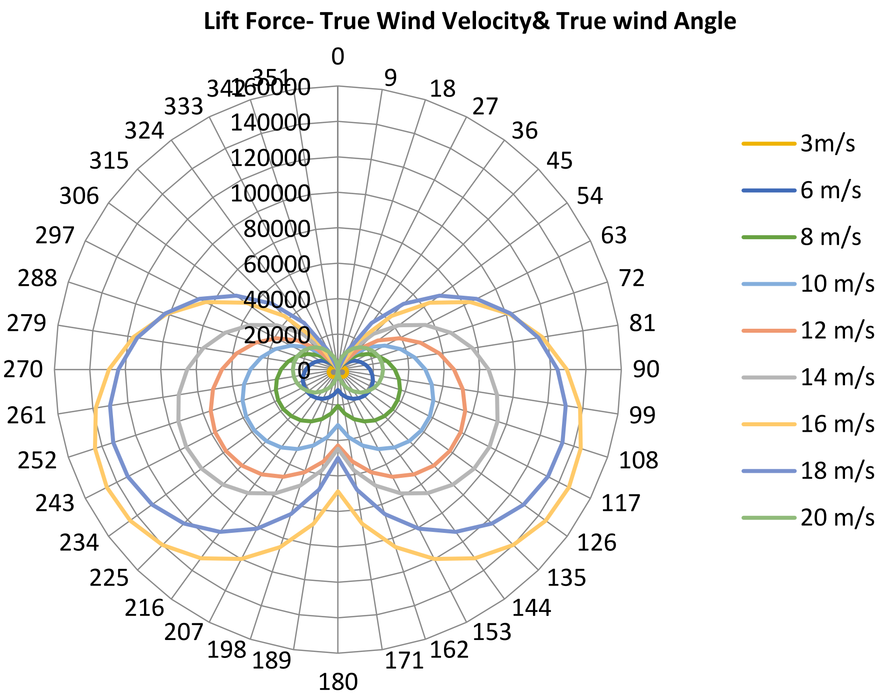


Figure 15. Lift force- true wind velocity& true wind angle graphic.

But the correct calculations are made with apparent wind. The ship cruising velocity is taken as 12 knots by calculating with apparent wind. The lift force, apparent wind velocity and apparent wind angle of the rotor are given as a graphic at Fig. 16.

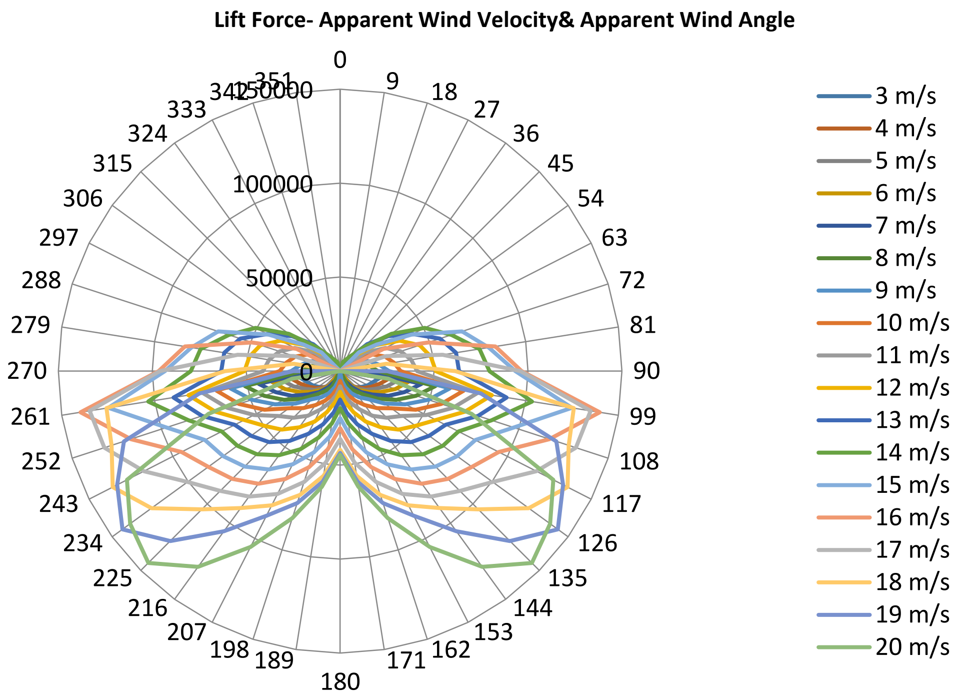


Figure 16. Lift force- apparent wind velocity& apparent wind angle graphic.

It can be said that if wind flows from board side of ship body, rotors can be more effective. After preparing apparent wind graphics, it can be used to combine with relations between wind directions, angle, force and distance of chosen route. Aim of this step is to find how much lift force produce on the cruising route. After combined the table which can be seen from Fig. 5, the new forces and velocities are found. The new forces and velocities can be seen from the Table 2.

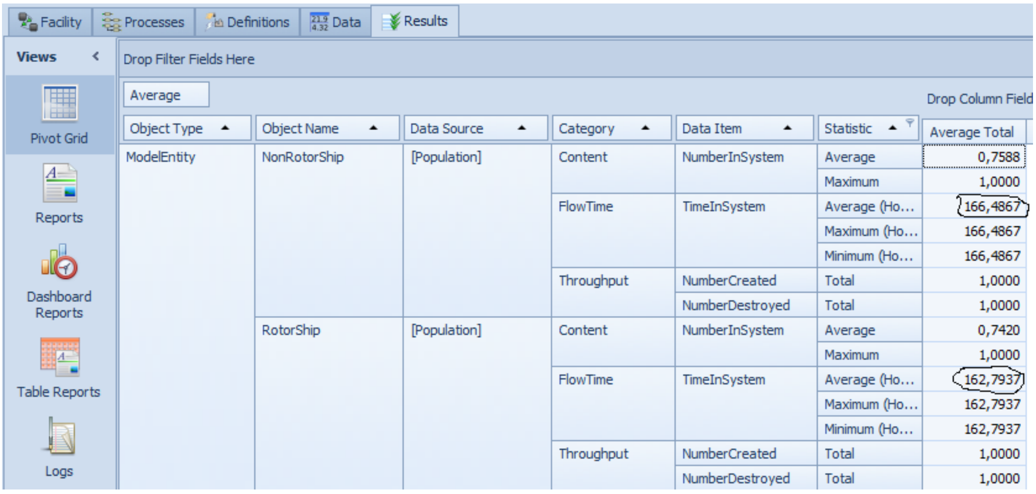
Table 2. Features of non-rotors ship and rotors ship

Distance (km)	Velocity of ship non-rotors (knot)	Velocity of ship with rotors (knot)	A rotor lift force (kN)	Non-rotor thrust on the ship (kN)	Added Rotor thrust on ship (kN)
0-50	12	12,0207	1,3394	588,0000	590,6789
50-150	12	12,5196	25,9222	588,0000	639,8444
150-200	12	12,0625	3,3580	588,0000	594,7160
200-250	12	12,2864	14,2931	588,0000	616,5863
250-350	12	12,4059	20,2195	588,0000	628,4389
350-400	12	12,6433	32,1961	588,0000	652,3922
400-500	12	12,5578	27,8551	588,0000	643,7101
500-600	12	12,2088	10,4767	588,0000	608,9533
600-700	12	12,4166	20,7568	588,0000	629,5135
700-900	12	12,0000	0,0000	588,0000	588,0000
900-1000	12	12,0000	0,0000	588,0000	588,0000

Table 2. Features of non-rotors ship and rotors ship (continued)

Distance (km)	Velocity of ship non-rotors (knot)	Velocity of ship with rotors (knot)	A rotor lift force (kN)	Non-rotor thrust on the ship (kN)	Added Rotor thrust on ship (kN)
1000-1200	12	12,0000	0,0000	588,0000	588,0000
1200-1300	12	12,1209	6,1861	588,0000	600,3721
1300-1400	12	12,2914	14,5376	588,0000	617,0752
1400-1500	12	12,0207	1,3394	588,0000	590,6789
1500-1700	12	12,6433	32,1961	588,0000	652,3922
1700-1800	12	13,3098	67,2255	588,0000	722,4509
1800-1900	12	13,2241	62,5977	588,0000	713,1954
1900-2050	12	12,0000	0,0000	588,0000	588,0000
2050-2200	12	12,0000	0,0000	588,0000	588,0000
2200-2250	12	12,0079	0,7253	588,0000	589,4507
2250-2300	12	12,4059	20,2195	588,0000	628,4389
2300-2400	12	12,0000	0,0000	588,0000	588,0000
2400-2500	12	12,0000	0,0000	588,0000	588,0000
2500-2650	12	12,0000	0,0000	588,0000	588,0000
2650-2800	12	12,6433	32,1961	588,0000	652,3922
2800-3200	12	12,4059	20,2195	588,0000	628,4389
3200-3600	12	12,1787	9,0041	588,0000	606,0082
3600-3700	12	12,0000	0,0000	588,0000	588,0000

The rotors can be ineffective at some distance, the reason of this situation is the angle and the velocity of the wind. From Fig. 14 it can be seen that at some specific angles and velocities are useless. The duration of cruising can be calculated after this step.



Object Type	Object Name	Data Source	Category	Data Item	Statistic	Average Total
ModelEntity	NonRotorShip	[Population]	Content	NumberInSystem	Average	0,7588
					Maximum	1,0000
			FlowTime	TimeInSystem	Average (Ho...	166,4867
					Maximum (Ho...	166,4867
					Minimum (Ho...	166,4867
			Throughput	NumberCreated	Total	1,0000
				NumberDestroyed	Total	1,0000
	RotorShip	[Population]	Content	NumberInSystem	Average	0,7420
					Maximum	1,0000
			FlowTime	TimeInSystem	Average (Ho...	162,7937
					Maximum (Ho...	162,7937
					Minimum (Ho...	162,7937
			Throughput	NumberCreated	Total	1,0000
				NumberDestroyed	Total	1,0000

Figure 17. Simulation results of rotor ship and non-rotor ship navigation.

Fig. 17 depicts the simulation results of the rotor and non-rotor ships' navigations. Accordingly, while non-rotor ship is completing the navigation in a span of 166.48 hours, the ship with rotor can reach the destination port in 162.79 hours. Therefore, as can be understood, the ship utilizing rotor arrives the destination port 3.69 hours earlier. So, inserting the rotor to the ships provides advantage in sense of navigation duration.

CONCLUSIONS

After the calculations and comparisons, it can be seen that cruising duration is shortened approximately 4 hours. That is obviously a satisfying gain for time. The route plan was very short against a full cruising of a merchant ship. It can be said that with the longer distance of cruising rotors can provide more gain on duration. So using Flettner Rotors can be a benefit for marine sector and relatively to the transportation business. But it is also important to prepare an optimizing course of cruising. So wind power can be used more efficiency with rotors.

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A STUDY ON THE EFFECTS OF TRIM OPTIMISATION ON SHIP RESISTANCE OF A SUB-PANAMAX TYPE CONTAINER VESSEL

Kerim ZİYLAN[1], Selçuk NAS[2]

ABSTRACT

Marine industry has a variety of energy resources to be used in a ship's propulsion system such as; fossil fuels, renewable energy, fuel cell technology and energy types that will be developed in future. Whether the energy resource is for today or even for future, the key feature is "efficiency". The energy efficiency of a vessel depends on many factors. There are lots of practical methods to ensure energy savings for vessels but trim optimisation is the one which is an easy application method and also has a high efficiency, about %5-15, considering its easy application. To date, ships have sailed with a trim to aft because of a common science belief. This could cause a waste of propulsion energy. To find out trim optimisation effects on energy efficiency, the study aims to investigate the trim optimisation of a sub-panamax type container vessel which has a capacity of 2478 TEU by using the relevant computational analysis softwares.

Keywords - Ship Resistance, Trim, Trim Optimisation, Maxsurf

INTRODUCTION

Shipping industry is one of the most important actors in global transportation. "There are many ways of optimising ship performance, but often the simplest changes offer the largest gains. An example of this is focusing on operating the ship at optimum trim in order to keep fuel consumption at a minimum." [1]. There are lots of practical methods to ensure energy savings for vessels but trim optimisation has a high potential fuel savings, about up to 15%, considering its easy application [3]. Trim optimisation enables to save fuel due to minimum resistance on related condition, also bringing about less emissions and providing economical aspects [6]. The relevant authorities underline the importance of trim optimisation on ship fuel savings and reducing ship resistances [1], [3] - [9]. Optimum trim condition could be by bow or by stern as shown in Figure 1.

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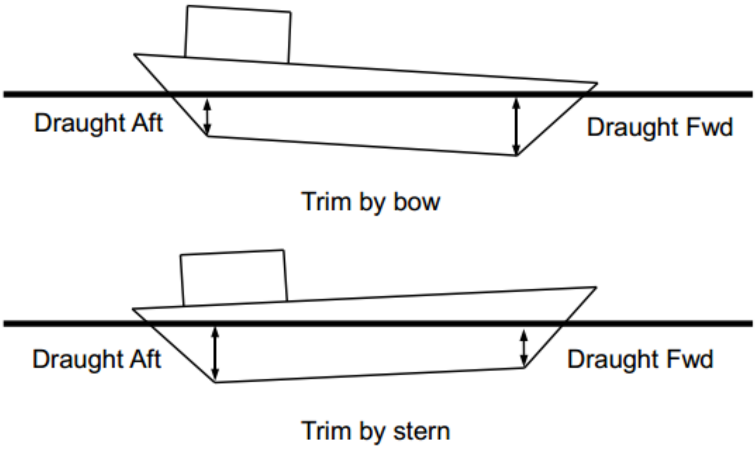

Figure 1. Different Trims on an Arbitrary Ship. [8]

TRIM OPTIMISATION

In recent years it is observed that, as a consequence of usability of computational fluid dynamics(CFD) programs instead of towing tank experiment, studies on trim optimisation are in the increase. Although towing tank experiment's result is the most accurate one, computational softwares are much easier to study. Towing tank experiment needs expensive and specialized hardware, a very long pool, a huge laboratory, a 3D hard model, and etc. The need of computer based analysis are less than those of the pool experiment, in addition to less study time and fewer personnel.

Trim optimisation is investigated by Larsen N. L. by comparing two different CFD programs which use two different CFD methods and towing tank trials. The study aims only one partly loaded draught to find optimum trim. In conclusion, results of one CFD method/program and towing tank trials are similar but not the other CFD method/program. Besides residual resistance is the major effect of gains from trim optimisation with a percentage of 80% [1].

Another study uses log data to find out optimum trim to improve ship energy efficiency. It is investigated that the connection between main engine fuel consumption and trim conditions. The study shows us, log speed of vessel could be improved due to appropriate trim level and main engine fuel consumption could be reduced [7].

A study on MOERI container ship (KCS), investigates hull trim optimisation by using a CFD program. CFD method results and experimental values compared in even keel condition and the results are approximately equal. Later, resistance calculations on different trim conditions are studied. Eventually, trim by bow is increasing factor of MOERI container ship resistance [6].

TRIM OPTIMISATION ON MAXSURF

It is important to use the data of an actual ship to examine the real effects of trim optimisation on ship resistance. In order to study a real ship and provide an improvement of resistance prediction, we applied to ARKAS company in 2016 to have a ship hull form data with a two-year permission of use in academic studies. The ship is a container vessel which is named as M/V Vivien A and main dimensions are given in Table 1.

Table 1. Main Characteristics of Ship

Length over all	L_{OA}	210.54 m
Length between perp.	L_{PP}	198.74 m
Breadth moulded	B	29.80 m
Depth moulded	D	16.40 m
Design draught moulded	T	10.10 m
Scantling draught moulded	T_{MAX}	11.40 m
Deadweight	DWT	34973
Capacity	TEU	2478 TEU
Flag		Turkish
Lightship data		
Mass	M	10740 t
Longitudinal centre of gravity	L_{CG}	81.10 m
Transverse centre of gravity	T_{CG}	0.04 m
Vertical centre of gravity	V_{CG}	12.25 m

This study aims to find out if Bentley Maxsurf Program could be used to predict resistance on different trims/displacements/speeds by aid of Rhinoceros Program. The results of Maxsurf program will be compared with Towing Tank Trial test result and be clarified if results are admissible.

Maxsurf is a well-known program which is used by naval architectures, engineers and academicians in marine industry. The program has a module of resistance calculation method named “Holtrop” and has a method named “slender body”, using potential flow CFD approach [2]. The program is used in preliminary design and in first resistance analysis of ships and it is easy to use.

It was needed to model the ship as 3D to investigate trim optimisation by using computer programs. Rhinoceros is a 3D modelling and design program and is used to get 3D model in the study. The gathered data includes *lines plan*, *body plans*, *loading manuals*, *displacement tables* and documents about ship’s construction.

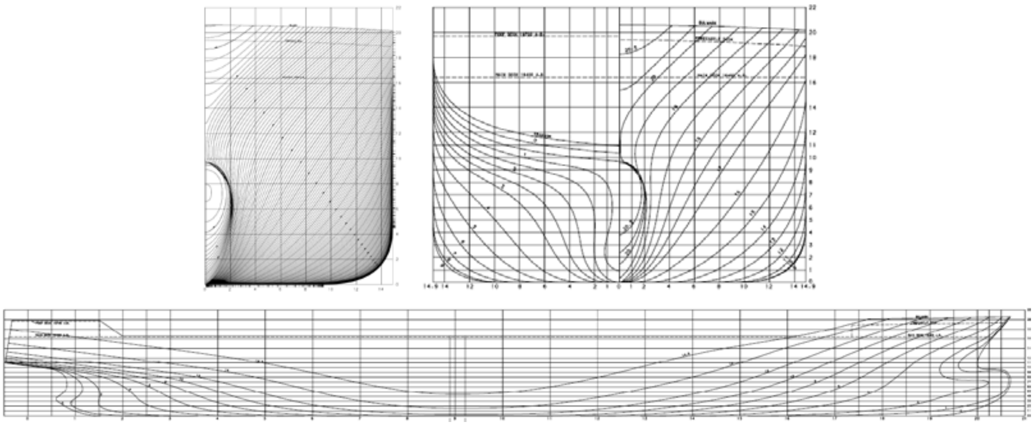

Figure 2. Body Plan of Ship’s Fore Part and Lines Plan

The vessel has a bulb and a non-basic propeller assembly area, so it is not easy to obtain accurate model surfaces in these areas. In *lines plan*, space between two lines is larger than the one in *body lines* because body plan has 257 transverse lines but lines plan has only 29 transverse lines. To have an accurate model, 3D model of ship has been developed by using *body lines* and centreline from *lines plan* in Rhinoceros 5.

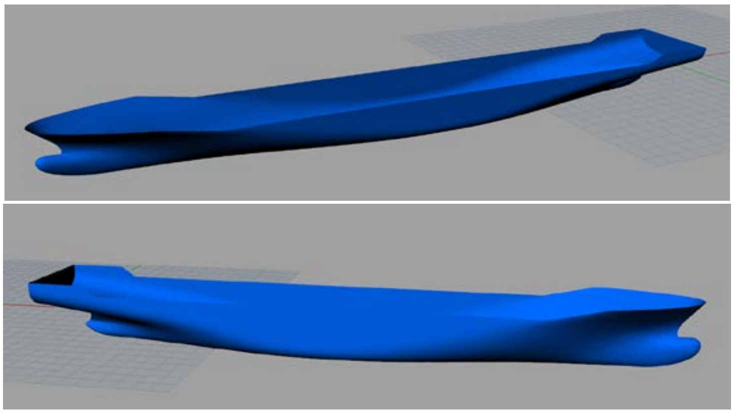

Figure 3. Model of the vessel in Rhinoceros 5

When the modelling is finished, vessel characteristics in *displacement tables* and *loading manuals* are compared in 5 random drafts with 3D model characteristics, gathered from Bentley Maxsurf v20 and Orca3D v1.4 WIP edition. The compared characteristics are; Length Over All(L_{OA}), Breath(B), Longitudinal Centre of Floatation (L_{CF}), Displacement (Δ), C_B, C_P, C_M, Waterline Length(L_{WL}), Displacement Volume (∇) and others. The results of the comparisons are reasonably acceptable, in this manner, the 3D model is selected to trim optimisation study of the vessel, M/V Vivien A.

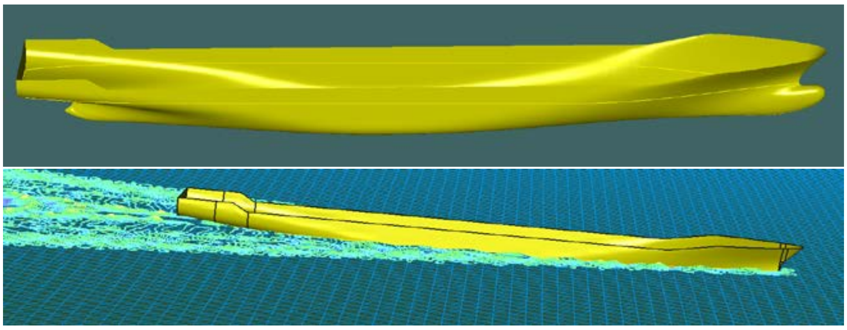

Figure 4. Model of the vessel in Maxsurf Modeler & Maxsurf Resistance

Subsequently, *loading manuals* and *displacement tables* of vessel were analysed, contacted to ship-owners and master of the ship to find out in which drafts/displacements conditions ship has been sailing generally. It has been selected 6 different displacements, a speed range from 0 knots to 20 knots and 7 trim conditions starting from -2 meters to +1 meters to find out optimum trim-speed-displacement conditions.

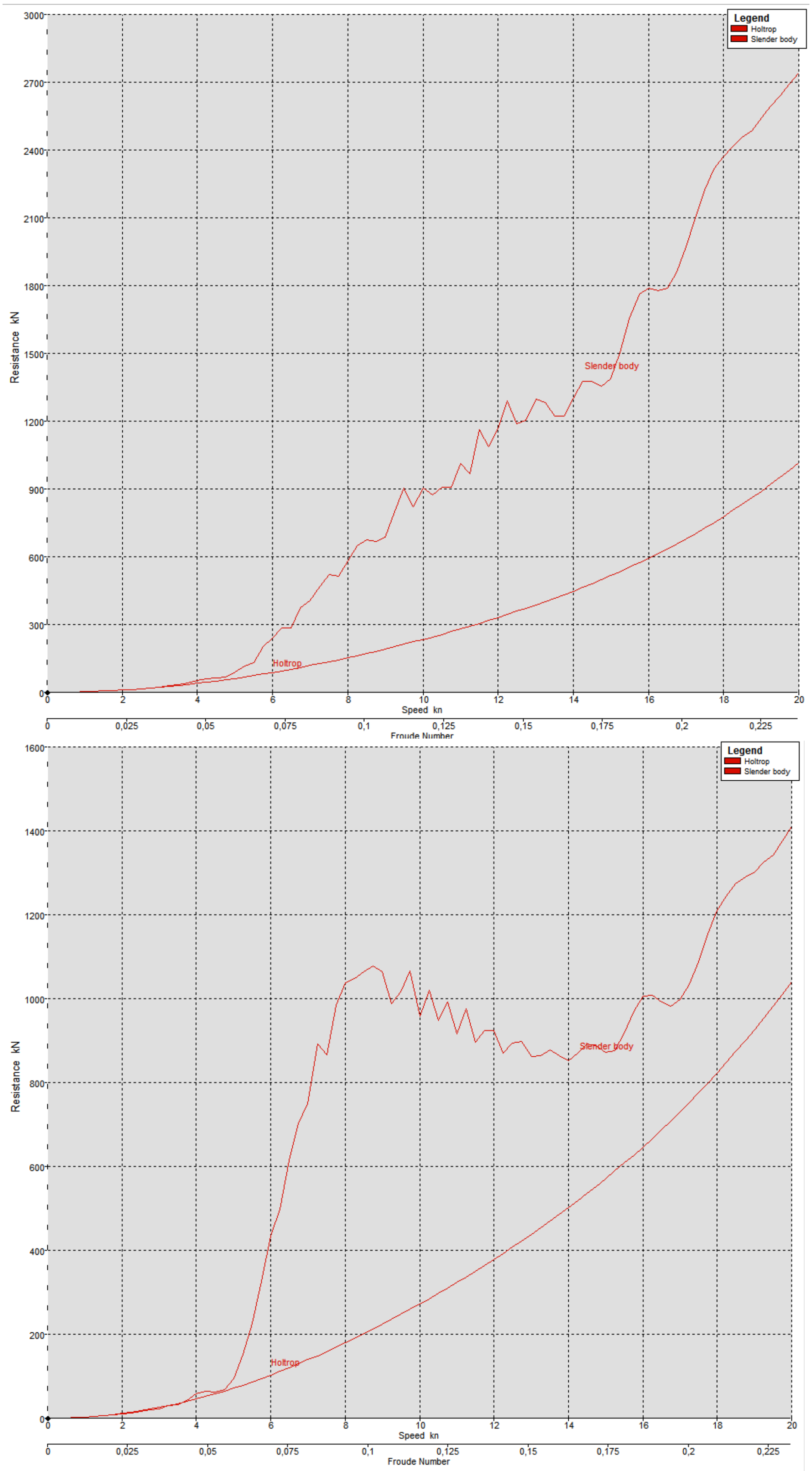

Figure 5. Sample results of Maxsurf Resistance on two different trim conditions.

FUTURE STUDY

In the study, a 3D model of a ship, named M/V Vivien A, has been developed using Rhinoceros program. Also, it is investigated that 6 most used displacements' resistance analysis in 7 trim conditions with a speed range from 0 knots to 20 knots in Maxsurf program's modules. Sample results could be seen in Figure 5. In future, it is planned to make a towing tank experiment in Istanbul Technical University's laboratory, in order to crosscheck results of the towing tank and Maxsurf Resistance program. At that time, this study will serve as foundation for if Maxsurf Resistance program could be used for trim optimisation or not.

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NEW CONCEPT IN ESCORT TOWAGE: DYNAMIC BOLLARD PULL

Cahit İSTİKBAL[1]

ABSTRACT

This paper concentrates on the "Dynamic Bollard Pull", which is a comparatively new concept and achieved only by means of special towing techniques, which is called "indirect towage". Recent tests have demonstrated that a stern tug operating in the indirect mode can generate high pulling forces. This is what this paper aims to highlight: the dynamic pull force or the dynamic bollard pull. In this paper, the phenomenon of dynamic bollard pull, it's technical explanation and the methods through which dynamic bollard pull could be produced will be discussed. Nevertheless; this new concept leaves us facing with a new threat: the strength of towing line as well as the strength of connecting points onboard. Therefore, the classical calculation methods of strengths of towing lines and "strong points" onboard tankers are no more valid. New concept requires the calculation of the towing system's strength in accordance with the dynamic bollard pull. Today the recommendation on tankers over 50.000 DWT are required to be fitted with a strong point arrangement, with suitable reinforcement, having a minimum SWL of 200 metric tons when used with a single eye towing line or grommet. This is good for an average escort tug with 80 tons of static bollard pull capacity, but, however, as this is still a recommendation and not an imperative tool, all ships of this size can be not expected to have this equipment fitted. Ship operators, tug operators, especially tug captains and pilots should be aware of this new concept and act accordingly during tethered escort towage operations. The escort towage which is in practice in the Turkish Straits will also be touched upon in the paper.

Keywords: Escort Towage, Bollard Pull, Dynamic Bollard Pull, Static Bollard Pull, Direct Towing, Indirect Towing

INTRODUCTION

The concept of towage has its roots behind as early as the history of maritime itself. Ships were never more maneuverable than they are today, even though they were much smaller. The magic touch provided by a helping hand has always been friendly and needed by captains onboard; yesterday and today.

The main concept has always remained the same, but however, some areas of operation and techniques today are different-if not new at all. Different types of tugboat designs have also emerged with each serving to appropriate maneuvering needs or high risk areas in which larger ships need the assistance of an able tugboat. Large ships navigating in a narrow channel are mostly challenged by turns and own limited steering capabilities. This was how the concept of “Escort Towage” was born.

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The practice of escort towage has evolved considerably over the last couple of decades, especially in the wake of the Exxon Valdez oil spill and the Oil Pollution Act (OPA 90) that followed. However, with the phasing-out of single hull tankers, the OPA 90 requirement of escort tugs does not find any vessel to be applied on today. However, In the United States, the mandatory escorting of laden tankers is required by Federal Regulation in Puget and Prince William Sounds, and by the State of California in the ports of San Francisco, Los Angeles/Long Beach, San Diego, and Port Hueneme. Both the Federal and State regulations require the master to operate the vessel within the performance capabilities of the escort vessels [1]. Similarly, Swedish Maritime Administration apply compulsory escort towage requirement to tankers over 15.000 DWT in certain restricted waters. In the Strait of Istanbul, tankers over 250 m in length usually escorted by a tug in a non-tethered operation. There are many more application areas of escort towage exist around the world.

Escort towage has been found the most effective method for risk reduction in narrow waterways in a research carried out by DNV GL, together with the existence of pilot onboard the vessel to which the tug is tethered (Figure 1) . In this research, the tug was accepted as tethered to the tanker in an active escort operation.

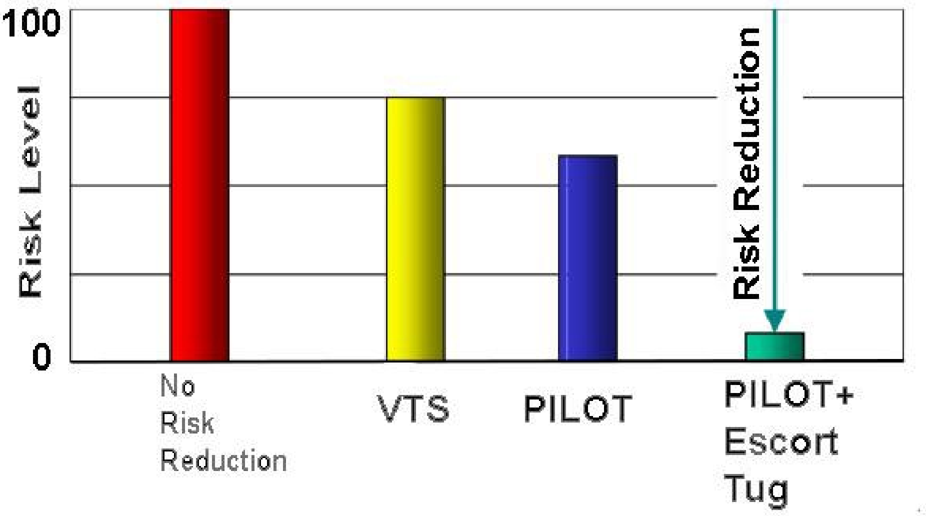

Figure 1. Representative roles of risk reduction methods in a narrow waterway [2]

We can assume that active escort towage is an accepted method in risk reduction at restricted waterways and narrow channels. The justification of this need is not the main subject of this paper. We will concentrate more on the bollard pull phenomenon in the tethered escort operations.

STATIC BOLLARD PULL

Bollard pull is a conventional measure of the pulling power of a tug. It is mostly defined as the force in tons and mentioned as TBP (Tons of Bollard Pull). Bollard pull is commonly measured with vessel under full power tethered on a shore-mounted bollard through a tow-line in calm water with sufficient depth, side clearance and free propeller stream (Figure-2). The bollard pull of a vessel may be reported as two numbers, the static or maximum bollard pull - the highest force measured - and the steady or continuous bollard pull, the average of measurements over an interval of, for example, 10 minutes. Bollard pull is primarily (but not only) used for measuring the strength of tugboats, with the largest commercial harbor tugboats in the 2000-2010s having around 60-65 tons of bollard pull, which is described as 15 tons above "normal" tugboats [3].

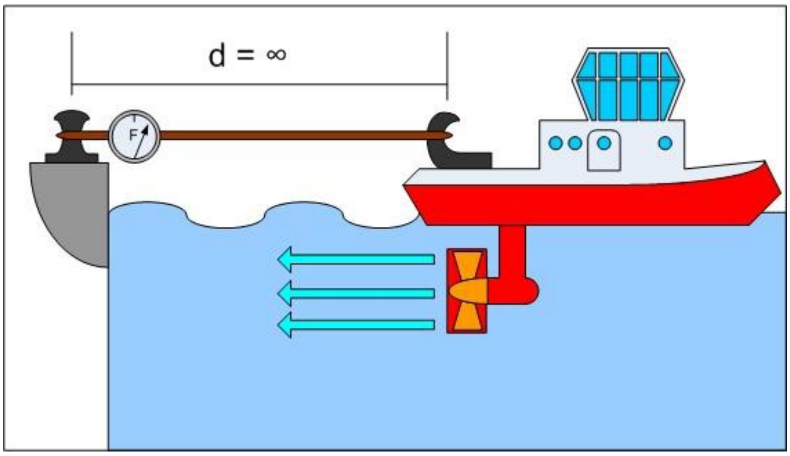

Figure 2. Bollard pull measurement under ideal conditions [4]

The bollard pull tests are certificated by the Class Societies, which is called as "Bollard Pull Test Certificate". On the certificate, the "Static Bollard Pull" under the continuous maximum RPM is mentioned after a test in which, an average bollard force is computed as the average of evenly spaced load cell recordings taken over a sustained pull interval of a minimum 3 minutes for each recorded pull at the rated engine horsepower and speed.

DYNAMIC BOLLARD PULL

Static bollard pull is essential in understanding the initial force of a tug; but in the real life, the force exerted on a towing line by a tug is effected by many other factors. The bollard pull exerted by a tug in the operational conditions in the actual life differs from that written on the Bollard Pull Test Certificate. In order to understand the dynamic bollard pull better, let's have a brief look at the conditions that affect the bollard pull in actual conditions:

1- **Kinetic Energy:** As a vessel's speed increases, it's kinetic (stored) energy increases geometrically. The kinetic energy is equal to one half the weight of the vessel multiplied by the velocity squared (KE = ½ WXV2). Simply put this means that at ten knots the kinetic energy that the tugs must control in an emergency is 100 times greater than that generated at one knot [1].

2- **Pivot Point:** In general use, pivot point describes the center point of any rotational system. In ships, it is the point around which the vessel will appear to turn. This is not a static or fixed point, though. It varies dynamically in accordance with the momentum of the ship. Although finding out the virtual location of the pivot point is a complex scenario, it can briefly be described as follows: when the vessel is static, the pivot point is almost the same as that of the center of gravity, which is at the center of the ship. When the vessel moves forward, the position of pivot point also shifts forward. As the vessel moves astern, the position of the pivot point shifts towards the stern. There may even be occasions at which the virtual pivot point falls ahead or astern of physical dimensions of the vessel. Knowing the location of pivot point is crucial for ship handling. Same is valid for escort towage. In the escort towage, most of the time the vessels having headway and tugs will be most effective in changing the vessel's heading when they are placed as far as possible from the pivot point. If a vessel has headway, an escort tug will be most effective on the stern due to the leverage realized, and least effective on the bow due to the reduced leverage.

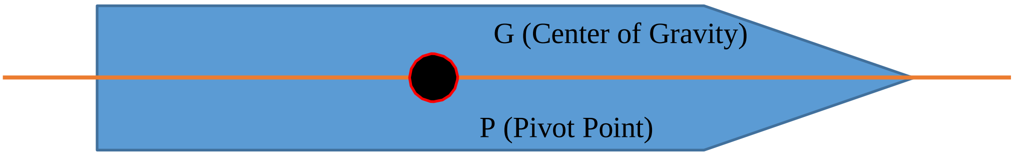

Figure 3. Pivot point when the vessel is static [5]

Figure 4. Pivot point when the vessel is on headway [5]

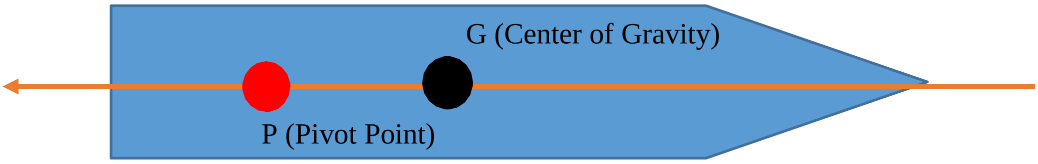

Figure 5. Pivot point when the vessel is on astern [5]

3- **Tug Force Vectors:** A tug influences the movement of a vessel by applying a force to the vessel at some angle called a force vector. When the escorted vessel is at zero speed a tug can basically apply its full bollard pull to the vessel in any direction. As the vessel gains way on ahead or astern, the tug's capability to apply force is reduced due to this movement. First of all, the tug should allocate some of it's power to pace with the ship's movement. Then, to take the position in the angle which the shipmaster of pilot requires takes away another portion of it's power. Then, the required vector could be produced with the remaining. Which is, we can call, actually, as the dynamic bollard pull. This is our main discussion in this paper.

Tug force vectors and thus the dynamic bollard pull varies with the towing methods as well. Towing methods in the escort towage can be grouped in two headings: direct towing and indirect towing (Figure 6).

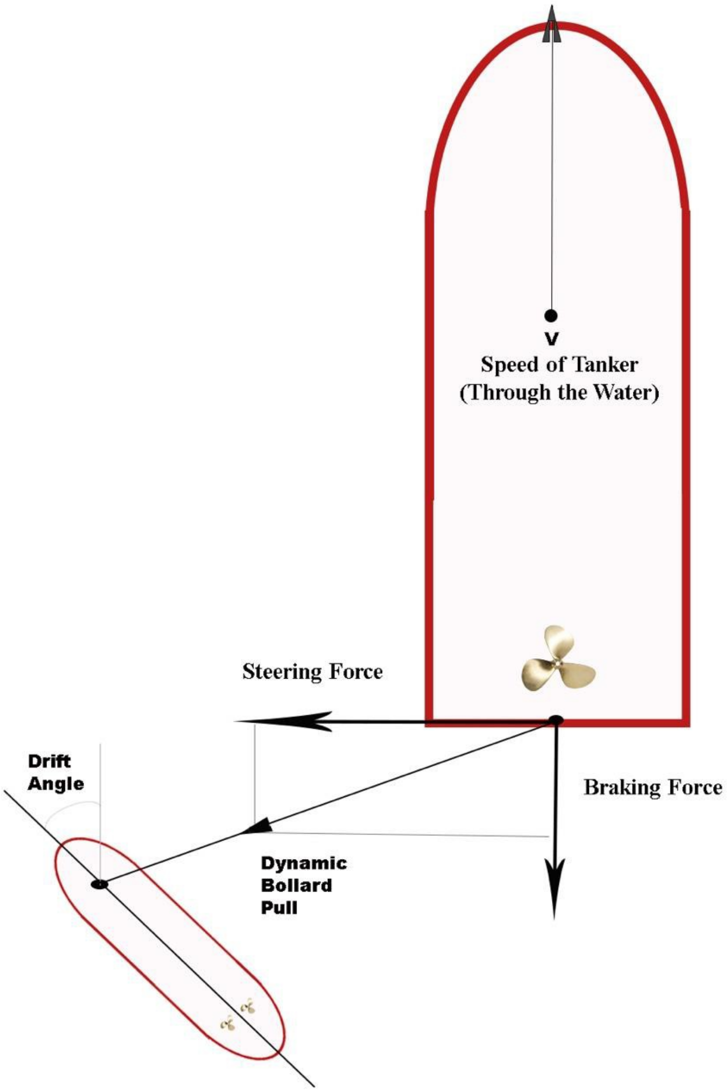

Figure 6. Forces and terminology on an ASD Tug engaged in indirect pull of a tanker connected center lead on the stern [5]

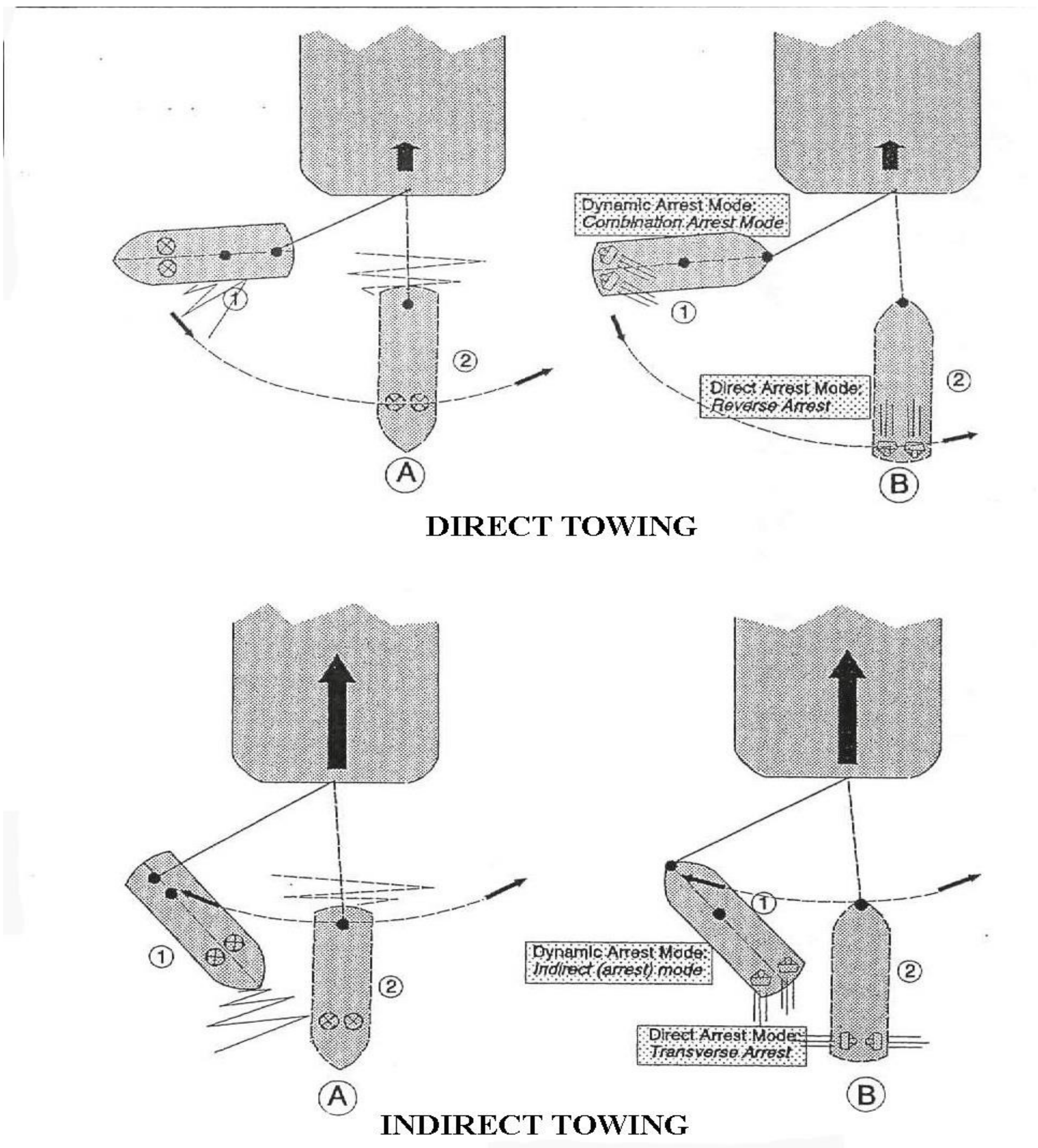

Figure 7. Terminology related to direct and indirect towing (A: Tractor tug, B: ASD Tug) [6]

3.1 Direct Towing (Direct Arrest): This method, which is shown for ASD and tractor type tugs on Figure 6, is mostly used in berthing/unberthing maneuvers of ships during which the assisted ship's speed does not exceed 4 knots. In the direct pull mode, the tug simply pulls on its line creating towline forces in the direction desired by the Pilot. When the ship is moving slowly, the tug can apply its full rated bollard pull to the ship, and move from one position to another in a short time. But, direct pull is not efficient in faster speeds at which the tug uses a lot of generated power for her own proceeding and steering in the water and the time needed to change positions also increases. Direct pull is is a method that can effectively be used in speeds up to 4 nots; which is accepted as the maneuvering speed by most ship handling experts. At direct towing operations, the order given by the pilot to the tug could be done in the following format: "TUG X, direct pull, port, 90 degrees, half". From the point of dynamic pull; direct pull applies a force on the towline which does not exceed the full power of the tugboat’s rated pull in most situations, if not less than it. In such operations, girting is a great risk as the speed increases up especially for the cases when conventional tugs are connected [1].

Direct towing can also be used in escort towage operations. During the escort, mostly a towline is placed through the center chock on the stern of the escorted vessel. From that point on the ship’s stern, the tug may pull on the ship and stay directly on the direction of drift; at speeds up to 6 knots as maximum. Between 0-6 knots; the direct pull capability of a Z-Drive or Voith propulsion tug is typically 1,5 times greater the static bollard pull of the tug. Starting from 6 knots and up to speed of 8 knots, arresting forces drop off and in this speed range most screw propeller tugs (both conventional and ASD) experience overload conditions on the propellers and main engines which turns out as stalling the drives. Stalling is due to a backward or negative flow of water through the propellers which acts like a brake. Direct arrest of a ship travelling at speeds over 6 knots through the water is a job well done by Voith-Schneider drive units [7].

3.1.1 Reverse Arrest: Reverse arrest is a direct towing method in which drives operate at an azimuth angle of 180 degrees and apply force on the opposite direction of the vector of escorted vessel. Reverse arrest is effective at speeds from 0 to 8 knots and can result in braking forces up to 1.5 times astern bollard pull, in which bollard pull refers to the maximum pulling force generated by a stationary vessel [8]. The Multratug 12, a 29m conventional tug able to produce 21 tons of bollard pull which was rebuilt as a carousel tug, was proved to create a 115 ton of braking force on a stern-connected transverse arrest to a Ro-Ro vessel, which meant 5.47 times more than it’s certified static bollard pull.

3.1.2 Transverse Arrest: Transverse arrest is a unique maneuver that only a Z-Drive or reverse tractor type tug can manage. This mode is known to be very effective in producing high braking forces which may be necessary in escort towage and for other maneuvering purposes at speeds above 8 knots. Transverse arrest involves orienting the Z-Drives perpendicular to the flow so that they both propel water outward at approximately 90 degrees. The "wall of water" created on each side of the tug actually slows the vessel. Manufacturers indicate the transverse arrest can achieve 2.5 times more than the certified bollard pull force.

3.2 Indirect Towing (Indirect Arrest): The indirect methods involve utilizing the hydrodynamic characteristics of the escort hull to generate lift and drag forces by orienting the tug at non-zero angles of attack to the flow. Indirect methods are generally used at speeds greater than 8 knots and often result in towline forces exceeding the vessel’s rated bollard pull. The two modes of indirect escort operations are pure and powered indirect. Pure indirect mode is when the tug thrusters apply a force perpendicular to the centerline of the tug resulting in a towline angle to the tug of approximately 90° as seen in Figure 6. At about 10 knots it can produce up to 2 to 2 ½ times the tractor’s rated static bollard pull. Significant heeling can occur during indirect towing. The tug operator must be extremely careful not to trip the tug as it heels over and nears deck edge immersion. Tractors with flat plate skegs must be extremely careful in conducting this maneuver at speeds over eight knots as the skeg can dig in too hard and potentially cause the tug to trip before the operator can recover from the maneuver.

Powered indirect mode consists of the tug utilizing all available engine power to provide the maximum possible steering forces. While pure indirect mode relies primarily on the hydrodynamic effects of the tug hull to create the steering and braking forces, powered indirect mode augments the hydrodynamic force with the thrusters to result in the highest steering forces.

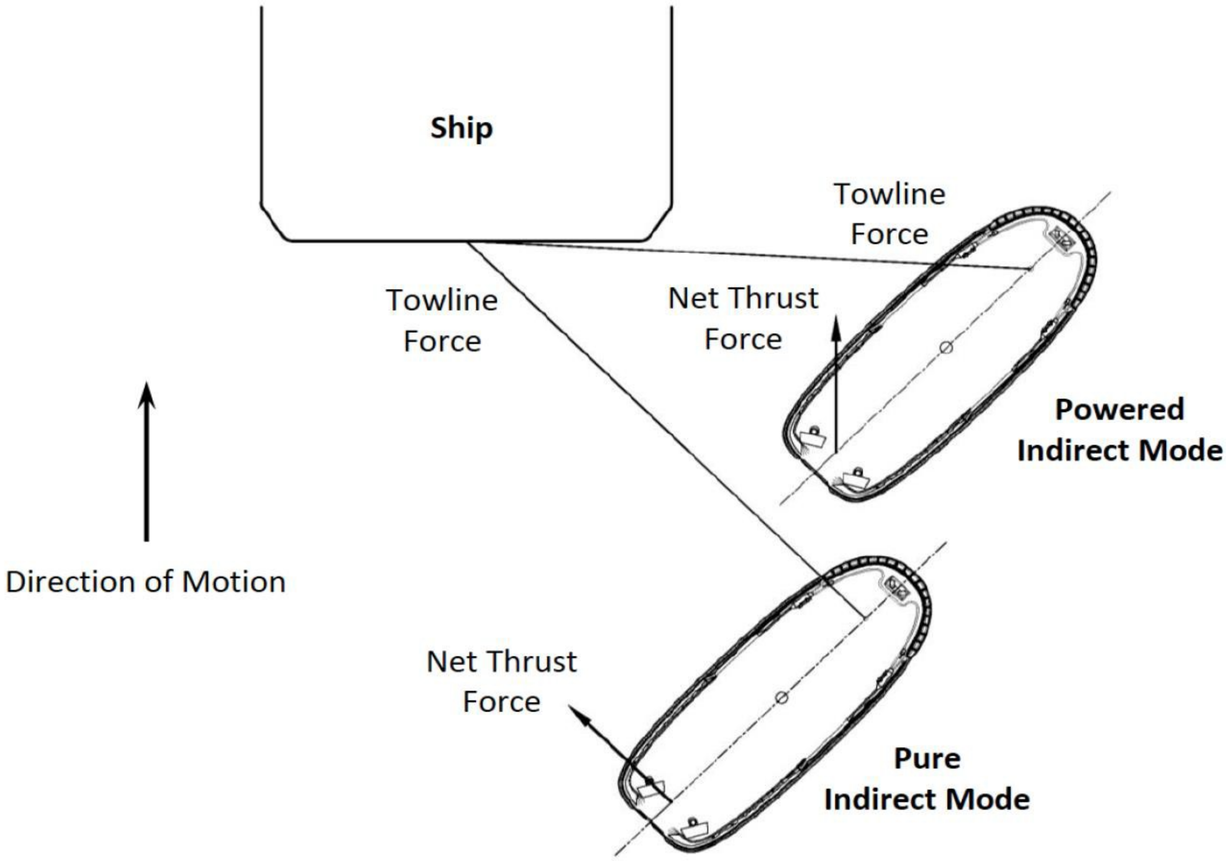

Figure 8. Comparison between Pure and Powered Escort Indirect Modes [9]

Figure 9. Escort Tug Foss America Escorting in Indirect Mode [10]

DYNAMIC AND REQUIRED BOLLARD PULL

The certified dynamic bollard pull (mentioned below as steering pull) of 68 TBP escort tug "Boxer" is a good example of the considerable tow line pull generated mainly by the hydrodynamic forces derived from the water flow around the forward fin of escort tugs:

Table 1. Certified tonnes of steering pull exerted by 68 TBP escort tug "Boxer" [11]

Certified tonnes of steering pull exerted by 68 TBP escort tug "Boxer"	
Tug Speed (Knots)	**TSP (Ton)**
6	90
8	125
10	148
12	160
15	170

The dynamic bollard pull values mentioned above were observed during indirect towing and results were officially announced by Bukser og Berging. In the table it is seen that the M/Tug Boxer, which has 68 TBP certified bollard pull, can produce a steering force which is 1,32 to 2.5 times more than the actual bollard pull.

For a cross reference, we need to have a look at the table Captain Henk Hensen included in in his book "Tug use in Port" regarding the required steering pull in order to create rudder effect for tankers being escorted:

Table 2. Required bollard pull to give rudder effect on a laden tanker [11]

Tanker Speed (Knots)	100.000 DWT Oil Tanker Rudder Angle		200.000 DWT Oil Tanker Rudder Angle	
	15 °	**25 °**	**15 °**	**25 °**
6	30 t	45 t	50 t	60 t
8	55	75	85	115
10	85	120	130	185
12	120	175	190	260

STRONG POINT ONBOARD VESSELS TO MEET THE REQUIRED DYNAMIC PULL

As the dynamic bollard pull is most of the time exceeding the static bollard pull, the towing line and the strong points onboard the vessel as well as onboard the tug should be fitted so that this extra force could be met.

There have been a number of occurrences reported worldwide where Escort tugs have pulled the bollards or fairleads off the stern of a tanker while engaged in tethered escort maneuvers.

The problem is not limited to escorting since conventional harbor tugs are also becoming increasingly more powerful resulting in similar failures of standard ship fittings.

Mooring equipment on tankers generally complies with the Oil Companies International Maritime Forum (OCIMF) Mooring Equipment Guidelines (MEGL), Third Edition 2008. The term “mooring” most commonly refers to the system for securing a Ship to a Terminal where the strength of equipment and fittings is usually related to the strength of the ship mooring lines. The MEGL also covers other shipboard operations such as emergency towing and tug handling which require specialized equipment.

ISO 3913 covers the construction of bollards and how they are attached to the tanker structure.

Where a bollard is used exclusively for securing harbour tug lines, the size should be related to the bollard pull of the tug, but need not exceed 500 mm. If this size bollard is fitted, ISO 3913 states that it should be capable of withstanding a Total Maximum Rope Loading (SWL) of 92 t when attached with single eye (e.g. the spliced eye at the end of the tug towline). This would appear to be more than adequate for port tug usage. The SWL of a 500 mm bollard is inadequate for forces generated during maneuvers by an escort tug.

OCIMF and SOLAS recommendations for ships recommend minimum capacities for ship mounted fittings to be used in tethered escort operations:

An extract from OCIMF MEGL:

Tankers over 20000 dwt but under 50000 dwt to provide:

- A fairlead arrangement, with suitable reinforcement, having a minimum SWL of 100 metric ton; and
- A strong point arrangement, with suitable reinforcement, having a minimum SWL of 100 metric ton when used with a single eye towing line or grommet.

Tankers of 50000 dwt and above to provide:

- A fairlead arrangement, with suitable reinforcement, having a minimum SWL of 200 metric ton; and
- A strong point arrangement, with suitable reinforcement, having a minimum SWL of 200 metric ton when used with a single eye towing line or grommet.

SOLAS requires all tankers over 20,000 DWT to be fitted with Emergency Towing Arrangements (ETA) at both the bow and stern. The regulations stipulate that these towing arrangements are the same as above mentioned.

In almost all cases a separate strong point should be available to attach the Escort or port tug line. If standard bollards are used for Active Escort towing, they should be of 800mm diameter. This would give an overall SWL of the towing unit of 200 ton.

It should also be remembered that the ETA has to be capable of being deployed within 15 minutes. Consequently component parts of this system should only be used for towing if such use does not extend the deployment of the ETA to a time in excess of 15 minutes.

DISCUSSION

In most harbour manoeuvres where the speed does not exceed 4 knots, the exerted pull of the tug is almost the same as mentioned in the bollard pull certificate. At these lover speeds, especially when there is no speed on the vessel, the tug's hull does not play an important role on the tension of the towing line.

For the forward tug pulling straight ahead at a ship having headway, propeller thrust is less due to the positive water flow through the propeller. In addition, the tug has to propel itself through the water with the cost of engine power; consequently, the exerted pull is less than the bollard pull, decreasing with ship's increasing speed [12].

When a stern tug is braking the ship's speed in a direct arrest or transverse arrest mode, the propellers are working in a negative water flow and a high pulling force can be developed. Together with the forces caused by the tug's resistance through the water, the tug actual pull can then be high, which can result in a even
higher pull than the bollard pull. Then the hull shape and build characteristics play an important role here.

That's why some tugs are titled as harbour tugs and some as escort tugs. Escort tugs does have this hull design and skeg fittings that allow them to succeed in such maneouvers.

When a tug is handling a ship that has speed, these hydrodynamic forces can generate high pulling forces, sometimes even in addition to the propeller thrust forces. A few examples:

- A stern tug operating in the indirect mode can generate high pulling forces, which increase with the ship's speed (and at a speed of 10 knots can be a high as twice the bollard pull); while the propeller thrust is used to keep the tug in an optimal position to achieve the highest possible pulling forces.
- A tug braking a ship's speed and working under a small angle with the ship's heading can exert high braking forces caused by the propeller thrust and tug resistance through the water.
- A conventional tug can also create high towline forces, generated by the hydrodynamic forces working on the tug hull when towing under an angle to a ship's heading on a ship having headway.

These few examples show that the exerted pull can be much higher than the bollard pull and that it does not always have a direct relation to the bollard pull.

Therefore these exerted forces should be referred to as 'dynamic bollard pull' which is comparatively a new phenomenon.

The exerted pull is passed to the towline. The forces in the towline can vary considerably and can reach high values, mainly caused by the unsteady and continuously varying situation of the tug compared with the assisted ship and the often vertical angle of the towline. When pulling in such an unsteady dynamic situation, peak loads are generated in the towline. These may also be caused by non-smooth tug handling or by waves.

In consequence, towline forces can be much higher than the maximum pull that can be exerted by the tug.

The main aim of this paper is to emphasize that whereas the bollard pull is an important indication of a tug's capability, in the dynamic situation of day-to-day operations, the actual pull that can be exerted by the tug can be lower but can often also be much higher, due to the hydrodynamic forces working on the tug's hull. We call this as "Dynamic Bollard Pull" but there are other terminology regarding this phenomenon.

One more important note is that when discussing the SWL of the ship's bollards, the tug's bollard pull is not the only factor to be taken into account. Of equal importance are the forces that can be generated in the towline by such a tug during day-to-day operations, especially in the escort towage. Therefore tug's certificated bollard pull may be a starting point, but, up to three times and as it was the case with carrousel tug, up to 6 times more force the tug can exert on the towing line and this should be taken into account by all related stakeholders; from pilots, captains, tugmasters to ship designers and class societies.

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APPLICATIONS OF FUEL CELL TECHNOLOGIES IN SHIPS AND A SYSTEM DYNAMICS APPROACH

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ABSTRACT

Research and development activities focus on different technologies that are related with reducing ship based exhaust emissions because of rapidly decreasing fossil fuel sources and increasing sensitivity about energy security and environmental issues. One of the most important of these technologies is the application of hydrogen energy in ships. Recent studies about the subject are mainly focused on developing fuel cell technologies on board. Even though the production and integration of fuel cell systems are still quite expensive, the system is being used in different applications in various areas of the maritime industry. Fuel cell technologies are used in submarines, commercial ships, yachts, ports and many areas of maritime industry not only as an auxiliary power unit but also as a main power plant. In this study, types of the fuel cell technologies and their working principles are introduced. Theoretical and practical applications of the fuel cell technologies on board are examined. Reviewed applications are considered and fuel cell selection criterias are decided by using systems dynamics approach which reveals a comparison among fuel cell technologies according to technical and operational, environmental, economical and safety issues.

Keywords – Maritime, Fuel Cell, System Dynamics, Auxiliary Power Unit, Vensim®

INTRODUCTION

Ships are the most cost effective way of goods transportation therefore in recent decade's seaborne transportation and global trade volume are considerably expanded. In 2007, total carbon emissions based on transportation in the world is 13.2% and carbon emissions based on ship is 2.8% and it is estimated that total CO_2 emissions based on ship is 1050 million metric tonne (MMT). The 870 MMT of CO_2 comes from international shipping activities and 180 MMT of CO_2 comes from domestic and inland ships activites [1]. According to IMO study in 2012, 796 MMT of CO_2 –which is only 2.2% of total emission volume of that year – emission is caused by international shipping activities. From now until 2050 IMO predicts the transportation volume increase between 2% to 4% annually [2]. This means greenhouse gase (GHG) emissions are almost three times higher from values of today. As a consequence, reducing ship based exhaust emissions and alternative ways for supplying energy demand, are getting enormous attention because of increasing sensitivity about energy security and environmental issues.

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Marine Environment Protection Committee (MEPC) adopted the Energy Efficiency Design Index (EEDI) for new ships. Some major categories are decided in order to reduce GHG emissions by EEDI. These categories are energy-saving engines, more efficient ship hull and design, more efficient propellers, cleaner fuels (low carbon content, low Sulphur content, Liquefied Natural Gas), alternative fuels (fuel cells, biofuels, etc.), emission reducing devices, waste heat recovery systems, solar panels, speed reduction, weather routing, hull coating and cleaning, high efficiency lighting, speed controlled pumps and fans.

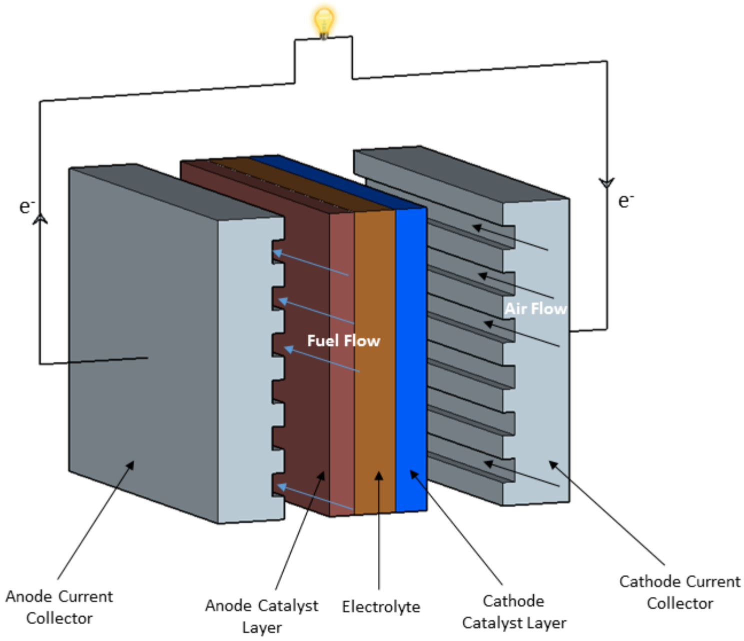


Figure 1. Schematic diagram of a fuel cell with its main components

More stringent environmental legislations are started applying Sulphur Emission Control Area (SECA) and Emission Control Area (ECA). The shipowners are being forced to use environmentally friendly and sustainable alternative energy resources, instead of fossil fuels. Control systems and propulsion systems are robustly developed of late years. In this study, we focused on fuel cells and hydrogen as a power plant and as an environmentally friendly and sustainable alternative energy resource for ships, respectively. According to the existing engines fuel cells could be up to 50% more efficient [3].

Fuel cells are devices that convert the chemical energy of the fuel directly into electricity with high efficiency. Since fuel cells limits are not restricted by the limitations of Carnot Cycle. Main components of a fuel cell have shown in Figure 1. Fuel cells generate continuously power as long as feeded by fuel and air by electrochemical reactions that takes place on catalyst layer. Electrodes are conducted one electrode to other via electrolyte and electrons are flow through an external circuit. This flow carries out electricity production of a fuel cell. Power could be produced by a single cell however it is not a significant amount of power. In order to produce meaningful amount of power, many single cells should be gathered.

FUEL CELL TECHNOLOGIES

Fuel cells are mainly classified by using electrolyte or operating temperatures as given Table 1. Molten Carbonate Fuel Cell (MCFC) and Solid Oxide Fuel Cell (SOFC) are called high temperature type of fuel cell due to higher operating temperature compared to others. Phosphoric Acid Fuel Cell (PAFC) are classified as medium temperature type of fuel cell; Proton Exchange Membrane Fuel Cell (PEMFC), Direct Methanol Fuel Cell (DMFC) and Alkaline Fuel Cell (AFC) are low temperature fuel cells. These types of fuel cells are explained in the next chapter.

Table 1. Types of Fuel Cells [4]

Fuel Cell Type	Electrolyte Used	Mobile Ion	Operating Temperature	Applications
Proton Exchange Membrane	Polymer Membrane	OH^-	30 – 100º C	Vehicles and mobile applications, and for lower power CHP systems
Direct Methanol	Proton Conducting Membrane	H^+	<100º C	Suitable for portable electronic systems of low power, running for long times
Alkaline	Potassium Hydroxide	H^+	50 – 200º C	Used in space vehicles
Phosphoric Acid	Phosphoric Acid	H^+	~220º C	Large numbers of 200-kW CHP systems in use
Molten Carbonate	Lithium/Potassium Carbonate	$(CO_3)^{2-}$	~650º C	Suitable for medium- to large-scale CHP systems, up to MW capacity
Solid Oxide	Yttria Stabilized Zirconia	O^{2-}	500 - 1000º C	Suitable for all sizes of CHP systems, 2 kW to multi-MW

Proton Exchange Membrane Fuel Cell

PEM fuel cells are used most commonly in portable and transportation applications. They are also called as polymer electrolyte membrane fuel cell. Main components of PEMFC and commonly used materials of these components that are shown in Figure 2 and also pros and cons are given Table 2.

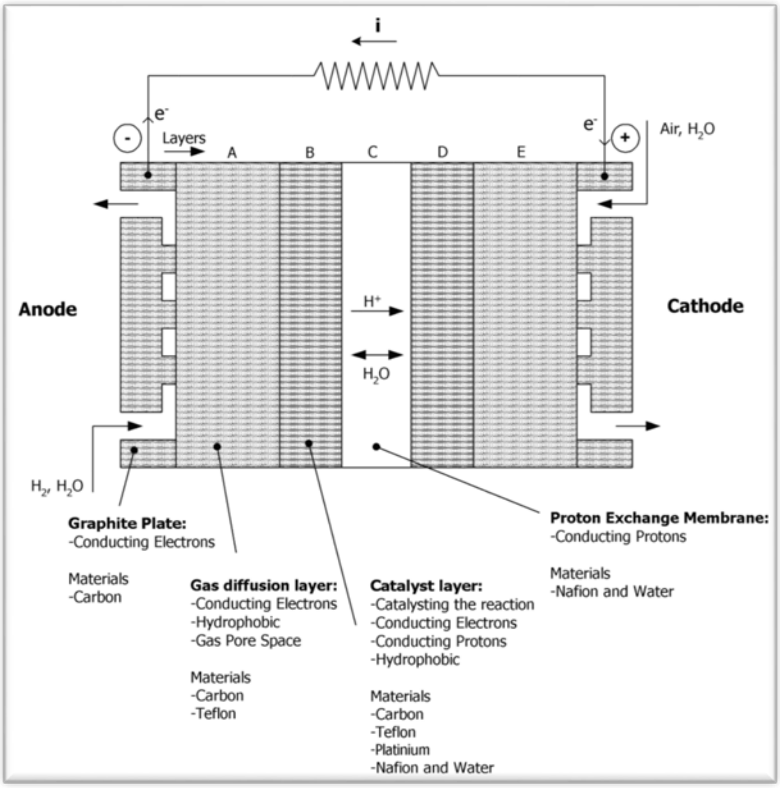


Figure 2. A cross section of PEM fuel cell [5]

Electrochemical reactions occurs at the anode and cathode side of the fuel cell, as shown in figure 2 and equations (1), (2) and (3):

Anode Reaction: $H_2 \rightarrow 2H^+ + 2e^-$ (1)

Cathode Reaction: $0.5O_2 + 2H^+ + 2e^- \rightarrow H_2O$ (2)

Overall Reaction: $H_2 + 0.5O_2 \rightarrow H_2O$ (3)

Table 2. Pros and Cons of PEMFC [6]

PROS	CONS
Short startup time	Expensive catalysts
No corrosion problem	Carbon monoxide and Ammonia poisoning
Suitable for compact architecture	Water management problem
High current density	Needs high purity of hydrogen as fuel

Direct Methanol Fuel Cell

Main difference of this fuel cell from PEMFC is directly feeding the methanol as fuel instead of reforming process before feeding [8]. Used membranes are the same with PEMFC. Electrochemical reactions occur at the anode and cathode side of the fuel cell as shown in Equations (4), (5) and (6) and also pros and cons are given Table 3:

Anode Reaction: $CH_3OH + H_2O \rightarrow CO_2 + 6H^+ + 6e^-$ (4)

Cathode Reaction: $1.5O_2 + 6H^+ + 6e^- \rightarrow 3H_2O$ (5)

Overall Reaction: $CH_3OH + 1.5O_2 \rightarrow CO_2 + 2H_2O$ (6)

Table 3. Pros and Cons of DMFC [6]

PROS	CONS
Using methanol as fuel	Slow reaction kinetics
High energy density of methanol	Lower power density – size proportion
Simple to use	Fuel crossover problem
Quick to refill	

There are two types of DMFC. One of them is active and other one is passive. Fuel and air compounding rates could be controlled. Hence, you could get more power compared to passive type. Meanwhile high power density demanding application are more suitable for active type, less power demanded applications are much more convenient for passive type [6].

Alkaline Fuel Cell

The alkaline fuel cells are one of the first fuel cell type used and developed by NASA and used this type at space projects like Gemini and Apollo. They produced not only electricity for spacecraft devices but also potable water for astronauts. Alkaline fuel cells generally uses solution of potassium hydroxide in water as electrolyte. AFCs could not achieve widespread usage due to needs of high purity of H_2 as fuel and enormous expensive catalysts (platinum) to speed up the reaction [7]. Electrochemical reactions occur at the anode and cathode side of the fuel cell as shown in Equations (7), (8) and (9) and also pros and cons are given Table 4:

Anode Reaction: $H_2 + 2(OH)^- \rightarrow 2H_2O + 2e^-$ (7)

Cathode Reaction: $0.5O_2 + H_2O + 2e^- \rightarrow 2(OH)^-$ (8)

Overall Reaction: $H_2 + 0.5O_2 \rightarrow H_2O$ (9)

Table 4. Pros and Cons of AFC [6]

PROS	CONS
High efficiency	Sensitivity to CO_2 and
Formation of six electrons from one mole of fuel	Large size
Produce potable water	Extremely expensive processes
Wide reange of electro-catalyst	Sensitive to O_2 impurities

Phosphoric Acid Fuel Cell

Phosphoric acid fuel cells (PAFC) use concentrated phosphoric acid as the electrolyte. The matrix used to retain the acid is usually SiC, and platinum is ued as the electro catalyst in both the anode and the cathode side of fuel cell. Operating temperature is typically between 150 and 220°C [9]. Semi commercial phosphoric acid fuel cells are already installed for stationary electricity generation up to 200 kW. Hundreds of units have been installed all over the world. Electrochemical reactions occur at the anode and cathode side of the fuel cell as shown in Equations (10), (11) and (12) and also pros and cons are given Table 5:

Anode Reaction: $H_2 \rightarrow 2H^- + 2e^-$ (10)

Cathode Reaction: $0.5O_2 + 2H^+ + 2e^- \rightarrow H_2O$ (11)

Overall Reaction: $H_2 + 0.5O_2 \rightarrow H_2O$ (12)

Table 5. Pros and Cons of PAFC [7]

PROS	CONS
1-2 % CO tolerant	Low power density
Good-quality waste heat	Expensive, platinum catalyst used
Demonstrated durability	Slow start-up
	Loss of electrolyte

Molten Carbonate Fuel Cell

Carbonate salts are used as electrolyte in the molten carbonate fuel cell. Approximate operation temperatures are between 600° C to 700° C in order to melt the salt as using electrolyte. Therefore, electrolyte conducts carbonate ions (CO_3) from cathode side to anode side of the fuel cell. Natural gas is generally preferred as fuel. Due to high operation temperatures expensive catalysts are not required and external reforming process of fuel is also not needed. Efficiency of the MCFC is reached up to 60% and combining the MCFC with a heating process is enhance the efficiency up to 80%. The MCFC is not sensitive to carbon monoxide and carbon dioxide. Electrochemical reactions occur at the anode and cathode side of the fuel cell as shown in Equations (13), (14) and (15) and also pros and cons are given Table 6:

Anode Reaction: $H_2 + CO_3^{2-} \rightarrow H_2O + CO_2 + 2e^-$ (13)

Cathode Reaction: $0.5O_2 + CO_2 + 2e^- \rightarrow CO_3^{2-}$ (14)

Overall Reaction: $H_2 + 0.5O_2 + CO_2 \rightarrow H_2O + CO_2$ (15)

Table 6. Pros and Cons of MCFC [7]

PROS	CONS
CO tolerant	Electrolyte dissolves cathode catalyst
Fuel Flexible	Extremely long start-up time
High-Quality Waste Heat	Carbon dioxide must be injected to cathode
Inexpensive Catalyst	Electrolyte maintenance

Solid Oxide Fuel Cell

Solid oxide fuel cells (SOFC) use a solid, nonporous metal oxide, usually Y_2O_3-stabilized ZrO_2 (YSZ) as the electrolyte. These cells operate at 600 to 1000 °C where ionic conduction by oxygen ions takes place. Similar to MCFC, these fuel cells are in the precommercial/demonstration stage for stationary power generation, although smaller units are being developed for portable power and auxiliary power in automobiles. Electrochemical reactions occur at the anode and cathode side of the fuel cell as shown in Equations (16), (17) and (18) and also pros and cons are given Table 7:

Anode Reaction: $H_2 + O^{2-} \rightarrow H_2O + 2e^-$ (16)

Cathode Reaction: $0.5O_2 + 2e^- \rightarrow O^{2-}$ (17)

Overall Reaction: $H_2 + 0.5O_2 \rightarrow H_2O$ (18)

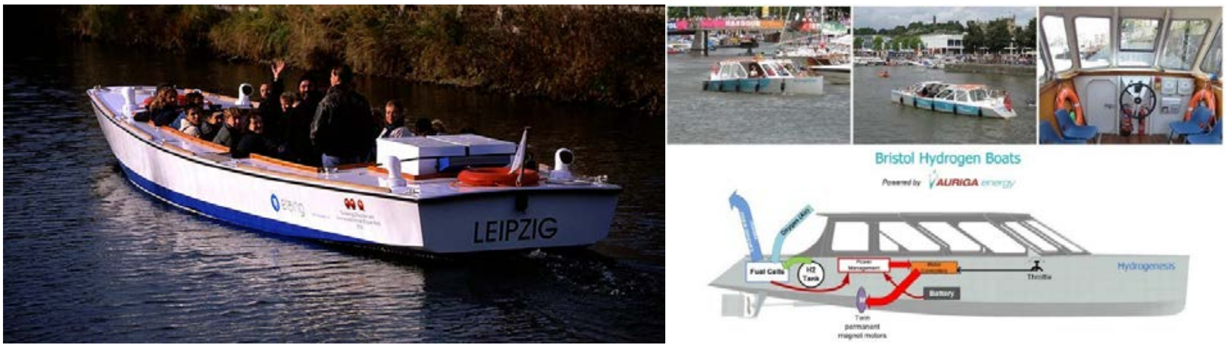
Table 7. Pros and Cons of SOFC [7]

PROS	CONS
CO tolerant	Long start-up time
Flexible fuel	Durability under thermal cycling
Suitable for waste heat recovery	Inactivity of electrolyte below 600°C
Inexpensive catalyst	

MARINE APPLICATIONS OF FUEL CELL

Hydra Boat

World's first fuel cell boat HYDRA used an Alkaline Fuel Cell (AFC) system with 5.5 kW net power output shown in Figure 3. Passenger capacity of The Hydra is 22 pessengers. Propulsion system powered by an electric motor which gets electricity from Alkaline Fuel Cell. The debut was in June 2000 on the Rhine near Bonn, Germany. The ship has transported around 2.000 passengers from 1999 to 2000 and was used as a ferry-boat in Ghent, Belgium during an electric boat conference in 2000. It is fully certified by the Germanischer Lloyd for passenger transport and the fuel cell system had the ability to start even at temperatures below the freezing point, operating voltage between 64 – 88 V and operating temperature 70 °C [13].



(a) **(b)**

Figure 3. (a) World's first fuel cell boat HYDRA [13], (b)Hydrogenesis Fuel Cell Powered Ferry [10]

Bristol Hydrogen Boats

Bristol City Council is initiated a project named Green Capital in 2010. A local consortium is constituted which consist of directors of Bristol Packet Boat Trips, Number Seven Boat Trips and Auriga Energy. A steel hull ferry has 11 meter long and 3.6 meter breadth, two permanent magnet DC motors powered by 12 kW fuel cell and named "Hydrogenesis" is constructed by Bristol Hydrogen Boats with CE marked. Hydrogenesis is the first hydrogen-powered ferry to operate in the United

Kingdom, is shown in Figure 3. Hydrogenesis carry 12 passengers and 2 crews. This is also the first commercially availiable fuel cell boat in UK and cost of hiring for private purposes costs 130 pound per hour in 2016 [10].

Ross Barlow Canal Boat

The purpose of the "Protium" project is to apply modern technologies to a traditional mode of transportation for using this in a hybrid canal boat on UK canal network. The boat is converted from British Waterways maintenance craft to a canal boat. The boat has a solid-state hydrogen store ($TiMn_2$-based metal hydride store), Proton Exchange Membrane (PEM) fuel cell (ReliOn Independence 1000TM model), lead-acid battery pack and high efficiency, permanent magnet (NdFeB) electric motor as shown in Figure 4. The speed limit for the majority of inland waterways in the UK is 6.4 kph. Thus providing an excellent opportunity for testing a low power PEM fuel cell in a marine environment. This boat is named as "Ross Barlow" which is officially launced in September 2007 [11]. The system has a large cylinders, each containing 30 kg of metal hydride power. Operating pressure of the system is lower than 10 bar. Approximately 4 kg of hydrogen is obtained from solid-state hydrogen storage system. Forced air cooled PEM fuel cell is rated at 1 kW and operates at 65 °C. Avarage fuel cell flow rate is measured 15 L min^{-1}. There is a huge loss due to purge of hydrogen in order to eliminate water management problem [11].

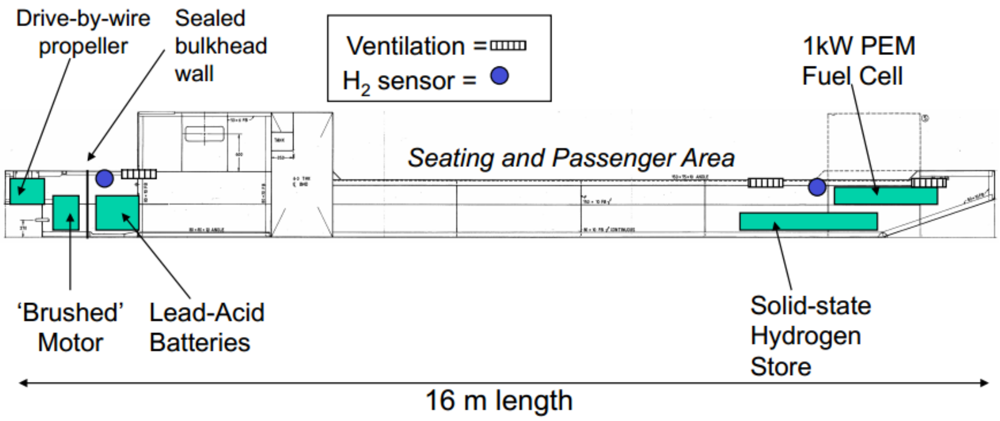


Figure 5. Boat Schematic of Ross Barlow [11]

The boat's schematic is shown in Figure 5. The system is mostly suitable for low power demand applications. Therefore, speed limitation makes the system suitable in the canals. High power demand situation is provided by batteries. The converted boat and the designed hybrid system is more efficient than traditional engine and also more silent and environmental friendly.

ZemShip Project

Zemships project was the first project in the world to integrate fuel cell technology on board of passenger vessel. This project demonstrate the suitability for daily use in line operation of the fuel cell technology for inland passenger ships**.** Under the control of Hamburg´s Department for Urban Development and the Environment, the following project partners developed the world's first inland passenger vessel with a fuel cell propulsion system on board and the needed hydrogen infrastructure:

- ATG Alster Touristik
- Germanischer Lloyd
- Hamburger Universitiy of Applied Sciences
- HOCHBAHN
- hySOLUTIONS

- Linde Group
- Proton Motor Fuel Cell GmbH
- UJV Nuclear Research Institute

Since the official end of the project in August 2008, the FCS Alsterwasser is always in normal line operation, operated by the ATG. The FCS Alsterwasser is used for Alster roundtrips, on Hamburg channels and charter trips [12]. General layout of FCS Alsterwasser is shown in Figure 6 and technical data of propulsion system is given at Table 8. Overall transported passengers are more than 43000 till the end of 2012 athough no operation is possible in 2010 because of the fire accident. And also fuel cell system is operated 2500 hours till the end of 2012 [12].

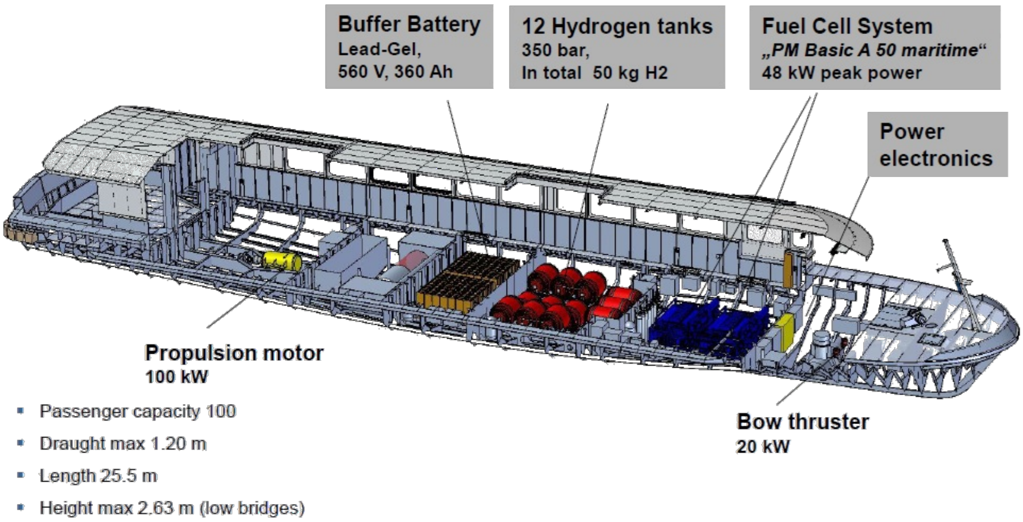


Figure 6. Layout of Fuel Cell System Alsterwasser [12]

Table 8. Technical Data Propulsion System [12]

Type of FC	Type of FC System	FC Power	Hydrogen Use	Weight FC System	Dimensions FC System (L x W x H)	Buffer Battery	Storage of H_2	Storage Volume on Board
PM 200 PEM	PM Basic A 50 maritime	48 kW	3kg/h at 48kW	Approx. 600 kg	1600 x 850 x 1000 mm	Lead-gel-Battery 560 V (7x80V), 360 Ah	Gaseous (GH_2) at 350 bar/15°C	12 hydrogen tanks 50 kg

Duffy-Herreshoff DH30 Watertaxi

This is the world first fuel cell powered shown in Figure 7, zero emission hydrogen-fueled public water taxi on the San Francisco Bay. The boat is funded by California's Center for the Commercial Deployment of Transportation Technologies (CCDoTT), a partnership of academic institutions, government, and commercial corporations at California State University, Long Beach (CSULB). The boat is launched in 20 October 2003. The water taxi powered by fuel cell/battery electric hybrid engine. This system is emitting only water and heat and this is also quieter and cleaner than traditional engines. Total passenger capacity of the water taxi is 18 passengers [14], 6 (1,5x4) kW PEMFC and batteries are used for propulsion which voyage speed is 8 knots [15].

Figure 7. The Duffy-Herreshoff DH30 Watertaxi [15]

The Xperiance NX Hydrogen

The Xperiance NX hydrogen is a 12 passenger hydrogen ship shown in Figure 8, power-assisted by an electric motor that gets its electricity from a fuel cell. The debut was on 23 June 2006 at Leeuwarden, Netherlands. The boats are refueled with exchangeable tanks. The boat's dimensions are 7 m, 2.35 m, 0.50 m. The boat is covered the full distance of 220 km without refueling [16]. Storage system has 4 exchangeable 200 bar, 3-liter hydrogen tanks, with a 1.2 kW PEM fuel cell and a 12 kWh battery for 12 passengers [17].

Figure 8. The Xperiance NX Hydrogen boat [17]

Tuckerboot

A tuckerboot on hydrogen is an 8 passenger ship shown in Figure 9, power-assisted by an electric motor that gets its electricity from a fuel cell. This boat is operating in Hamburg. The design is based on the AMS Tuckerboot 675. The boat is refueled with exchangeable tanks at the hydrogen station at Hamburg Airport. The boat has 6.76 m long, 2.44 m wide, draft 0.54 m, 15 Nm^3 hydrogen storage tank, with two 1.2 kW/24 V PEM fuel cells, a 24V/180Ah battery, two electric motors (672 W (0.901 hp), 24 V, 28 A each) for 8 passengers [18].

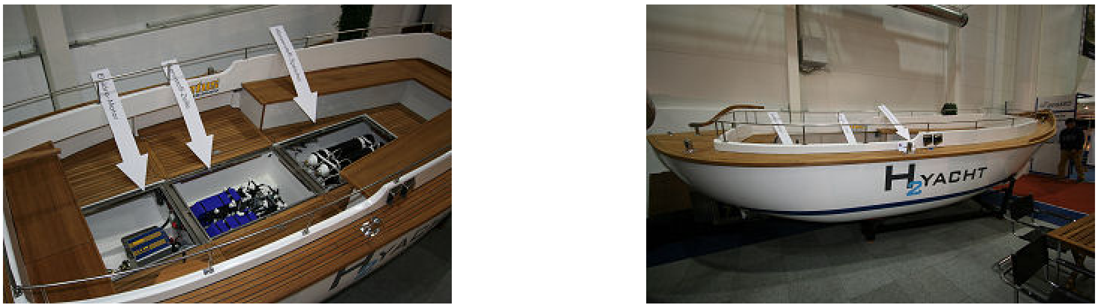


Figure 9. Tuckerboat Hydrogen Boat [19]

Nemo H_2 Ferry

The Nemo H_2 is the first boat powered by fuel cell in for 86 passengers and 2 crew in Amsterdam which is owned by Boat Company Lovers. Dimensions of the boat is 21.95 meter length and 4.25 meter width. Propulsion system is consist of 1 electrically powered, 75 kW stern thruster and 1 electrically powered, 11 kW bow thruster. It has two 30 kW PEM fuel cells and 70 kWh battery and maximum speed of the boat is 8.6 knots/hour. Without refueling voyage time is 9 hours when the speed is approximately 7 knots. Hydrogen stored in 6 cylinders at 350 bar for 24 kg of hydrogen. The canal boat meets all European regulation for barges. Boat is in operation on the canals in Amsterdam since December 2009 [20]. The new boat cost more than double to build than a canal boat running on a diesel engine. Needs to visit a hydrogen dispensing station for a refill once a day. Normal boats only need a fuel top-up once a week [21].

Gold Green Hygen

A 20-meter-long tourist boat shown in Figure 10 is designed for operating in coastal waters which powered by PEM fuel cell and Li-ion batteries hybrid system. Propulsion of the boat is provided by a waterjet. PEM fuel cells generated 50 kW power and Li-ion batteries generated 47 kW power for boat's propulsion and auxiliary equipments of the boat. All system components are newly developed by the project partners. The boat was built using an aluminum alloy to arrange the developed PEM fuel-cell-battery hybrid system inside of it. This is the first fuel cell powered boat in Korea which is operated in the costal waters of Busan. Hydrogen is stored at 35 Mpa pressurized cylinders which contains maximum 25 kg of hydrogen. Boat voyage speed is between 6.6-7.8 knots at a power output approximately 85 kW. The fuel cells are designed and produced by collabratives of the partners of the project. Two identical fuel cell units are produced for generating 28 kW power output [22]. After one-hour constant load operation at a power output of ~52.7 kW, electrical efficiency was estimated as 48.5% based on the lower heating value. At the same operating conditions, hydrogen consumption rate is measured 53.1 gram per minute. The boat is operated 8 hours at a power output of 50 kW whithout refueling [22].

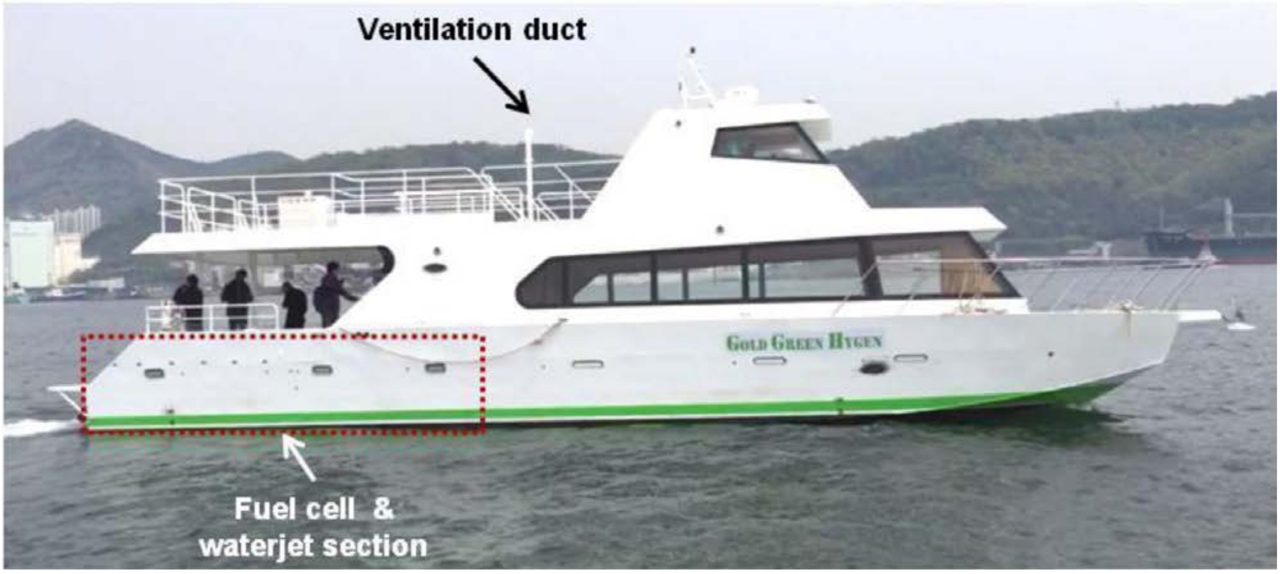


Figure 10. Photo of the fuel-cell boat during a test operation in the coastal waters of Busan [22]

FUEL CELL SELECTION

In this chapter the proper fuel cell selection criterias for small and medium size vessels will be explained. Many different criterias should be considered while choosing an appropriate fuel cell for a small and medium size vessels. For many shipowner the most important point is the cost of the vessel however small and medium sized vessels cost should be assessed as the third or forth priority, since this market is a niche market and the expenditures for owners are mostly for hobby or luxury. Therefore, we should sort the order for selection criteria in our study as below:

- Technical and Operational [23]
  - High Efficiency
  - High Reliability
  - High Durability
  - Providing Ship's Specific Power Demand
  - Integration into a vessel
    - Structural Requirements
    - Limited Space for Installation
    - Space for Maintenance and Repair
  - Total Life Time
  - Easy and Fast Start-up
  - Easy Initial Installation
  - Minimum Labor Force for Operation
  - Easy Maintenance
  - Fuel Storage
  - Fuel Supply
  - Fuel Consumption
- Economical [24]
  - Initial Cost
  - Spare Parts Expenditures
  - Fuel Cost
  - Regular Maintenance Cost
- Environmental [23]

  - Low Emission (SECAs and ECAs)
  - Low Vibration
  - Low Noise
- Safety
  - Basic Load Coverage With Parallel Operation (safe return to port) [23]
  - Regulations and Class Notification
  - Fuel Safety
  - Environmental Conditions [23]
    - Salty, oily, and humid air (possible effect corrosion – proper material selection of suitable coverage and filter systems)
    - Ambient temperature up to 50 °C, electrical components up to 55 °C
    - Be able to operable even up to heel of 22.5°, for electrical components heel angle of 45°C

As listed above 4 main categories and sub categories are reveal us the fuel cell system dynamics factors for selecting a proper fuel cell for small and medium size vessels. A model of system dynamics is adjusted by Vensim® software shown in Figure 11.

As considered SOFC and MCFC offer large variety of fuel opportunity generally preferred for stationary applications. SOFC and MCFC working with high operation temperatures and used with the hybrid systems provide us high total efficiency, inspite of to long start up time, less amount of carbon emissions, high costs, corrosion of metal stack components and large size and weight [24].

Pure hydrogen and oxygen are needed for PAFC and platinum is required as electro-catalyst both anode and cathode side of the cell. Costs are much more expensive than the others [25].

DMFCs could produce small amounts of power and use directly methanol as fuel. Therefore large quantities of platinum are needed, since DMFCs are mostly suitable for very small applications such as mobile phones, mp3 players etc. [23-25].

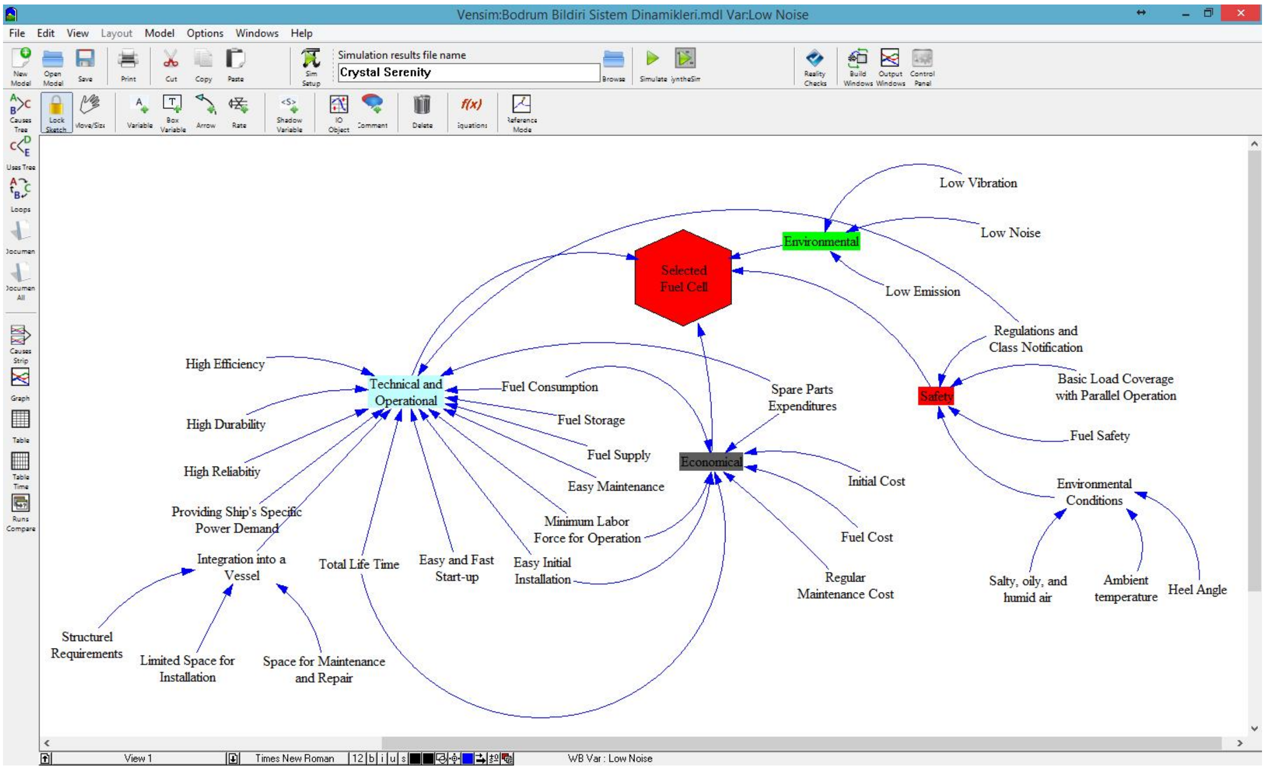


Figure 11. System Dynamics Model of Fuel Cell Selection Criterias

Potassium hydroxide (KOH) is electrolyte used in AFCs and it's very sensitive to the presence of CO_2. Another drawback of this kind of fuel cell is needed pure hydrogen as fuel. Generally preferred in space applications and laptops batteries [24]. Only one of the reviewed application is preferred AFCs as power supply unit for propulsion or auxiliary.

PEMFCs are mostly suitable for low and medium power demand applications. As shown in Figure 12 fuel cells could be used as propulsion unit in medium and low power demand applications. PEMFCs used in prime movers or auxiliary power unit with hybrid systems. 8 from 9 applications that uses PEMFC were selected because of zero emission, high power density, easy and quick start-up, relatively low initial costs, and compact size [25].

Small and medium size vessels have low power demanded applications like pleasure craft, small ferries, canal boats etc. Fuel cells could be used as range extender or as a hybrid system for the power supply for propulsion and auxiliary purposes. Pleasure crafts are used very limited times during the year, hence lifetime of the fuel cells is not a real criteria for being selected [23]. Among these, the one which fits the best because of its low operation temperature, easy and quick start up, zero emission concept and high power density is PEMFC.

CONCLUSION

One of the most promising technology for using hydrogen as fuel onboard power producing is fuel cell systems. These sytems are the most efficient and cleaner way to produce electricity directly from chemical energy of fuel instead of conventional internal combustion engine and gas turbines. The fuel cell systems are also suitable for All Electric Ship Concept [24].

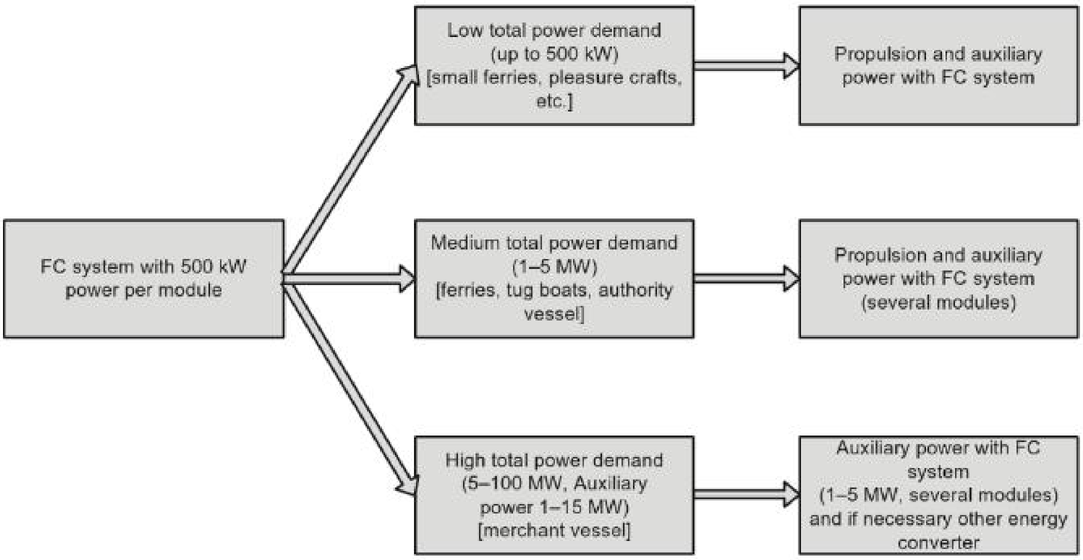


Figure 12. Capabilities of Maritime Fuel Cell Systems [23]

Initial and operational cost of the fuel cells are still much more expensive than traditional competitors due to still being in development stage, fuel supply infrastructure and onboard storage problems of hydrogen, relatively short lifetime and high costs of fuel cells. Most developed and matured fuel cell type is PEM fuel cell.

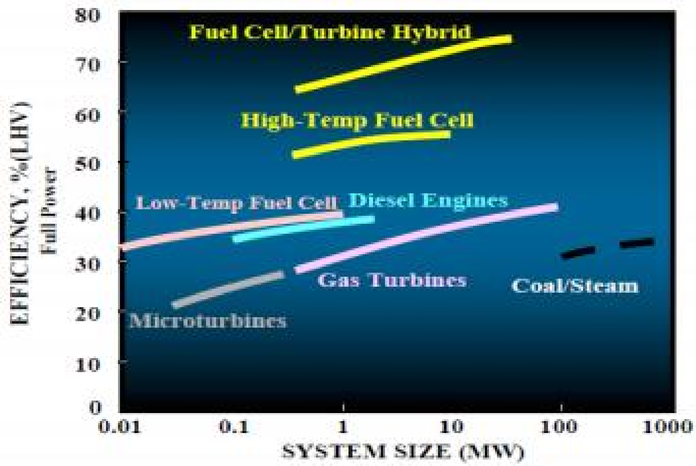


Figure 13. Comparison of efficiencies of different fuel cells for electric power plant [26]

It is used as air independent propulsion unit for submarines and also preferred for transportation applications power demand up to 500 kW as shown in Figure 13. Reforming technologies are provided using fuel cell onboard with conventional fossil fuels that causes some CO_2 emission however it is still much more lower than internal combustion engines and gas turbines and the fuel cell system provides compliance with the MARPOL Treaty Annex VI.

Until appropriate solutions will be found to produce hydrogen in cleaner and sustainable way and also store the hydrogen onboard with high power density these reformer technologies also provides us to gain experiences onboard fuel cell technologies. As fuel cell applications widespread, the cost will be lower because of mass production – cost curve. So the fall down prices, they become more attractive option and their applications will scaled up.

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EXPERIMENTAL INVESTIGATION OF ATTACK ANGLE EFFECT ON FLOW STRUCTURE AROUND LEADING AND TRAILING EDGES OF A TORPEDO-LIKE GEOMETRY

S. Yagmur[1], I. Goktepeli[2], M. Ozgoren[3], F. Kose[4], L. A. Kavurmacioglu[5]

ABSTRACT

Studies about flow characteristics around underwater vehicles such as submarines, torpedoes etc. are very significant due to their effects on the development of underwater defense industry. In this study, the flow structures around leading and trailing edges of a torpedo-like geometry positioned in uniform flow conditions have been experimentally investigated via Particle Image Velocimetry (PIV) for varying attack angles of α = 0˚, 4˚, 8˚ and 12˚. Flow patterns of time-averaged vorticity, streamwise and cross-stream velocity components, turbulence kinetic energy contours and streamline topologies have been examined at Re = 20000 and Re = 40000. It is observed that when the attack angle increases, flow characteristics around the torpedo-like geometry have lost symmetrical distributions. As a result of increase in attack angle, stagnation point at the nose tip of the geometry has moved up. Moreover, wake region has come closer to the body owing to the increase in Reynolds number.

Keywords – Attack angle, leading edge, PIV, Reynolds number, torpedo, trailing edge

INTRODUCTION

Investigation of the depths of oceans, defense systems and commercial applications affects the development of underwater vehicles positively. Torpedoes, submarines, autonomous underwater vehicles (AUVs), remotely operated underwater vehicles (ROVs) and unmanned undersea vehicles (UUVs) appear in the category of the underwater vehicles. Despite the fact that oceans and seas are the two thirds parts of the world, enough attention for the studies could not be attracted when analogized with land and atmosphere. The reason can be shown as underwater research or underwater defense vehicles are exposed to more viscous and hydrostatic forces than other vehicles. That is why flow fields around these vehicles should be examined in detail. Correspondingly, the objective of this study is to present a proper background for the development of these vehicles. Most of the previous studies have been done both experimentally and numerically to attain the hydrodynamic characteristics of underwater vehicles. Soren (1997) has determined the hydrodynamic forces acting on an underwater vehicle. He has concluded that the flow separation depended on angle of attack for the effect on the hydrodynamic forces [1]. Bridges et al. (2003) have

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examined the flow over a submarine at angle of drift as an experimental study. They have measured the forces and moments by using an internal force balance. Laser Doppler velocimeter (LDV) system has been utilized to obtain the velocity field [2]. Jagadeesh et al. (2009) have investigated the hydrodynamic force coefficients of AUV hull form experimentally and have completed the measurements for different velocities (0.4 – 1.4 m/s) and pitch angles (0˚ - 15˚). A series of tests has been conducted in a towing tank in the range of Re = 1.05 x 10^5 and Re = 3.67 x 10^5. A maximum increase has been seen for the normal force coefficients when it was compared to the axial force coefficients in terms of higher speeds and angles of attack [3]. Dantas and de Barros (2013) have examined the hydrodynamic flow structure for an AUV at different angles of attack. They have determined that the most appropriate one for this case was k-ω SST turbulence model [4]. Allston et al. (2014) have reported the measurements of the wake behind an experimental hydrofoil on an autonomous underwater vehicle. In terms of four flow speeds and five angles of attack, experimental results obtained by using Particle Image Velocimetry (PIV) of a full scale prototype in a large flume tank have been compared to two-dimensional numerical simulations [5]. Saeidinezhad et al. (2015) have investigated the pitch angle effect on drag coefficient of a submersible vehicle model with a non-axisymmetric nose. The results have shown that increase in pitch angles increased the drag and lift coefficients and the flow separation for a non-axisymmetric nose shape was very near to the nose tip than the symmetric nose shape [6]. Fureby et al. (2016) have studied a generic conventional submarine at yaw angle of 10˚. Wind tunnel with PIV has been utilized as an experimental setup and LES turbulence model has been used for the numerical study [7]. Skarolek and Karabelas (2016) have evaluated the flow past an aircraft wing by LES turbulence model at Re = 2.5 x 10^6 while the attack angles changing from 4˚ to 12˚. They have stated that maximum drag reduced by nearly % 40 at low angles of attack [8]. Yagmur et al. (2016) have examined the attack angle effect on a torpedo-like geometry at Re = 40000 by using PIV technique for attack angle changing from α = 0˚ to α = 30˚ [9]. In this paper, both leading and trailing flow pattern have been experimentally examined for various angles of attack.

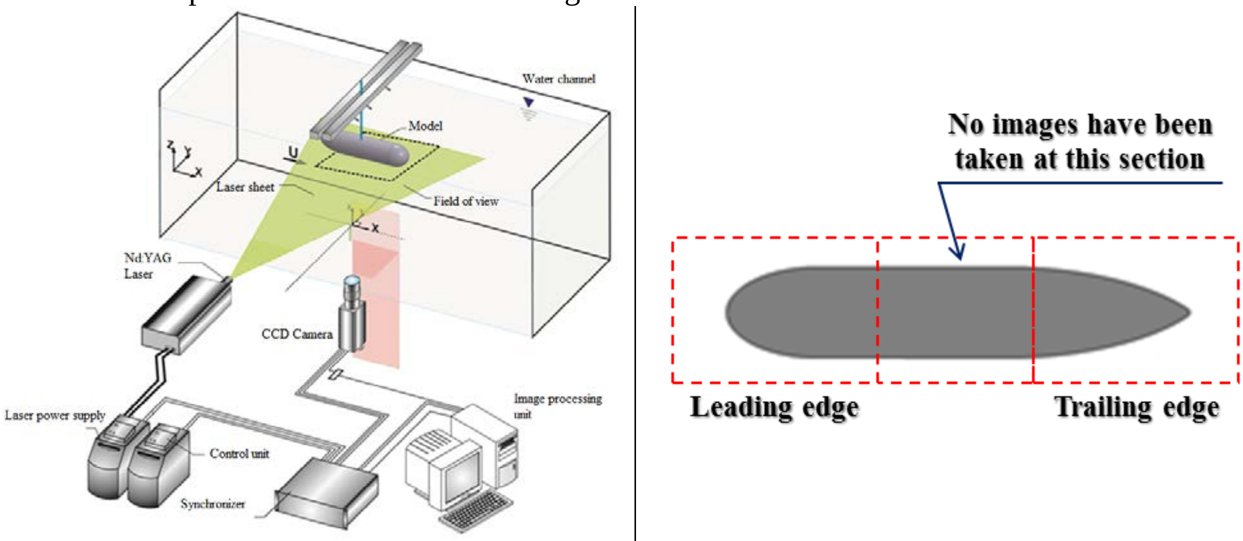
MATERIAL AND METHOD

Attack angle effect on flow structure around leading and trailing edges of a torpedo-like geometry has been experimentally investigated at Re = 20000 and Re = 40000. In the experimental study, Particle Image Velocimetry (PIV) method has been used.

Particle Image Velocimetry (PIV) Measurement

All experiments have been carried out in a large scale open water channel having a rectangular test section of 6000 mm x 600 mm x 770 mm for length, width and height dimensions, respectively. The water channel of Advanced Technology Research and Application Center of Selcuk University in Konya/Turkey has been utilized. Test section walls have been constructed from transparent glass plates with 15 mm thickness to enable laser transmission and flow visualization. The water channel has been filled with water to a level of h_w = 47 mm. The water is pumped by a centrifugal pump controlled by a frequency converter and previously reaching the test section, passed through a honeycomb section and a two-to-one channel contraction. Reynolds number has been given as Re = (U_∞ L)/ν, based on the characteristic length. Here, L is the length of the torpedo-like geometry, ν is the kinematic viscosity and U∞ is the free-stream velocity values of 100 mm/s and 200 mm/s. The length and the diameter of the model are L = 200 mm and D = 40 mm, respectively. The model has been made of acrylic glass with a thickness of 2.5 mm. The geometry is hollow and filled with water to diminish the laser shit deflection and highly polished to avoid surface roughness. Nd:YAG laser with 15 Hz has been used to generate a laser sheet perpendicular to the axis of the model. The thickness of the laser sheet was nearly 1 mm. The 10 μm diameter suspended seeding particles in the flow are silver-coated hollow glass spheres.

As indicated in Figure 1(a), the torpedo-like geometry is horizontally located at the middle section of the water channel between two false walls to avoid surface and wall effects from channel bottom. Furthermore, to provide the high-image- density criterion, it is enabled that the interrogation area contains nearly 20 – 30 particles per image. A CMOS camera with a resolution of 1632 x 1200 pixels was used to capture 1024 instantaneous image at the rate of 15 Hz to calculate 1024 vector fields.



(a) **(b)**

Figure 1 (a) Schematic figure of the experimental setup and (b) fields of view from leading and trailing edges

An interrogation window of 32 x 32 pixels for each image was selected and converted to approximately 1.41 x 1.41 mm^2 grid size with an adaptive correlations consisting of 7474 (101 x 74) velocity vectors. During the adaptive-correlation process, an overlap of 50% was used for all interrogation areas in order to satisfy the Nyquist criterion. From instantaneous velocity vector fields, the time-averaged flow patterns were calculated. For the post processing, software was employed including proper filters to compute the raw displacement vector field from the particle image data.

RESULTS AND DISCUSSION

The flow characteristics around a torpedo-like geometry have been investigated by PIV. Following figures (Figures 2, 3, 4 and 5) indicate the comparison of different attack angles ($\alpha = 0^\circ, 4^\circ, 8^\circ$ and 12°) at Re = 20000 and Re = 40000, respectively. As shown in Figure 1(b), fields of view on the torpedo-like geometry have been considered. Time-averaged normalized vorticity $\langle \omega^* = \omega L/U_\infty \rangle$, time-averaged normalized streamwise velocity components $\langle u^* = u/U_\infty \rangle$, time-averaged normalized cross-stream velocity components $\langle v^* = v/U_\infty \rangle$, time-averaged normalized turbulence kinetic energy values $\langle T.K.E.^* = T.K.E./U_\infty^2 \rangle$ and streamline topologies $\langle \psi \rangle$ around the geometry have been obtained. The dimensions of all images have been normalized with the diameter of the torpedo-like geometry as x/D and y/D.

In case of $\alpha = 0^\circ$ as shown in Figure 2, symmetrical distribution of normalized time-averaged vorticity $\langle \omega^* \rangle$ is dominant for the uniform conditions at both Reynolds numbers. The maximum and minimum values have been obtained in the regions of flow separation occurred. The distributions of the normalized time-averaged streamwise velocity components $\langle u^* \rangle$ are illustrated. At the nose tip, negative values of streamwise velocity components are not available. Negative values of streamwise velocity components have only occurred in the wake region of the model. It is clearly seen that the wake region of the torpedo-like geometry has shrunk and become closer to the torpedo-like geometry. Normalized time-averaged cross-stream velocity components <v*> indicate symmetrical distribution for α = 0˚ and cross-stream velocity components have been obtained as approximately zero through the symmetry axis. Reynolds number increase to Re = 40000, clusters of maximum and minimum values have been tightened and approached to the trailing edge of the geometry. At the attack angle of α = 0˚, the minimum values for turbulent kinetic energy <T.K.E.*> have been obtained in the wall of the model.

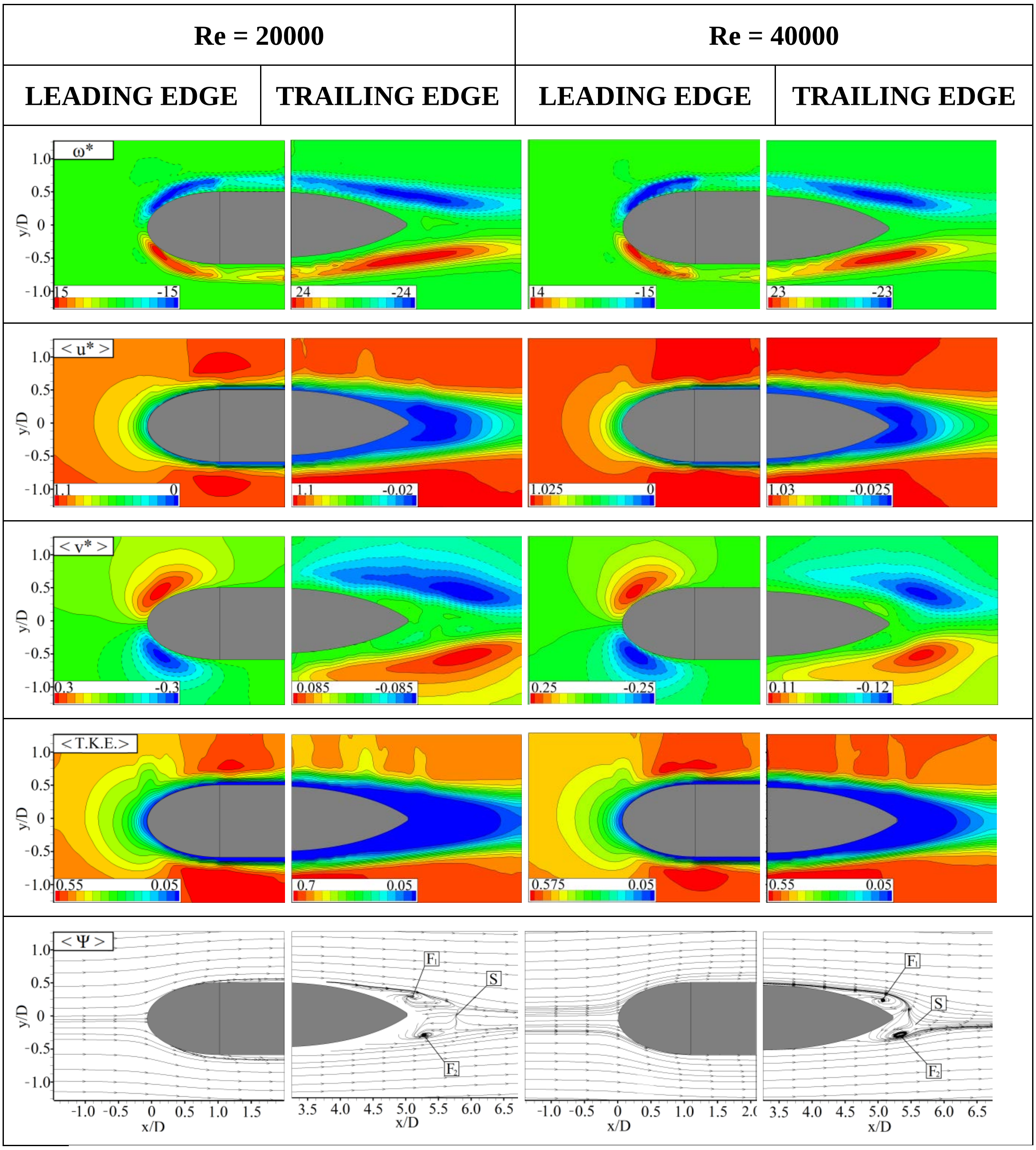


Figure 2 Comparison of normalized time-averaged vorticity <ω*>, time-averaged streamwise velocity components <u*>, time-averaged cross-stream velocity components <v*>, turbulent kinetic energy <T.K.E.*> and streamline topology <Ψ> around leading and trailing edges of a torpedo-like geometry for the attack angle of α = 0˚ at Re = 20000 and Re = 40000

Owing to some reflection occurred on the geometry by manufacturing defect, the symmetrical flow structure has not been overtly for time-averaged streamline topology <ψ> of the model. In terms of streamline topology <Ψ>, F indicates the focus of the rotational flow field in a limit cycle, S stands for the saddle point and it shows the free stagnation point in the flow field. At both Reynolds numbers, two foci points (F_1 and F_2) and a saddle point (S) have been observed in the wake region whereas nothing in the leading edge.

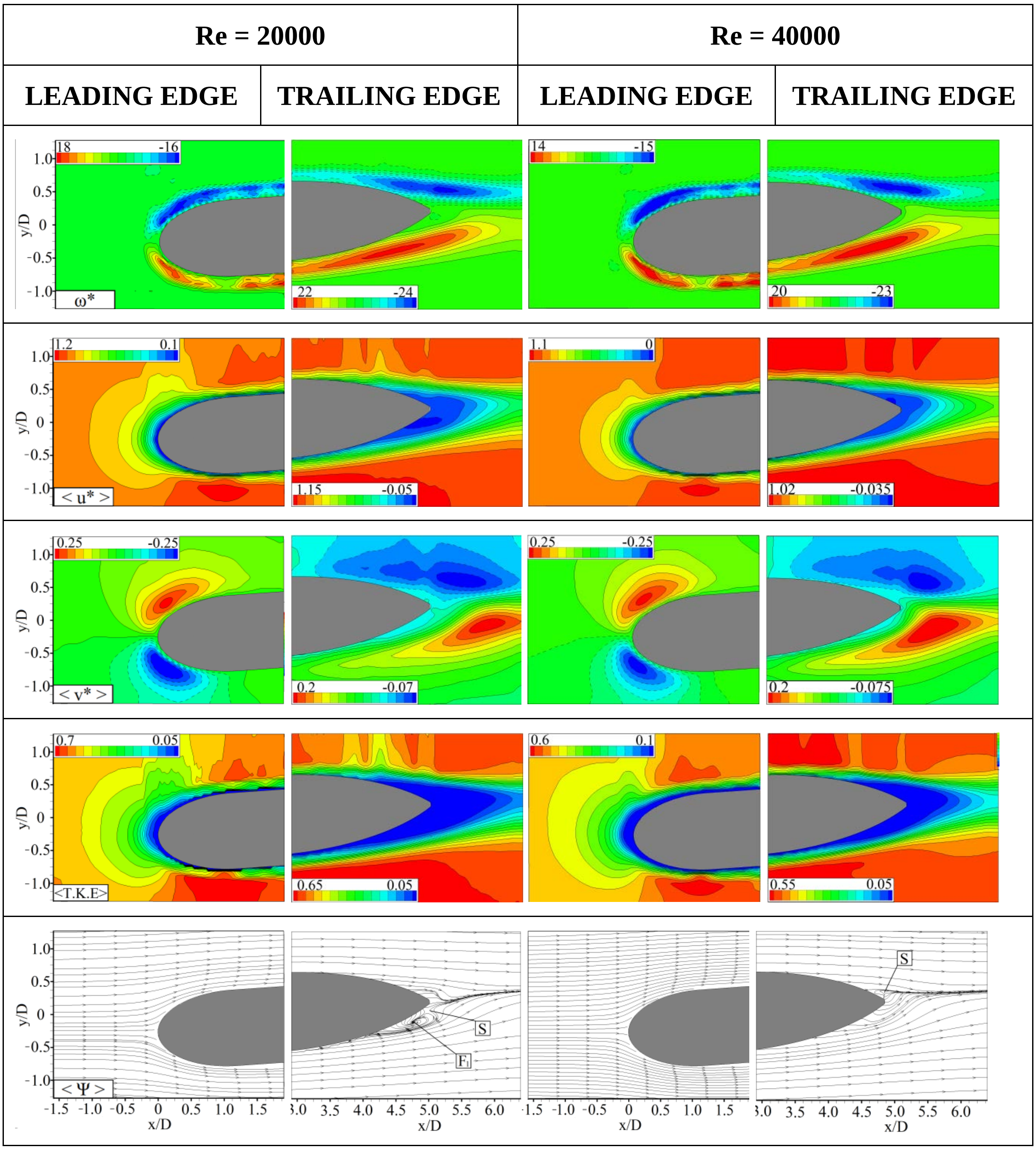


Figure 3 Comparison of normalized time-averaged vorticity <ω*>, time-averaged streamwise velocity components <u*>, time-averaged cross-stream velocity components <v*>, turbulent kinetic energy <T.K.E.*> and streamline topology <Ψ> around leading and trailing edges of a torpedo-like geometry for the attack angle of α = 4° at Re = 20000 and Re = 40000

Figure 3 indicate the flow characteristics of the model at the attack angle of α = 4˚. Certain symmetrical distribution of normalized time-averaged vorticity <ω*> could not be attained for both Reynolds numbers and all regions, it seems a little damaged when attack angles increase to α = 4˚ with respect to the reference condition. The maximum and minimum values are very near to flow separation zones around the torpedo-like geometry. The distributions of the normalized time-averaged streamwise velocity components <u*> are given and negative values of streamwise velocity components have not been seen at the leading edge. Streamwise velocity components having negative values have taken place in the wake region of the model. After the increase in attack angle to α = 4˚, stagnation point at the nose tip of the geometry has moved up. It is clearly seen that the wake region of the torpedo-like geometry has expanded and moved away from the symmetry axis to the lower side of trailing region of the torpedo-like model due to the rise in attack angle. The reason of that phenomenon is pressure difference between the upper and lower sides of the geometry. Correspondingly, drag force acting on the model increases as the attack angle rises. Approximately unsymmetrical distribution in normalized time-averaged cross-stream velocity components <v*> have been obtained and cross-stream velocity component values approximately zero through the symmetry axis. Due the increase in attack angle, the symmetrical flow structure has damaged. While the attack angle is α = 4˚, the maximum values for turbulent kinetic energy <T.K.E.*> have been provided under the model. The maximum values of turbulent kinetic energy at Re = 20000 are greater than Re = 40000. F stands for the focus of the rotational flow field in a limit cycle, S represents the saddle point and it is given for the free stagnation point in the flow field. When streamline topology <Ψ> is examined, there is only one focus point which is F likewise a saddle point of S is acquired in the wake region of the torpedo-like geometry at Re = 20000. On the other hand, a saddle point (S) is available in the same region for Re = 40000.

When the attack angle equals to α = 8˚ as seen in Figure 4, flow structure obtained from the normalized time-averaged vorticity <ω^*> predicates asymmetry between the clusters of upper and lower sides of the geometry. The maximum and minimum values have been attained as very close to regions where flow separation occurred at the leading edge for α = 8˚. Normalized time-averaged streamwise velocity components <u*> have been presented and negative values of streamwise velocity components are not available for both leading and trailing edges of the model. It has been observed that stagnation point at the leading edge of the torpedo-like geometry has displaced to upper zone therewith the rise in attack angle value. The maximum values of streamwise velocity components have decreased due to the increase of Reynolds number. The cluster of the minimum values for streamwise velocity components have diminished while the wake region of the torpedo-like geometry has got larger. Furthermore, the wake region has become distant with respect to the symmetry axis of the geometry and it has become closer the lower part of the model. The rise in attack angle causes pressure difference between the upper and lower parts of the model and drag force increment when compared with the attack angle of α = 0˚. Normalized time-averaged cross-stream velocity components <v*> show asymmetrical distribution. In terms of the leading edges at both Reynolds numbers, the dominant cluster has occurred over the nose tip of the torpedo-like geometry. In the meantime, stagnation point in front of the nose tip has replaced and approached to the upper zone. When the trailing edges are compared for the cross-stream velocity components and it is interpreted that dominant clusters of cross-stream velocity components have been obtained under the torpedo-like geometry with the attack angle of α = 8˚. When the attack angle is α = 8˚, the maximum values for turbulent kinetic energy <T.K.E.*> have been attained at the lower region of the model just as for the leading edge case of Re = 40000. On the other hand, maximum values have also been seen at the upper side of the geometry at Re = 40000. In addition, the maximum values of turbulent kinetic energy for Re = 20000 have been obtained as higher than Re = 40000. In the case of streamline topology <Ψ>, there are not any foci points (F) or saddle points (S) around leading or trailing edges of the torpedo-like geometry at Re = 20000 and Re = 40000.

Figure 5 shows the flow structure around leading and trailing edges of the torpedo-like geometry for the attack angle of $\alpha = 12^{\circ}$. With respect to the comparison of normalized time-averaged vorticity $<\omega^{*}>$, certain unsymmetrical distribution have been attained for both Reynolds numbers and whole geometry. The maximum and minimum values obtained from the results are very close to flow separation regions around the torpedo-like geometry. Streamwise velocity components <u*> have been presented and negative values of streamwise velocity components have not been attained for all parts of the torpedo-like geometry at Re = 20000 and Re = 40000.

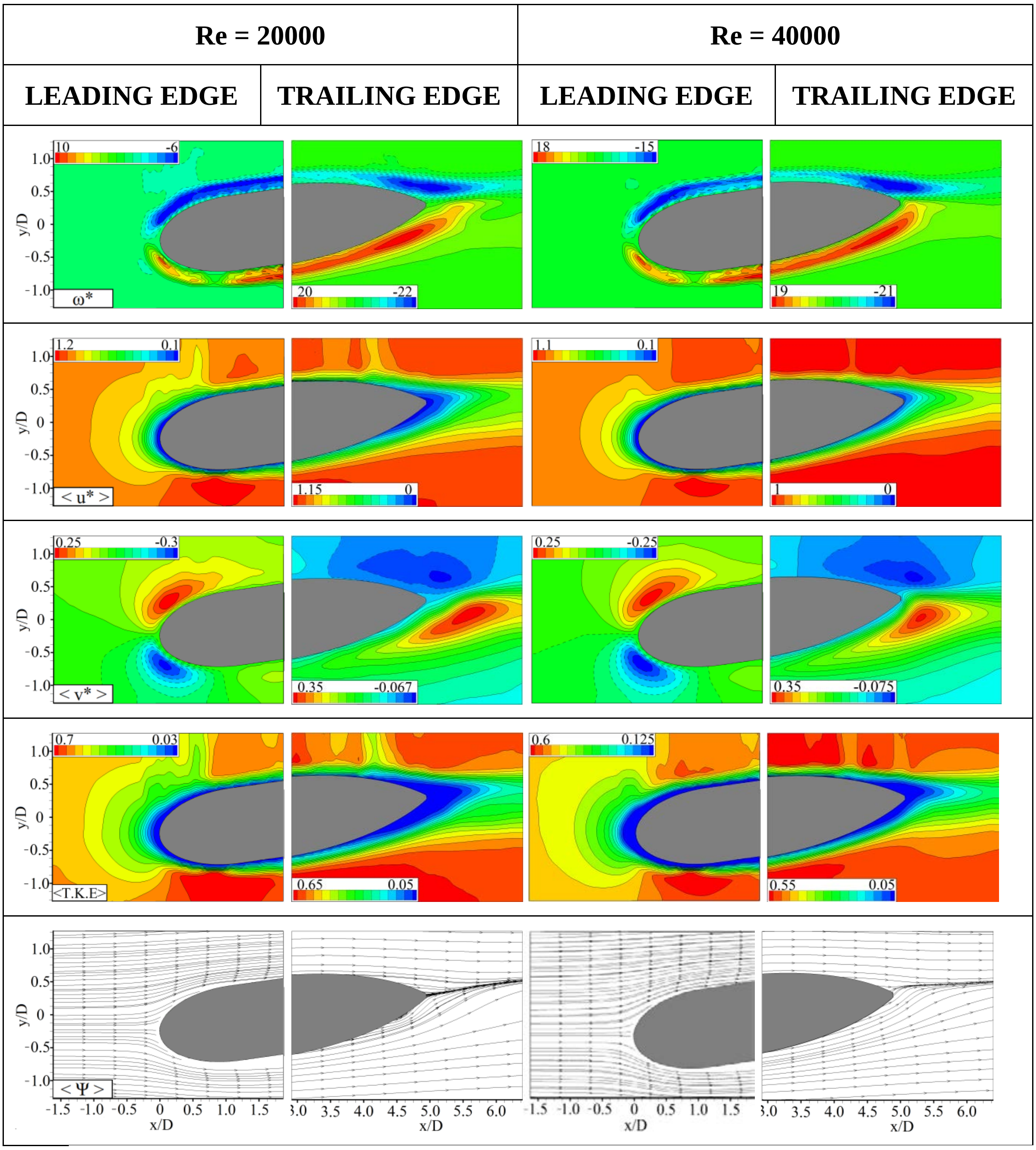


Figure 4 Comparison of normalized time-averaged vorticity <ω*>, time-averaged streamwise velocity components <u*>, time-averaged cross-stream velocity components <v*>, turbulent kinetic energy <T.K.E.*> and streamline topology <Ψ> around leading and trailing edges of a torpedo-like geometry for the attack angle of α = 8˚ at Re = 20000 and Re = 40000

Owing to the increase in attack angle to α = 12˚, stagnation point at the nose tip of the geometry has gone up. It is observed that the wake region of the torpedo-like geometry has got larger, become distant from the symmetry axis and approached to the lower region of trailing part of the model as a result of increment in attack angle value. Thereupon the pressure difference between the upper and lower sides of the torpedo-like geometry, drag force has been affected negatively due to increase of the attack angle. Unsymmetrical distributions of normalized time-averaged cross-stream velocity components <v*> have been given.

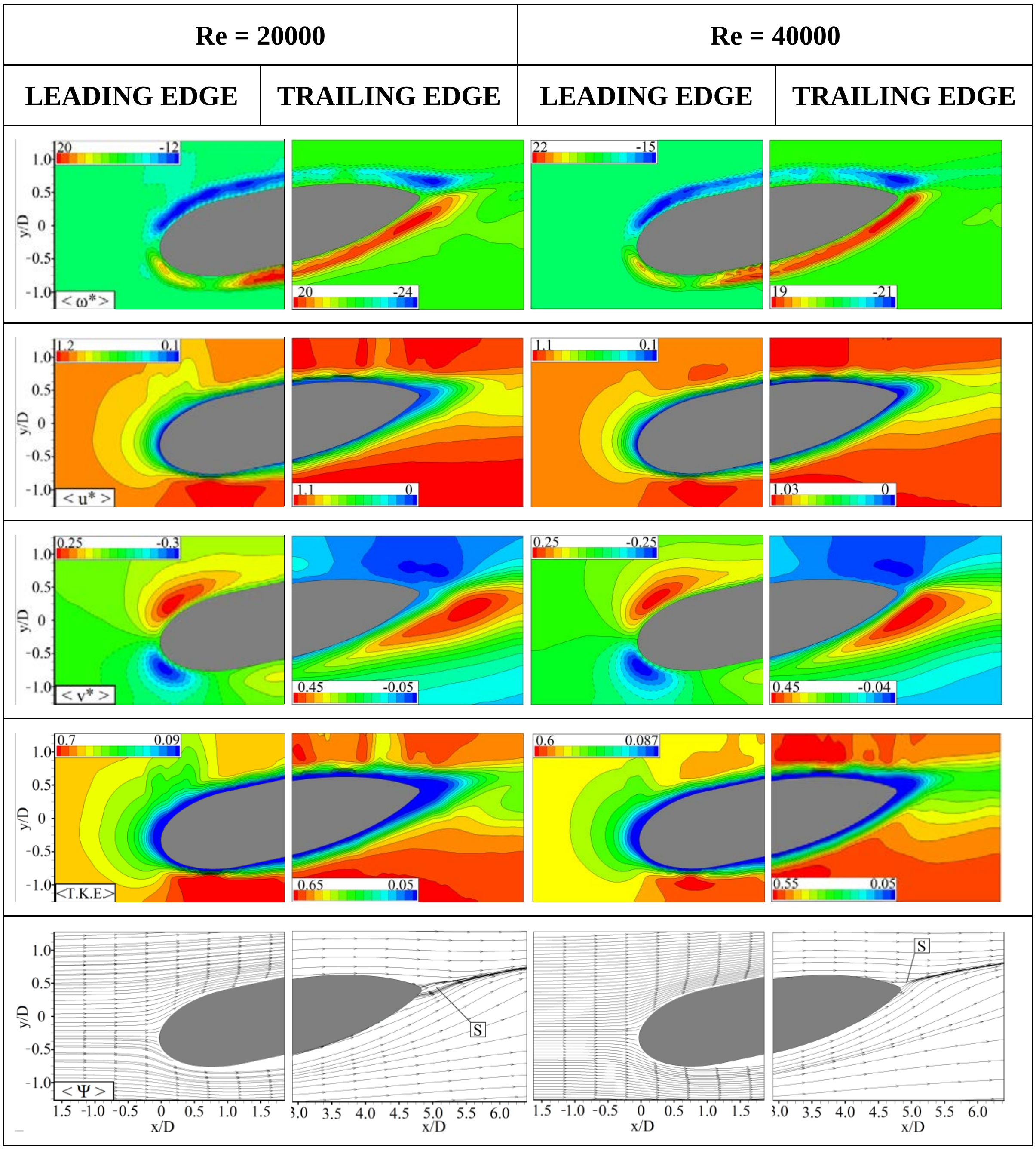


Figure 5 Comparison of normalized time-averaged vorticity <ω*>, time-averaged streamwise velocity components <u*>, time-averaged cross-stream velocity components <v*>, turbulent kinetic energy <T.K.E.*> and streamline topology <Ψ> around leading and trailing edges of a torpedo-like geometry for the attack angle of α = 12˚ at Re = 20000 and Re = 40000

At both Reynolds numbers, the dominant cluster has been obtained at the upper side of the leading edge. Additionally, stagnation point of the model at the leading edge has moved up. On the other hand, the dominant cluster has been attained beneath the torpedo-like geometry for the trailing edge case. The symmetrical flow structure has diminished completely in case of α = 12˚. The maximum values for turbulent kinetic energy <T.K.E.*> have been observed under the model. The maximum values of turbulent kinetic energy at Re = 20000 are higher than Re = 40000. In case of α = 12˚, streamline topology <Ψ> indicates only one saddle point for each trailing edges at Re = 20000 and Re = 40000 as in Figure 5. S is the saddle point and it is the free stagnation point in the flow field.

CONCLUSIONS

Experimental flow characteristics around the leading and trailing edges of torpedo-like geometry have been determined at Re = 20000 and Re = 40000 by using PIV technique in the range of attack angles α = 0˚, 4˚, 8˚ and 12˚. The time-averaged vorticity $<\omega^*>$ show symmetrical flow patterns at angle of attack α = 0˚ occurring along the symmetry axis of torpedo-like geometry. Due to increase in angles of attack, symmetrical distribution has damaged. At the nose tip, negative values of streamwise velocity components $<u^*>$ are not available while the negative values have been obtained in the wake region. Stagnation point at the nose tip of the geometry has moved up because of the increasing angles of attack. In case of cross-steam velocity components $<v^*>$, the rise in angle of attack causes pressure difference between the upper and lower regions of the model and drag force increment when compared with the attack angle of α = 0˚. Most of the maximum values for turbulent kinetic energy <T.K.E.*> have been provided under the model. The maximum values of turbulent kinetic energy at Re = 20000 are generally greater than Re = 40000. After the increase in angles of attack, symmetrical pattern of streamline topology <Ψ> has disappeared.

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A STUDY ON COST OPTIMIZATION IN THE SHIP MANAGEMENT

Ergün DEMİREL[1], Dinçer BAYER[2]

ABSTRACT

Shipping is a risky business by its very nature that runs within a complex and ever changing market set up having variables in both income and expenditure. Ship management is a highly competitive and a cost-conscious arena of which one of the most prominent objectives is the cost optimization. The aim of this study is to conduct a research on the cost optimization in the ship management, to define the dominant factors that seriously affect the cost and to propose solutions which reduce the cost. Primary intention is to make an investigation on the factors which affects the costs in the ship management and to evaluate the effects of these factors on the costs. Then the fuzzy logic method is applied to find dominant factor(s) which are controllable and could seriously reduce the cost. The findings on the dominant factors are used to produce proposals to optimize the ship management costs for the shipping companies. This study not only helps to understand the dominant cost factors in the industry, but also provides essential data for the organizational changes which ensure the cost reduction in the ship management.

Key Words- Ship Management; Cost Optimization; Shipping; Procurement and Maintenance; Procurement and Repair.

INTRODUCTION

Shipping business runs within a complex and ever changing market which leads to variables in both income and expenditure. Accordingly, being an international business, the shipping activity should follow both national and international law and regulations. The shipping operates under the supervision of not only national authorities but also global actors such as classification societies, finance providers, marine insurance companies, shipping related non-governmental organizations which regulate commercial management.

Shipping is a high level risky business which is very sensitive to many risks which may jeopardize survival of the shipping company. Sea transportation is full of hazards which may cause serious damages on human lives and the ship to a degree of even total loss. Normally ships are owned by credits and a financial risk is always possible. Shipping is also very sensitive for changes of the national and international policy. Those alterations and risks require all ship management companies to handle a continuous risk assessment and management process.

Additionally, shipping is a complex business – with a substantial exposure to financial, commercial, political and physical risks – that requires skilled management. Ship management – again unsurprisingly in a cost-conscious business such as ship ownership – is a highly competitive business sector, especially in respect of management fee levels (Drewry, 2006).

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Ship owners are always looking for securing their revenue to survive in a challenging business. To control revenue flow, they need reduce the cost and increase the income. Increasing the income is not possible whereas reducing the cost is much more available in general. Reduction of the capital, operation and voyage costs is generally not applied due to the economic considerations. For that reason, to secure cost savings, the ship owners are looking for instruments to control expenses of additional crew travels, stores, spares, repairs, shipyard, port agency bills and extra insurance fees.

Technical management is at the core of successful ship operation. A ship's ability to earn revenue will be hampered if it is unable to operate optimally. This introduces the need, among others, to attain the appropriate standards for crewing, repairs and maintenance, procurement and inventory systems and management itself (Drewry, 2006).

RESEARCH METHOD

The aim of this study is to conduct a research on the cost optimization in the ship management, to define the dominant factors which seriously affect the cost and to propose solutions which reduce the cost. To reach the aim, data is collected and processed by using literature review techniques. Problem of the study is defined such as "to reduce the cost for shipping companies. "Accordingly, research is conducted in three phases. In the first phase, it is intended to make an investigation on the factors which affects the costs in the ship management and evaluate the effects of these factors on the cost. Then the fuzzy logic method is applied to find dominant factor(s) which are controllable and seriously reduce the cost. In the last phase, the findings on the dominant factors are used to produce proposals to optimize the ship management costs for the shipping companies.

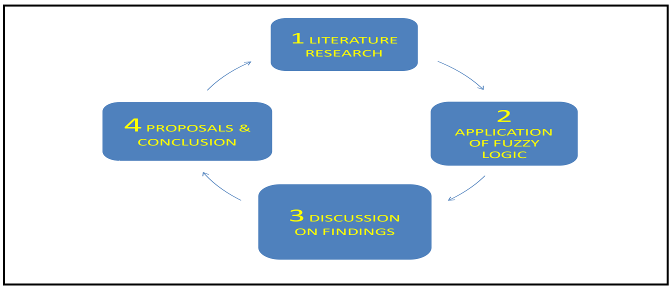

Figure 1: The research method applied

This study not only will help to understand the dominant cost factors in the industry but also will provide essential data for the organizational changes which ensure the cost reduction in the ship management.

ANALYSIS OF REVENUE AND COSTS

Main Elements of Shipping Management

Main elements of the ship management are introduced in Figure 2. The commercial ship management is "getting the income in'' and the technical ship management is ''keeping the hardware/seagoing operation going''. Administration is a set of activities in support of commercial and technical managements.

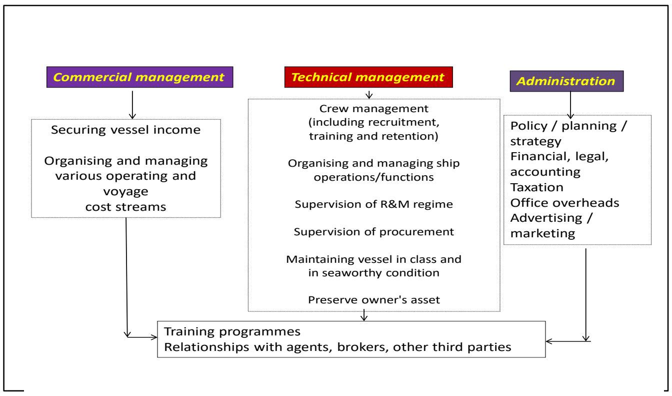

Figure 2: The Main Elements of Ship Management (Source: Drewry, 2006)

According to Drewry (Drewry, 2006), the inevitable principal in commerce is "securing the revenue stream". In shipping there are two factors to provide earning income; freight rates secured for the carriage of cargo and hire earned from chartering out the ship. In some extraordinary cases, the revenue may be secured from selling ships.

Whoever has responsibility for commercial management, the success or otherwise of the venture will hinge on two key factors; (i) an ability to 'read the market' and (ii) an element of luck. The latter may sound disconcerting to those not closely involved with shipping markets but the truth is that shipping markets are some way from being transparent. Hence, interpretations have to be made based on incomplete or imperfect information. This creates a mix of speculation and sentiment to go with the underlying 'realities'. Sentiment is not something suited to 'mathematical models' (Drewry, 2006). As it has been mentioned before, mostly the ship managers are lack the ability of reading the market and that makes them play their games on luck in which success is not always possible. So it is clear that they should work on "cost reduction" rather than" gaining or increasing income" which is very variable and hard to forecast.

From an economic standpoint, the entrepreneur will try to maximize his profits and therefore expand his output, so long as the increase in his total costs is less than the increase in his total revenue. He will therefore continue to expand to the point where his marginal additional cost is equal to his marginal additional revenue (Archer, 2008).

The following issues are key issues in ship management;

- Commercial Management:
    - Freight development-negotiating and securing charters
    - Cargo booking and ship scheduling
- Technical Management (Cost side based on the Voyage Estimation)
    - Crew cost
    - Bunkers & lubricators consumption and cost
    - Hull and engine maintenance costs
    - Insurance costs
    - Capital costs
    - Administration costs (Distribution of overhead for each voyage)
    - Voyage costs for ports, agency, pilotage, cargo handling, canal transits, etc.)

- Administration;
- Financial control and accounting

Cost Factors in Ship Management

The share of the cost for each type of charter is shown in the Figure 3. Operating cost which is main part of spending for all charter modes is under the ship owner responsibility except bareboat chartering.

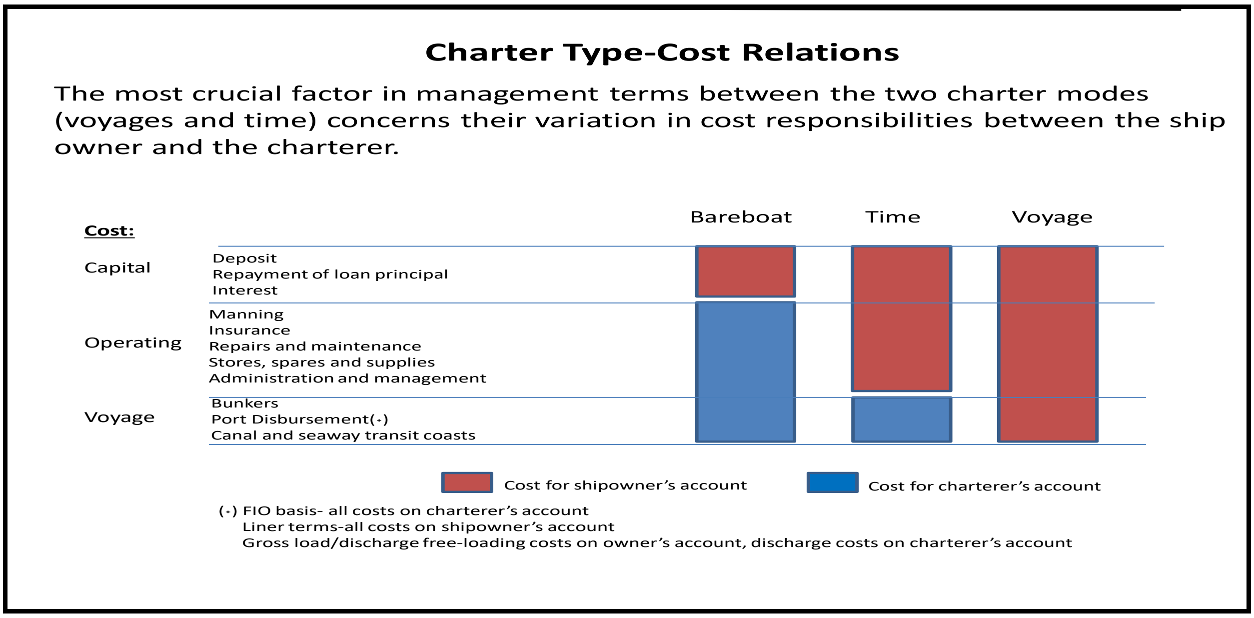

Figure 3: Charter Type Cost Relations (Source: Drewry, 2006)

It is not possible to negotiate for capital cost except initial stage which is related the financial markets' fluctuation. Most part of the voyage costs (port disbursements, canal and seaway transit costs) are dependant to tariffs and not negotiable. Bunker prices follows the fixture of the market and provides a little opportunity to bargain. Some elements of operating cost (manning and insurance) are not negotiable. But the others (Repairs and maintenance; stores, spares and supplies, administration and management) are more flexible to negotiate for cost reduction. The quality of purchase/procurement staff and technical staff and support of ship crew is important to make cost optimisation in these areas.

Marfin Management Company made a study on Operational Cost and Daily Overall expenses for ships (Albertini, 2011). The following tables show these figures;

Table 1: Operational Expenses Proportion

Crew costs	48%
Administration	18%
Stores	16%
Insurance	13%
Spare &Repairs	5%

The biggest portion is the crew cost and it is not flexible for bargain. Insurance also has a very limited chance to negotiate for cost. Except company staff salaries, all other administration aspects (office rent, transportation, and communication, stationary) are in the procurement and purchase. The stores and Spare & Repair cost are almost 19% of the operational expenses.

These are all related maintenance and repair policy and finally procurement/purchasing activities. If we separate non-flexible factors (crew cost and insurance), the remaining cost factors are directly related to maintenance, repair and procurement/purchasing.

Table 2: Proportion of Daily Overall Expenses

Financing	51%
Crew Cost	19%
Dry Docking	9%
Administration	7%
Stores	7%
Insurance	5%
Spares & Repairs	2%

As far as concerning Daily Overall expenses, except non-negotiable factors (financing, crew cost, and insurance) all other aspects are also directly related to maintenance, repair and procurement & purchasing.

Effectiveness of purchasing/procurement

The three areas which in the core of ship operations are important to evaluate cost optimization; Maintenance, Repair and Procurement.

Maintenance is an activity should be based on a plan namely Planned Maintenance System (PMS). Being a planned activity planners foreseen the cost and may prepare a budget which has a little fluctuation in general. If company and ship masters are keen to follow application of PMS on board there would not be an unexpected change in maintenance cost. The equipment and external manpower for PMS is crystal clear and if company finds suitable material and organize suitable external manpower with reasonable price there will be no surprise affecting cost seriously. The company should make an applicable plan for maintenance, conduct it fully and establish a full control, the cost will be reduced.

Repair requirements rise in case of malfunction of equipment which is mainly due to lack of maintenance. Although it is not fully approved, many maritime management experts assume that the cost of the maintenance (Cm) causes square of Cm(Cm^2) value of repair and missing opportunities cost. The age of the ships is a critical factor which increases the probability of incidents.

Procurement is made for supplying for all types of expenditure for ship and company. The procurement policy and the stores and supplies budget play a significant role in the expenses of the company. The stores and supplies budget and account has the potential to be one or the more irksome aspects of ship management. This is to do with the large number of transactions that it is capable of generating but, allied to this; many of these purchases – on an individual basis – may be of relatively little cost. The other key consideration is the manner in which these are purchased (i.e. the process adopted by the managers, including the degree of autonomy delegated to the vessel) and the locations around the world where deliveries to the vessel are affected. Clearly, it is vital that a cost-effective store, supplies and inventory policy is established and operated. The 'art' is to see that this process is not 'over managed'.

That is, it is vital that an owner or manager does not fall into the trap of 'knowing the price of everything, but the value of nothing'. This is not to suggest that price is unimportant – but buyers have to be aware of the potential of substitution of inferior products, reliability of delivery, etc. It is unlikely that a 5% saving on a stores and supplies order will seem to be a bargain if late delivery means the vessel is delayed for a day – or the vessel has to sail without its order (Drewry, 2006).

The purchase and procurement is a complex subject and requires a systematic approach to fulfil the requirements. The fundamental of procurement is related to the following issues;

- The purchase staff should be well experienced and qualified
- The company staff and ship crew should be capable of providing exact information for purchase staff
- There should be a reliable system to monitor supply follow ensuring that the right thing is arrived to right place in right time as well as correct invoice and payment
- Geography plays a critical role on the price
- The actual product mix is highly diverse
- Purchase staff deals with a wide range of suppliers.
- Purchase requires a selection to meet both quality and price
- Supplier reliability is important for an uninterrupted supply flow

Traditionally, the picture of the ship stores and supplies market held by most has been one focused solely on the negotiations and transactions between the ship owner or manager (as the marine purchaser) and some category of ship supplier. Hence, purchasing has tended to become an 'exclusive' niche within the shipping company set up. However, this picture is changing. Purchasing becomes 'less isolated' as it moves within the wider considerations of procurement. Purchasing is self-explanatory. Procurement, naturally, is about acquiring items needed by the vessel but it brings other 'management' and 'analytical' aspects beyond the pure purchasing process into the equation.

DISCUSSION

A study made by Fraunhofer CML and GL (Germanischer Lloyd) (2013), covering 100 shipping company on the "best management of ship management showed that the followings are assumed as the core tasks of ship managers by shipping companies;

- Technical management
- Quality and safety management
- Crewing
- Financial management
- Procurement

The financial management is an essential to survive and it is mainly dependent to the initial credit agreements. Technical management including Crewing and Quality & Safety management is an inevitable function to continue commercial operations and the cost of all this functions are approximately fix exempt some minor changes. The only area which manager can make arrangements related to the cost is procurement

In the Fraunhofer study it is also defined that "procurement of spares, supplies and services" is another elementary task of every ship manager to keep the vessel ready to sail. He does that on the account of the owner. Although low operational costs are a key differentiator for ship managers, there is no immediate effect of good purchasing in their pockets. This might be a reason why this function often gets less attention compared to Technical Management. However, the budgets {assigned for procurement} handled are still significant with a steady trend to rise. Tighter regulations and new international maritime conventions on safety, manning and the environment will continue to exert pressure on budgets post-2013.

With the emerging changes in world patterns of manufacturing—with much of it now being relocated to so-called low cost countries, of which China is perhaps the premier example—the issue of trading also becoming even more important. To develop trading capabilities to be able to make long or short positions when it comes to "procurement and supply" is becoming increasingly vital (Lorange, 2005).

All these studies prove that means procurement will be rather important in the future and should be carefully investigated for the survivability of the companies.

In a study on cost optimization "Services and Operations" of the shipping companies is analysed at a second level as shown in the Figure 4. One of the core processes of the product (Door to Door and Port to Port) is namely "Sea Voyage and Berthing". The ship management is also analysed at a second level in the Figure 5. This is a very important entity for the availability of the fleet vessels and hence for the schedule keeping of a line (Lyridis et al, 2005).

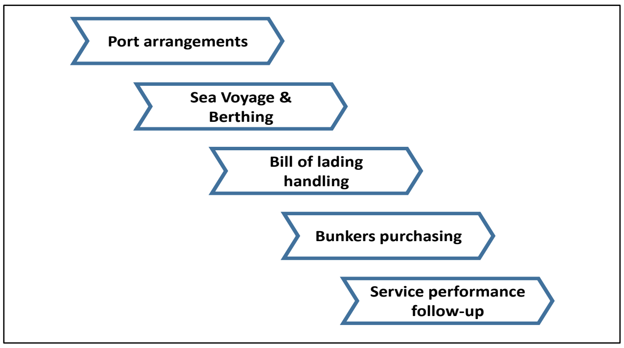

Figure 4: The Services and Operations of the Shipping Company

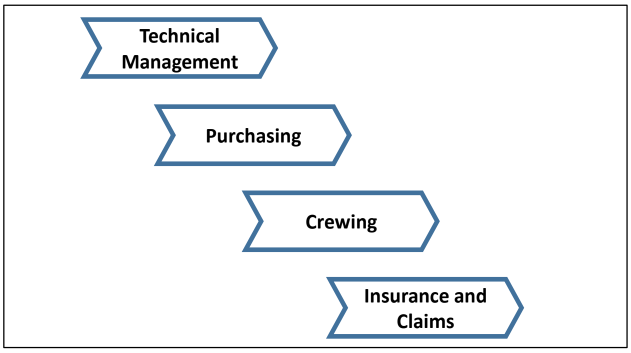

Figure 5: Ship Management Operations

If we examine the impact of successful commercial strategy and how it can deliver lower costs through effective procurement, primarily the managers should;

- Understand the role strategic procurement plays in an effective commercial operation

- Find the balance between cost, quality and innovation in procurement
- Examine total costs and the opportunity costs in relation to pricing strategies
- Apply project management techniques to procurement and commercial projects
- Evaluate and mitigate the risks in commercial strategy
- Build your understanding of the tendering and bid processes from both buyers and sellers perspective
- Realise how an effective negotiation strategy can achieve commercial success
- Discover the benefits of effective contract management

Actually main parts of procurement is related to the maintenance and repair cost. To make a full coverage study the regression analysis should be made between procurement and maintenance and repair costs. But the maintenance and repair costs are variables pending upon the type, ages, operation hours of the ship, maintenance policy of the company, quality of repair etc. So it is very difficult to make a regression analysis between these factors. Such a regression analysis may be conducted for a specific company but not for general survey. Another issue preventing such an analysis is the non-transparent structure of the shipping business and this hampers the collection of essential data for analysis.

Fuzzy Logic Application

This study is supported with a Fuzzy Logic Application supported with an expert team. Fuzzy logic provides a method for representing analog processes in a digital framework. Processes that are implemented through fuzzy logic are often not easily separated into discrete segments and may be difficult to model with conventional mathematical or rule-based paradigms that require hard boundaries or decisions, i.e., binary logic where elements are a member of a given set or they are not. Consequently, fuzzy logic is valuable where the boundaries between sets of values are not sharply defined or there is partial occurrence of an event (Klein, 2004).

A group of 6 doctorate students (1 ship master and 1 chief engineer working in the shipping companies, 1 ship master and 1 chief engineer working as maritime lecturer, in maritime transportation engineering programme and a civil engineer who wants to work offshore structures) made a research study under the supervision of a lecturer holding PhD on the maritime management as a part of their fleet management course. Detailed information has been delivered the group to understand the main elements of the cost in the ship management including a discussion period. They have investigated the main activities affecting the cost reduction in the ship management. Considering main areas affecting the cost in the ship management, they have decided that these factors are the procurement, maintenance and repair. The followings are defined as the main areas that will be evaluated:

M= Maintenance
P= Procurement
R= Repair

The group has also evaluated factors which directly affect the success of the procurement, maintenance and repair. The followings are defined as the factors (criteria) which will be weighted:

A: The experienced and qualified company staff is important to reduce the cost.
B: The well-organized outsourcing is important to reduce the cost

C: The geographic factor is important to reduce the cost.
D: The attitude of the ship crew is important to reduce the cost.

The group has studied on the weight of the each factor for each areas which are important in the cost reduction. The scale used is between 1 and 5 and 5 is the most important weightiness. The weights of each criterion for the areas which will be evaluated are defined in the Table 3.

Table 3: Weight of Importance of each factor

	Factor A	**Factor B**	**Factor C**	**Factor D**	**Sum**
Importance Level	4	3	2	2	11
Importance Weight	36%	27%	18%	18%	100.0%

The importance of the each factors for each area (Choice) to be investigated is discussed in the group and group decision is reflected to Table 4. The scale used is between 0 and 1. The normalized score is found used the formula below.

Normalized score= ½ (1-Sum/Total Sum)

Table 4: Normalized Scores based on Range

Criteria | Alternatives	**Choice M (Maintenance)**	**Choice P (Procurement)**	**Choice R (Repair)**
Factor A (Staff)	0.8	0.9	0.8
Factor B (Outsourcing)	0.9	0.6	0.9
Factor C (Geography)	0.3	0.9	0.5
Factor D Ship Crew)	0.4	0.4	0.3
Sum	2.4	2.8	2.5
Normalized Score	29.5%	32%	34.5%

Sum for choices is M=29.5%, P=32% and R: 34.5%.

Having the normalized weight of each factor, now we can multiply the converted score of Table 4 with the normalized weight and get the new weighted score as show in Table 5.

Table 5: Weighted Scores

Criteria | Alternatives	Weight	Choice M (Maintenance)	Choice P (Procurement)	Choice R (Repair)
Factor A	36%	0.8	0.9	0.8
Factor B	27%	0.9	0.6	0.9
Factor C	18%	0.3	0.9	0.5
Factor D	18%	0.4	0.4	0.3
Sum (Initial)	100.0%	0.180	0.722	0.808

Criteria | Alternatives	Weight	Choice M (Maintenance)	Choice P (Procurement)	Choice R (Repair)
Factor A	36%	0.29	0.32	0.29
Factor B	27%	0.24	0.16	0.24
Factor C	18%	0.05	0.16	0.09
Factor D	18%	0.07	0.07	0.05
Sum	100.0%	0.65	0.71	0.67
NORMALIZED SCORE		32%	35%	33%

Comparing the normalized score of Table 4 and Table 5 we can observed some shift on the choice. In Table 5, choice R (Repair) is preferable than M (Maintenance) and P (Procurement). However, after we include the weight of importance of each factor, we conclude that choice P (Procurement) is the most preferable alternative.

Organizational Issues

As we progress through the early years of the twenty-first century, the size and the scope of the shipping companies continue to change. The change is based on the company business plan formulated by the directors. Archer (2008) draws attention the following factors which is going to be very important issues in the near future;

(a) The IMO codes introduced in the past decade include the ISM, STCW and ISPS codes which influence the company structure primarily in the marine sectors of the business in particular, the chain of command between the ship and shore with emphasis on ship management and security.

(b) A further factor is the impact of information technology which continues to become more sophisticated and quickens the pace of the decision-making process. It extends all parts of the shipping company organization and in many companies has resulted in layers of management structure - especially in the middle management range - being eliminated. The application of information technology has shortened the decision management procedures and resulted in quicker decisions thereby making the company more competitive.

(c) At the same time the headquarters structure tends to be much smaller with authority devolved to encourage more accountability of personnel at all management levels. The profit centre concept has been developed through strong budgeting management techniques. The devolution of executive authority has involved cross border structures and in so doing yielded tax benefits and lower wage scales. The development of computerized technology has greatly facilitated this devolution and change.

(d) The development of third party ship management outsourcing is a growth section especially in the area of crew, insurance, ship survey and bunker management.

If we make evaluation on the above mentioned facts related to the procurement, the following findings may be listed;

(a) Improvement in the maritime regulations and respective strict applications will naturally increase the cost. So, more measures should be taken to optimize the cost.

(b) A significant change in the organization of the companies is expected. In particular more importance should be devoted to the branches which play crucial role to reduce cost.

(c)The close connection and information between company and ships will be rather important. This will provide better control of maintenance and repair activities and cost. The close relations of the company and the ships will also improve the decision making processes.

(d) Application of the third party management is expected to increase. This will require establishment of a new branch which controls the operations of the third parties in particular cost.

It is not possible to say that all shipping companies are ready to apply or have intention to take measures on the above mentioned facts. But they will take steps on the requirements mentioned e above to survive.

Ship management companies fall into two main categories, one being a ship-owning company that manages its own ships and offers the same services to the other ship owners. The other types are companies that have no ships of their own and solely provide ship management services to the ship-owners: Whichever type it is, the function of shipping management is the same and it falls under five main headings (ICS, 2006);

- Crewing
- Technical
- Storage
- Insurance
- Operations

The Germanischer Lloyd and Fraunhofer CML (2014) conducted a large scale study involving 100 ship management companies across the globe to find what they are doing to improve their operation and what they consider as best practices in the industry. The companies have explained that their biggest challenges of ship management in mid-term future could be stated in the following five areas; Crewing (88%), Technical Management (62%), Financial Management (%50), Quality and Safety (%27) and procurement (12%).

The Administrative Process Theory of Henri Fayol is based on economic efficiency and rationality. Although Fayol’s theory does not cover only the organization issues but also other aspects of the management, the organization (structure) is the key element to investigate management aspects of a company (Kocel, 2007). Accordingly, studies on the shipping companies’ should be included in their organization as well.

A study covering 17 Turkish shipping companies showed that most of the departments are missing in their organization. The important findings are resumed in Table 1 (Demirel, 2015). The average number of the staff varies between 10 and 20 and some posts are twin mandate. There is not a department responsible for Procurement/Purchasing. Mostly one person is deployed as purchase staff and, procurement and purchase decision is made by upper level management led by technical management staff (Table 6).

Table 6: Existence of the Management Branch/Departments of the 17 companies

Commercial Department	YES	NO
Existence of Commercial Department	5	4
Chartering Capability	9	8
FFA Capability	2	15
Outsourced	8	9
Technical Management	YES	NO
Existence of Technical Management Department	15	2
Operations Branch	16	1
R/M Branch	14	3
New Ship Building	3	14
Crewing	15	2
Administration	YES	NO
Legal Branch	2	15
Finance Branch	2	15
Budgeting Branch	3	14
Accounting	17	0
Public Relations	3	12

In many companies procurement is conducted by deployment of technical staff as twin mandate such as procurement which seriously creates negative impact in procurement with may cause many problems in the operation of the ships and high costs. It is not an effective way of deployment for critical duties. If possible the unification of some departments is considered as more feasible to solve this problem.

The impacts of the each management factors on business functions are shown in the Figure 6 (Drewry, 2006). The Sales and Purchase(S/P) is an essential and interlinked function of the company to apply a strategic plan for surviving in volatile maritime business. Stopford (2008) states that “When an owner has finished with a ship, he sells it. Another shipping company buys it at a price at which it believes it can make a profit”.

Maclachlan (2004) assumes finance, including budgeting, arranging loans and mortgages, sale and purchase of new vessels as other shipping company functions. A department named S/P in coordination with Finance Department is required. Lorange (2009) states that it is becoming more and more important to have a purchase option that might to be executed at the end of a charter- assuming that owner is willing to grant them. The companies in growing trend needs to establish such departments soon. Actually S/P is a part of the procurement activities and requires additional competencies as well as main qualification needs for procurement staff such as contract management, feasibility analysis, legal issues etc.

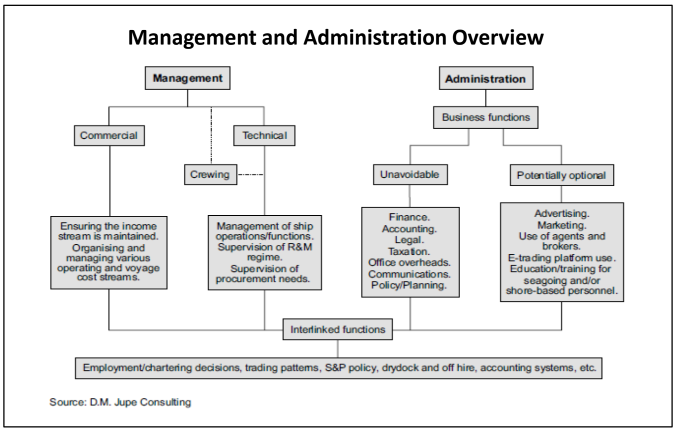

Figure 6: The impacts of the each management factors on business functions.

The lack of sufficient finance may hamper all purchasing activities. The success of the purchasing is closely related to the finance, budgeting and accounting. The close relationship should be established between these departments and Purchasing department for better planning and conducting acquisition activities.

As a nature of the maritime business, shipping companies operates worldwide. This situation also requires planning and conducting acquisition and procurement activities in the global scale. So, the procurement activities in the shipping sector should not be considered in the local supply chain but in the international supply network. Detailed information on global markets will play a critical role for decision making process.

CONCLUSION

The nature of the maritime business is a volatile and generally not a transparent. The success of a company is dependent upon correct decisions to provide smooth operation of the organization and also the "luck" factor. As a result of this study it is understood that income /profit of a shipping company is variable in the shipping business which generally operates in a "diseconomies of scale" system. That makes the companies to be very keen on the cost reduction.

It is evident that all institutions should adopt new business management techniques and practices to survive in a challenging economic system. As a result of this study it is understood that "procurement" plays a key role to reduce or optimize the cost for shipping companies. To achieve that (effective procurement job), companies should adopt the contemporary business and management practices taking into account the real requirements of today.

The followings are suggested for the companies to improve their procurement systems;

a. A strong procurement department manned with competent staff is required.

b. In many companies procurement is conducted by deployment of technical personnel as twin mandate which seriously creates negative impact in procurement with may cause many problems in the operation of the ships and high costs. This is not an effective way of deployment for such critical duties. The procurement department should be established and equipped with competent staff and tools.

c. The success of the procurement relies on the following factors;

- ✓ The accurate technical and financial information to fully meet the requirements,
- ✓ Close information exchange between procurement and respective technical staff including crew on board,
- ✓ Competent procurement staff qualified in contract management.

d. The Ship Sales and Purchase(S/P) is an essential function of the company to apply a strategic plan for surviving in volatile maritime business. A new department named S/P in coordination with finance department is required.

e. Finance, Budgeting and Accounting are closely related to Purchasing. The close relationship should be established between these departments and Purchasing for better planning and conducting acquisition activities.

f. As a nature of the maritime business, shipping companies operate worldwide. This situation also requires global acquisition and procurement activities. So, the procurement activities in the shipping sector should not be considered in the local supply chain but in the international supply network.

Finally, the success of procurement plays a critical role for survival of shipping business. All companies operating in this sector should carefully review and revise their procurement operations taking required actions in particular in the organization and staffing.

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A BRIEF STUDY ON TURKISH MARINE OFFICERS

Selçuk Nas[1], Remzi Fışkın[2], Erkan Çakır[3]

ABSTRACT

This study aims to find out the profile of merchant marine officers' manpower in Turkey. In all steps of the study, data has been classified into age, gender, marital status, certificate of competency, the school where they graduated, graduated year and experience in existing companies. The findings of the study demonstrated that the Istanbul Technical University, Maritime Faculty (36%) is currently the primary resource of the marine officer manpower in Turkey.

Keywords: Marine Officer, Gender, Ages, Turkey

INTRODUCTION

There is an ongoing shortage of seafarers, especially of officers, around the world according to the current study from the Baltic and International Maritime Council (BIMCO) and the International Shipping Federation (ISF) [1]. According to the influential BIMCO/ISF Manpower Update 2010 an anticipated shortage of some 7,917 maritime officers worldwide is forecasted by the year 2020 [2] and according to study of Japan International Transport Institute and The Nippon Foundation, there would be an additional 32,153 officers to meet the demand in 2020 [3]. In Turkey, a study entitled "Human resource planning in maritime industry: A study on Turkish seafarers" [4] reveals that according to benchmark scenario, 2812 oceangoing officers would be needed in 2020.Because of this shortage of officers, increasing attention needs to be given to the problems that hinder the effective recruitment and retention of seafarers in order to stabilize the flow of skilled labor to the global shipping industry [5].

This study aims to provide detailed profile of maritime officers who work at Turkish ship management companies. The study also provides comparable information for officers who work in tanker ships, container ships, bulk carriers and etc. For this purpose, the data was gathered from institutional Turkish ship management companies and it contains age, gender in the current company of officers.

MOTIVATION

Necessity of revealing the current profile of Turkish seafarers who are on the 6th rank within the global seafarer labor market according to SIRC report [6] constitutes the motivation of this study. In addition, having done this type of study by some other countries has brought up the need for such a

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study. In other respects, it is thought that research findings and results to be obtained from the study would be especially useful in terms of making comparisons with officers from other nations such as Filipino.

MATERIAL AND METHODS

The chapter shares information about aim, scope and limitations of the study. Besides, it also informs material and methods techniques used during the research process.

Aim of the Study

Demographics and profile studies are used by governments, corporations and non-government organizations to learn more about a population's characteristics for many purposes, including policy development and economic market research. In this sense, the aim of the study is to put forward to profile of merchant marine officers who work at Turkish ship management companies and also to provide information for being able to make comparison in officers who work in different types of merchant vessel.

Scope and Limitation

Rating seafarers are excluded from scope of the study and also the largest volume within companies operating in Turkey were tried to be included in the sample in order to represent the universe.

Method

A detailed literature review was carried out before composing question form. Profiles studies both related to seafarers and not related to seafarers were scanned and variables were determined by means of this detailed literature review. The question form consists of two sections. First section contains profile information of interviewee such as age, gender, education level and position in the company and profile information of ship management companies such as fleet size, crew size, vessel type and flag register. Second section contains questions related to demographic information which refers to baseline information of merchant marine officers such as age, gender, marital status. And also, section two contains questions about experience, rank, department and educational institution of marine officers.

The 31 Turkish ship management companies were contacted via phone and e-mail throughout 2015. A total of 3894 profile data about merchant officers obtained from these companies and the data were analyzed by using SPSS 20.0 (Statistical Package for the Social Sciences) Programme.

FINDINGS

The age profile of seafaring force reflects not only the supply of seafarers and the rate of renewal of seafaring force, but also provides estimation for seafaring experience. The average age of the officers in the sample is 32.58 (see figure1).

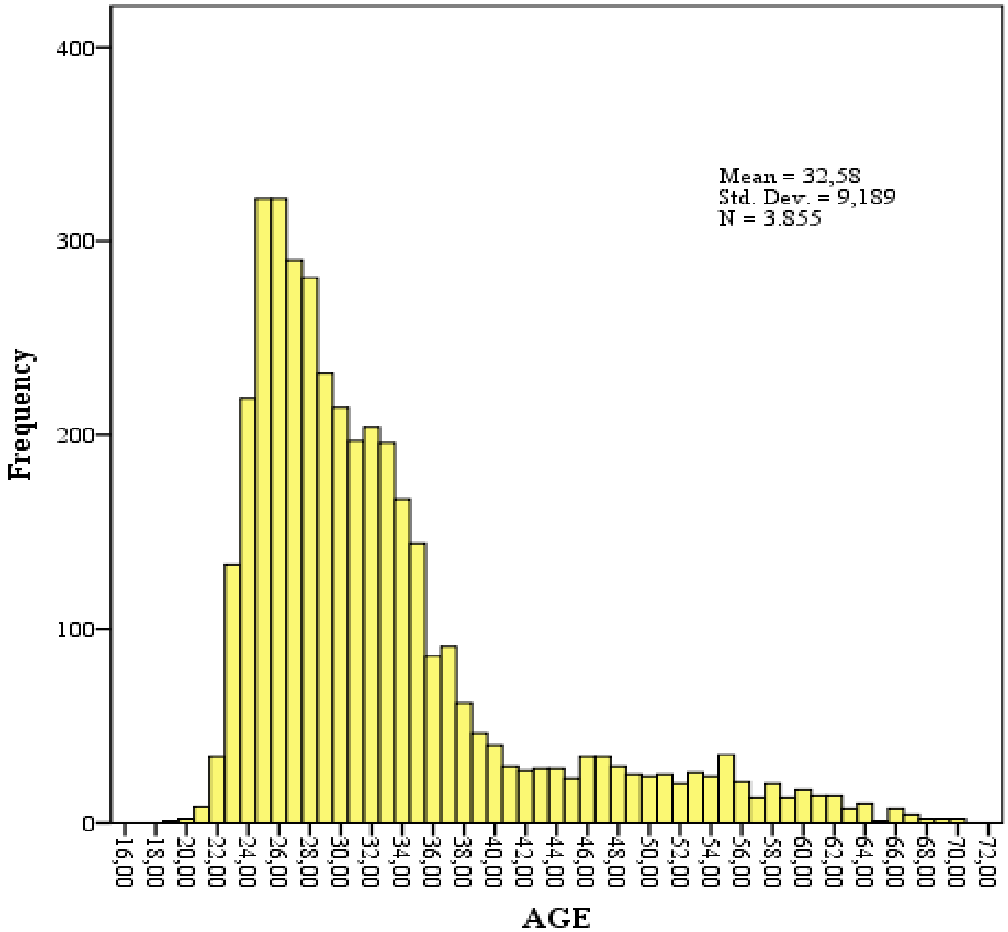

Figure 1. Age Distribution of the Turkish Merchant Marine Officers

In the study, the education level defined as in the report of International Standard Classification of Education by UNESCO (2011) [7]. According to the report, level 6 equals to bachelor's or equivalent level. Programs at this level are traditionally offered by universities and equivalent educational institutions. Level 5 equals to short-cycle tertiary education. The academic tertiary education programs below the level of a Bachelor's program are classified as level 5. Level 4 equals to Post-secondary non-tertiary education. The level provides learning experiences building on secondary education. Level 3 equals to upper secondary education. The level is typically designed to complete secondary education in preparation for tertiary education.

The majority of Turkish officers (62,6%) is also found to have level 6 education level. Across the sample there is a distribution of seafarers by rank as follows: 57.8% of the sample occupy senior officer positions; 42.2% are junior officers and there is not an immense difference between two groups. And 52,5% of seafarers is classified as working in the deck department, 37,3% is working in the engine department. In the sample, 61% of the officers preferred to work at medium size companies, 30,2% of the seafarers preferred big size companies and small size companies were preferred by only 8,8% of the officers. However, when analyzing preferred ship type; 35,8% of the officers preferred bulk carriers, 21,1% preferred chemical tankers and 17,5% choose to work at crude/oil tankers. The other main profile information about merchant marine officers are shared in detail in Table 1.

Table 1. General Profile of Turkish Merchant Marine Officers

General Profile

Age	(f)	%
19-30	2058	52,9
31-40	1233	31,7
41-60	495	12,7
61-…	69	1,8
Miss. Value	39	1,0
Total	**3894**	**100,0**

Gender	(f)	%
Male	3741	96,1
Female	91	2,3
Miss. Value	62	1,6
Total	**3894**	**100,0**

Sea Experience (Year)	(f)	%
00-03	610	15,7
04-06	744	19,1
07-09	470	12,1
10-12	385	9,9
13-15	303	7,8
16-18	151	3,9
19-21	40	1,0
22-24	55	1,4
25-27	60	1,5
28-30	86	2,2
30-…	211	5,4
Miss. Value	779	20,0
Total	**3894**	**100,0**

Competency	Age ($\bar{x}$)	(f)	%
U. Cpt	39,3	596	15,3
U. 1st Off	30,7	494	12,7
U. W. Off	26,6	891	22,9
U. C. Eng	43,7	508	13,0
U. 2nd Eng	32,2	329	8,4
U. W. Eng	27,6	498	12,8
Cpt	40,7	9	0,2
1st Off	32,0	5	0,1
W. Off	27,2	48	1,2
C. Eng	44,4	59	1,5
2nd Eng	37,1	22	0,6
W. Eng	30,3	37	1,0
Miss. Value		398	10,2
Total		**3894**	**100**

U: Unlimited;

The findings of the study demonstrated that the Istanbul Technical University, Maritime Faculty (N: 1397, P: 36%) is currently the primary resource of the maritime officer manpower in Turkey. Turkish Maritime Education Foundation (TUDEV) (N: 502, P: 13%) and DokuzEylül University (N: 352, P: 9%) are also the other major contributors to maritime officer manpower in Turkey. These three educational institutions nearly comprised of 60% of the sample in terms of the officers' graduation school. That's why these three educational institutions comprised of big proportion of the officers for the sample is that these institutions are old established educational institutions when compare with the rest of the educational institutions which included in this study. The contributions provided by the other institutions apart from these three institutions are shown in Figure 2.

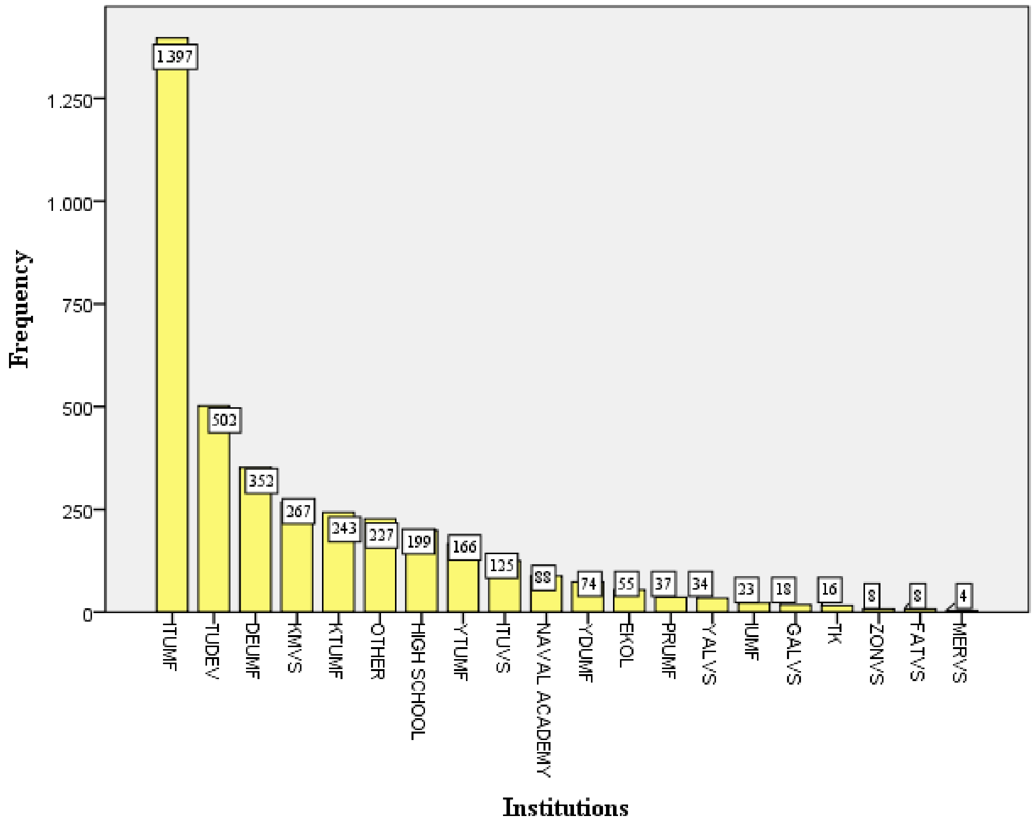

Figure 2. Institutional Contribution to Maritime Officer Manpower in Turkey

When compare education level of deck and engine officers: 66% of the deck officers had level 6 degree of marine transport, 11% had level 5 degree and 17,6% had right to be an officer through level 4, while 57% of engine officers had level 6 degree of marine engineering, 15,8% had level 5 degree and 9,7% had completed level 4 (see Table 2).According to chi-square test results, it is revealed that the deck officers have level 6 degree more than expected count (Count: 1350, Exp. Count.: 1276), on the other hand, the engine officers have level 6 degree lower than expected count (Count: 829, Exp. Count.:903).

Table 2. Comparison of Education Level of Deck and Engine Officers

		Education Level						
		Level 6	**Level 5**	**Level 4**	**Level 3**	**Other**		**Total**
Department	Deck	1350	224	360	58	42		**2034**
	Engine	829	228	140	117	125	Miss Value	**1439**
Total		**2179**	**452**	**500**	**175**	**167**	**421**	**3894**

When making comparison between the officers’ marital status and ship type, 35,3 % of the officers are married and 64,7 % of them are single who served on bulk carriers. These percentages slightly differ for the officers who served on crude/oil tankers; 22,4 percent of the officers are married; 77,6 percent is single. However, marital status of the officers who served on chemical tankers, container vessels, Ro-Ro vessels and LNG-LPG carriers is identical (see Table 3). According to chi-square test results, it is revealed that the officers who are married prefer chemical and container ship type

(Count: 389:291, Exp. Count.: 310:241; respectively); the officers who are single prefer bulk and crude/oil ship type for working (Count: 865:523, Exp. Count.:826:416, respectively).

Table 3. Comparison of the Officers' Marital Status as to Ship Type

Types of Ship	**Marital Status**							
	Married		**Single**				**Total**	
	(f)	**%**	**(f)**	**%**			**(f)**	**%**
Bulk	472	35,3	865	64,7			**1337**	100,0
Crude/oil	151	22,4	523	77,6			**674**	100,0
Chemical	389	47,8	425	52,2			**814**	100,0
Container	291	46,0	341	54,0			**632**	100,0
Ro-Ro	44	40,0	66	60,0			**110**	100,0
LNG/LPG	18	46,2	21	53,8	**Miss Value**		**39**	100,0
					(f)	**%**	**288**	
Total	**1365**	**35,0**	**2241**	**57,6**	**288**	**7,40**	**3894**	**100,0**

CONCLUSION AND DISCUSSION

The study aims to disclose the marine merchant officers' manpower profile in Turkey. The ratings are not included in the scope of the study. The sample data has been classified into age, gender, marital status, certificate of competency, the school where they graduated, graduated year, experience in existing companies and more that shared in a detailed manner in the study.

The majority of the Turkish officers (62,6%) has finished Marine Transport and Marine Engineering Level 6 degree in the sample. The officers who graduated from level 5 were 12,2% and 13,6% of the officers were qualified to be an officer by level 4. When compare education profile of the Turkish officers with Filipino officers, there found a difference. 61% of senior officers and 65% of junior officers had level 6 degree of Marine Transport or Marine Engineering in Turkey, whereas 61% of the senior officers and 33% of the junior officers had been through a level 5 degree (associate in nautical/marine engineering) in Philippine [8].

When compare the average age of officers with other countries, there is a significant difference. ISF/BIMCO (2010) [2] report in which information on age profile was found in national statistics for only five countries (Bulgaria, Lithuania, Norway, UK and Greece) shows more than 25% of officers are over 50 years old and also the total older than 40 years old is more than 50%. In the sample of our study more than 84% of officers are under 40 years old. Besides, it is noteworthy that there are more seafarers in the 19-30 category than there are in the 31-40 category. As seen from age profile of seafarers, Turkey has considerably younger seafaring workforce which causes questions related to experience and seafarer turnover.

Within the dataset 96,1% of seafarers is male and 2,3% of seafarers is female. The percentage of female seafarers is slightly higher than European Countries. According to study on EU Seafarers Employment Final Report, in which only six countries (Bulgaria, Germany, Lithuania, Norway, Sweden, UK) provide detailed information in national statistics on women employment reveals that 1,07% of deck officers and 0,3% of engine officers is constituted by female seafarers [9].A comprehensive study on women employment in the maritime industry held by ILO survey carried on by the Seafarers International Researcher Centre, Cardiff UK in 2003 (Women seafarers: Global employment policies and practices).From this study, women in Scandinavian countries constitute more than 10% of the seafaring workforce, 8,3% in UK, 4,2% in Germany [10]. There is a significant gap between ILO survey and the sample in terms of women seafarers. The main reason of this gap is that women seafarers were concentrated in hotel personnel on passenger ships in Scandinavian countries, UK and Germany, whereas women seafarers in Turkey are mostly employed cargo vessels (i.e., container ships, bulk carriers, etc.).

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HUMAN RESOURCE MANAGEMENT IN MARITIME TRANSPORTATION: A LITERATURE REVIEW

Burak KUNDAKÇI[1], Can ATACAN, Emrah BULAT, Ahmed GURE, Bülent GÜREL, Ahmet ÇANKAL, Sercan DAĞ, Yusuf ZORBA

ABSTRACT

The previous accidents shows that human factor is highly important and not only the role of the human factor in maritime accidents but also with regard to the business management, human resources must be manage properly. Human resource management and its practices like personal planning, recruitment, selection, release from the job, performance management, learning and development, reward, etc. have a crucial importance in the maritime transportation because of its commercial importance and prevalence in the transportation sector. The aim of this research is to analyze academic studies about maritime transportation for revealing the core areas of human resource management. In this study, more than 50 subscribed databases of the Dokuz Eylül University like APS, Emerald, JSTOR, ProQuest, ScienceDirect were reviewed and articles were analyzed. Some of the key findings were personal recruitment from different sources, importance of the human resource in organization, quality standards and improvement of the personal; nevertheless, there were still some gaps to examine about the core areas of human resources management related with the maritime transportation.

Keywords: HRM, Maritime, Strategic Management, Transportation

INTRODUCTION

Human resource management is very important subject and there are too many studies about human resources management in different areas. When it comes to maritime there were not that much study about human resource management. The aim of this study is to analyze the present situation of the literature related with human resources in maritime and find the core areas of the human resource management in those articles. After that the gaps in the literature will be seen in this study. Subscribed databases of the Dokuz Eylül University (DEU) Library used for this research. Some keywords was used to find the articles related with human resources in maritime.

METHODOLOGY

The core areas of the human resources were Job design, Human Resource Planning, Recruitment, Selection, Release from the Organization, Performance Management, Learning and Development, Reward, Job Evaluation, Grade and Pay, Employee Relations, Health and Safety. These words were used with “maritime” and “shipping” to find the studies related with human resources in maritime. There are 56 subscribed databases of the DEU online library and 923 articles were found from those subscribes databases after using the human resource core areas and “maritime”, “shipping” words. It was seen that some studies were not related with human resource in maritime, some studies were

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related with different subject of maritime, some studies were not scientific article and full text of the some articles were not found. After the analyses it was found out that 76 studies were about human resource management in maritime.

ARTICLE ANALYSES

All 76 studies which were related with human resource management in maritime were examined and some findings were given below.

According to the Figure 1, it was seen that most of study about human resources in maritime were published in the last 15 years and the most (8 article) study were published in 2014 about this subject.

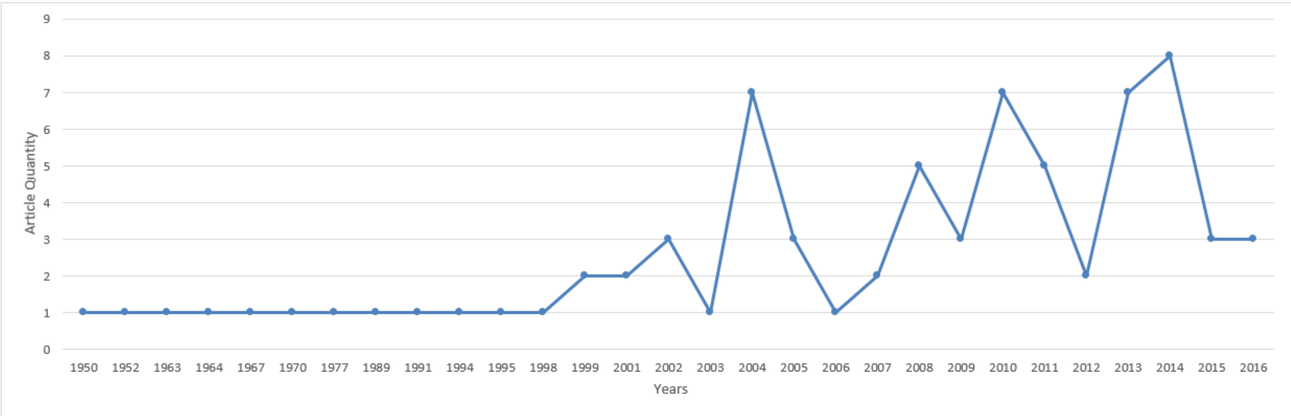

Figure 1: Distribution of the Studies according to the Year of Publication

Distribution of the studies according to the number of authors were given in Table 1. According to the table it can be seen that more than 85% of all studies were published by three or less authors.

Table 1: Distribution of the Studies according to the Number of Authors

Number of Authors	Number of Studies	%
1	33	43,42
2	21	27,63
3	12	15,79
4	7	9,21
5	2	2,63
6	1	1,32

135 authors from 80 universities, institution or companies were published those 76 studies. The most frequent authors were given in Table 2. As we seen from this table, Clifford Donn and Richard Morris were published the most study about human resource in maritime.

Table 2: The Most Frequent Authors

University	Author	Number of Studies
Le Moyne College	Clifford B. Donn	5
University Of Western Sydney	Richard Morris	5
University Of Western Sydney	Thomas Klikauer	4

In Table 3, it was seen that most of the studies were published from Cardiff University and the following were University of Western Sydney and Le Moyne College.

Table 3: The Most Frequent Universities

University	Number of Studies
Cardiff University	7
University Of Western Sydney	6
Le Moyne College	5
Constanta Maritime University	4
The Hong Kong Polytechnic University	3

Table 4 shows that 76 studies were prepared from 24 different countries. 54,45% of the all studies were prepared by the authors from United States of America, United Kingdom and Australia. These were the countries of university, institution or company not date of birth of the authors. Those numbers are different from total number of studies because some studies were published from authors in different universities.

Table 4: The Most Frequent Countries

Countries	Number of Studies	%
United States Of America	23	25,56
United Kingdom	16	17,78
Australia	10	11,11
Germany	4	4,44
Romania	4	4,44
(Unknown)	4	4,44
Greece	3	3,33
Turkey	3	3,33
Sweden	3	3,33
China	2	2,22
Hong Kong	2	2,22
Norway	2	2,22
Singapore	2	2,22
Switzerland	2	2,22
Bulgaria	1	1,11
Canada	1	1,11
Croatia	1	1,11
Denmark	1	1,11
Finland	1	1,11
Italy	1	1,11
Japan	1	1,11
Kazahstan	1	1,11
Latvia	1	1,11
Vietnam	1	1,11

Table 5 shows that the distribution of the studies according to the journals which were published in. Studies related with human resource management in maritime were published in 51 different journals and the most popular journal about human resource in maritime is “Maritime Policy & Management: The Flagship Journal of International Shipping and Port Research” with 12 studies.

Table 5: Distribution of the Studies according to the Journals

Journals	Number of Studies
Maritime Policy & Management The Flagship Journal of International Shipping and Port Research	12
Constanta Maritime University Annals	3
Employee Relations	3
Industrial & Labor Relations Review	3
Journal for Maritime Research	3

Table 6 show that the distribution of the studies according to the human resource management core areas. As we can see from the table, 20 studies were related with "Recruitment", 19 studies were related with "Learning and Development" and also 19 studies were about human resource management in maritime but not with a specific core area and it was found that there were no study about "Release from the Organization" in maritime. Total numbers are different from numbers of studies because some articles were related with more than one core areas of human resource management.

Table 6: Distribution of the Studies according to the Human Resource Core Areas

Human Resource Core Areas	Number Of Studies
Recruitment	20
Learning and Development	19
Related with Human Resource in Maritime	19
Employee Relations	15
Selection	9
Grade and Pay	8
Performance Management	4
Human Resource Planning	3
Health and Safety	2
Job Evaluation	2
Reward	2
Job Design	1
Release from the Organization	0

CONCLUSION

As we can see from the tables above, the studies were mostly about "Recruitment" and "learning and Development" and no study was found about release from the organization and few studies were found about "Performance Management", "Human Resource Planning", "Health and Safety", "Job Evaluation", "Reward", "Job Design". Authors may focus on these subject about human resource management in maritime.

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APPENDIX 1

Details of Articles

	Title of the Study	Authors	University, Institution or Company	Journal	Publication Date	Core Areas of Human Resource Management
1	A forgotten history: The impacts of globalization on Norwegian seafarers' shipboard organizational lives.	Mack, K. S.	Mercer University	Journal of Management History	2010	Learning and Development ; Work Performance
2	A great improvement in the sailor's feeling towards the naval service': Recruiting seamen for the royal navy, 1815–1853	Walton, O.	University of Duisburg-Essen	Journal for Maritime Research	2011	Recruitment ; Selection
3	'Asiatic' sailors and the East India Company: racialisation and labour practices, 1803–15	Man-Cheong, L.	Stony Brook University & State University of New York	Journal for Maritime Research	2014	Learning and Development ; Employee Relations
4	Chinese and Filipino Seafarers: A Race to the Top or the Bottom?	Zhao, M. ; Amante, M.S.V	Cambridge University	Journals of Cambridge, Modern Asian Studies	2005	Recruitment ; Grade and Pay
5	Current Challenges in the Recruitment and Retention of Seafarers: An Industry Perspective from Vietnam	Nguyen, T.T. ; Ghaderi, H. ; Caesar, L.D. ; Cahoon, S.	Oxylane Group HCMC & Australian Maritime College	The Asian Journal of Shipping and Logistics	2014	Recruitment ; Selection
6	Determinants of Indian sub-continent officer–seafarer retention in the shipping industry	de Silva R. ; Stanton, P. ; Stanton, J.	University of Newcastle ; University of Western Sydney	Maritime Policy & Management, The flagship journal of international shipping and port research	2011	Employee Relations
7	Finding Lascar 'Wilful Incendiarism': British Ship-Burning Panic and Indian Maritime Labour in the Indian Ocean	Fisher, M.H.	Oberlin College	South Asia: Journal of South Asian Studies	2012	Recruitment,
8	'Get yourself a proper job girlie!': recruitment, retention and women seafarers	Thomas, M.	Cardiff University	Maritime Policy & Management The flagship journal of international shipping and port research	2004	Recruitment ; Selection
9	Human resources in the German maritime industries: 'back-sourcing' and ship management	Klikauer, T. ; Morris, R.	Western Sydney University	Int. J. of Human Resource Management	2003	Performance Management ; Employee Relations
10	Indian ghat sarangs as maritime labour recruiting intermediaries during the age of sail	Fisher, M.H.	Oberlin College	Journal for Maritime Research	2014	Recruitment
11	Kiribati seafarers and German container shipping	Klikauer, T. ; Morris, R.	University of Western Sydney	Maritime Policy & Management The flagship journal of international shipping and port research	2002	Learning and Development ; Recruitment ; Selection ; Employee Relations
12	Labour Flexibilization at Sea, 'MINI U[NITED] N[ATIONS]' CREW ON CRUISE SHIPS.	Chin, C.B.N.	American University	International Feminist Journal of Politics	2008	Recruitment ; Selection
13	Participation in the global labour market: experience and responses of chinese seafarers	Wu, B.	Cardiff University	Maritime Policy & Management The flagship journal of international shipping and port research	2004	Learning and Development ; Reward
14	Recruitment of Seamen in Asia	Argiroffo, E.	International Labour Office	International Labour Review	1967	Recruitment ; Selection

15	Revisiting the seafarer shortage problem: the case of Singapore	Thai, V.V. ; Balasubramanyam, L. ; Yeoh, K.K.L. ; Norsofiana, S.	Nanyang Technological University	Maritime Policy & Management The flagship journal of international shipping and port research	2013	Human Resource Planning ; Employee Relations
16	Sea-going labour and Greek owned fleet: a major aspect of fleet competitiveness	Evangelos, S. ; Joanna, T.	University of Piraeus	Maritime Policy & Management The flagship journal of international shipping and port research	2001	Recruitment ; Learning and Development
17	Strategic Human Resources Management in the Maritime Knowledge Based Organization	Blagovest, B. ; Hanzu-Pazara, R. ; Nistor, C.	"Nikola Vaptsarov" Naval Academy ; Constanta Maritime University	Revista Academiei Fortelor Terestre	2010	Learning and Development
18	Structuring fuzzy integrated multi-stages evaluation model on academic personnel recruitment in MET institutions	Çelik, M. ; Kandakoğlu, A. ; Er, I.D.	Istanbul Technical University	Expert Systems with Applications International Journal	2009	Selection ; Recruitment ; Learning and Development
19	'The want of sufficient men': Labour recruitment and training in the British North Sea fisheries, 1850–1950	Wilcox, M.	University of Hull	The International Journal of Maritime History	2015	Recruitment ; Learning and Development
20	Transformations and continuities of issues related to Chinese participation in the global seafarers' labour market	Tang, L. ; Llangco, M.O.S. ; Zhao, Z.	Cardiff University ; Dalian Maritime University	Maritime Policy & Management The flagship journal of international shipping and port research	2016	Learning and Development ; Employee Relations
21	Youngsters' motivations and difficulties for choosing seafarer Career. The case of latvia	Gonzalez, M.J.F. ; Semjonovs, D. ; Bogdanecs, A. ; Ozola, S.	Novikontas Maritime College – Novikontas Research	European Integration Studies	2014	Reward ; Employee Relations
22	A study of the relationships between quality management practices and organizational performance in the shipping industry	Cheng, T.C.E. ; Choy, P.W.C	The Hong Kong Polytechnic University	Maritime Economics&Logistics	2013	Related with Human Resource in Maritime
23	Ship Management Attitudes and Their Relation to Behavior and Performance.	Röttger, S. ; Vetter, S. ; Kowalski, J.T.	German Naval Medical Institute ; German Military Hospital	Human Factor	2013	Related with Human Resource in Maritime
24	Development of quantitative team performance evaluation method for ERM.	Wu, Y. ; Miwa, T. ; Shimamoto, K. ; Uchida, M.	Kobe University	WMU Journal of Maritime Affairs	2015	Learning and Development
25	Effects of cold environments on human reliability assessment in offshore oil and gas facilities	Noroozi, A ; Abbassi, R. ; MacKinnon, S. ; Khan, F. ; Khakzad, N.	Memorial University of Newfoundland ; Princeton University	Human Factor	2014	Related with Human Resource in Maritime
26	Performance-based ship management contracts using the Shipping KPI standard	Rialland, A. ; Nesheim, D.A. ; Norbeck, J.A. ; Rødseth, Ø,J.	Norsk Marinteknisk Forskningsinstitutt AS (MARINTEK)	WMU Journal of Maritime Affairs	2014	Performance Management
27	Multi-Iteration Usability Testing of the U.S. Navy's Performance Management System	Dean, E. ; Aspinwall, K.R. ; Schwerin, M.J. ; Kendrick, D.E. ; Bourne, M.J.	RTI International ; Navy Human Performance Center	Military Psychology	2009	Performance Management (Performance Appraisal)

28	The call of the sea: The marine knowledge industry in the UK	Smith, H.D. ; Lalwani, C.S.	Cardiff University	Marine Policy	1999	Learning and Development
29	The motivations and added values of embarking on postgraduate professional education: Evidences from the maritime industry	Ng, A.K.Y. ; Koo, A.C. ; Ho, W.C.J.	The Hong Kong Polytechnic University ; Eastport Shipping Pte Ltd.	Transport Policy	2009	Learning and Development
30	Weak knowledge for strengthening competences: A practice-based approach in assessment management	Ripamonti, S. ; Scaratti, G.	Catholic University of Milan	Management Learning	2012	Related with Human Resource in Maritime
31	Computer-based assessment in safety-critical industries: the case of shipping.	Gekara, V.O. ; Bloor, M. ; Sampson, H.	RMIT university ; Cardiff University	Journal of Vocational Education&Training	2011	Related with Human Resource in Maritime
32	National Regulation of International Industry: Industrial Relations in the Maritime Industry	Donn, C.B.	Le Moyne College	International Journal of Employment Studies	1994	Recruitment ; Selection ; Grade and Pay
33	Can sectionalism be good for solidarity? Some evidence from the maritime construction industry on Tyneside.	McBride, J.	Bradford University	Economic and Industrial Democracy	2011	Related with Human Resources in Maritime
34	Reforms of work practices and IR procedures in the maritime industry: an Australia-USA comparison	Donn, C.B. ; Morris, R. ; Phelan, G.	Le Moyne College ; University of Sydney ; Macquarie University	Industrial Relations Journal	1991	Recruitment
35	Partnership and process in the maritime construction industry	McBride, J. ; Stirling, J.	University of Northumbria	Employee Relations	2002	Employee Relations
36	Internationalising industrial disputes: The case of the Maritime Union of Australia	Smith, C.	University of Strathclyde	Employee Relations	2010	Related with Human Resources in Maritime
37	Communication's Management in Crisis and Conflict Situations. Application of Communication's Skills in Maritime Industry	Zhuldz, I. ; Onaichan, K. ; Surugiu, F. ; Mina, S.	Caspian State University of Technologies and Engineering ; Maritime University of Constanta	Constanta Maritime University Annals	2013	Employee Relations
38	Concessison Bargaining in the Ocean-Going Maritime Industry	Donn, C.B.	Le Moyne College	Industrial & Labor Relations Review	1989	Recruitment ; Grade and Pay
39	Ownership structure and operating performance: evidence from the European maritime industry	Lambertides, N. ; Louca, C.	Aston Business School ; Durham Business School	Maritime Policy & Management	2008	Related with Human Resources in Maritime
40	The Unlicensed Seafaring Unions	Taft, P.	Brown University	Industrial & Labor Relations Review	1950	Related with Human Resources in Maritime
41	Industrial Unrest in the Nation's Maritime Industry	Shils, E.B.	University of Pennsylvania	Labor Law Journal	1964	Related with Human Resources in Maritime
42	Labor and the Geographic Reorganization of Container Shipping in the U.S.	Jaffee, D.	University of North Florida	Growth & Change	2010	Related with Human Resources in Maritime
43	Union Networks and Global Unionism in Maritime Shipping	Lillie, N.	University of Helsinki	Relations Industrielles / Industrial Relations	2005	Related with Human Resources in Maritime
44	The Maritime Industry	Goldberg, J.P.	UNKNOWN	Labor Law Journal	1970	Related with Human Resources in Maritime
45	Industrial Relations in the British Shipping Industry	Powell, L.H.	Chamber of Shipping of the United Kingdom	International Labour Review	1952	Related with Human Resources in Maritime
46	The Pacific Coast Maritime Strike of 1936: Another View	Saffor, J.J.	Montana State University	Pacific Historical Review	2008	Related with Human Resources in Maritime
47	The Impact of Atlantic-Gulf Unionism on the Relative Earnings of Unlicensed Merchant Seamen	Rapping, L.A.	Carnegie Mellon University	Industrial & Labor Relations Review	1963	Grade and Pay
48	Ethical Issues in the Wharf Strik in Australia	Clatworthy, A.	UNKNOWN	Business Ethics: A European Review	1998	Related with Human Resources in Maritime

49	Ain’t No Money in the Cure: Arbitration Trumps Solicitude When Enforcing Postinjury Arbitration of Seamen’s Personal Injury Claims	Maruca, M.K.	Tulane University	Tulane Maritime Law Journal	2008	Related with Human Resources in Maritime
50	Globalisation and Norwegian shipping policy, 1850–2000	Brautaset, C. ; Tenold, S.	University of Bergen	Business History	2008	Related with Human Resources in Maritime
51	Global Collective Bargaining on Flag of Convenience Shipping	Lillie, N.	Cornell University	British Journal of Industrial Relations	2004	Grade and Pay
52	Making Coolies, (Un)making Workers: “Globalizing” Labour in the Late-19th and Early-20th Centuries	Balachandran , G.	Graduate Institute of International and Development Studies	Journal of Historical Sociology	2011	Recruitment ; Grade and Pay
53	Maritime health care	Putnam, J.	Maridocs, Des Moines	British Journal of Sports Medicine	2005	Health and Safety
54	Bonuses and the Bureau System: Incentive Schemes and the Management of Waterfront Labour in New Zealand, 1951-1968	Reveley, J.	University of Wollongong	International Journal of Maritime History	1999	Employee Relations
55	Working the Docks: Labor, Management and the New Waterfront	Greenwald, R.A.	U.S. Merchant Marine Academy	Review of Business.	2004	Employee Relations
56	Varieties of Industrial Relations in the Shipping Industry: A Comparison of two Anglo-Saxon Liberal Market Economies and two European Coordinated Market Economies	Klikauer, T. ; Donn, C.B.	University of Western Sydney ; Le Moyne College	New Zealand Journal of Employment Relations.	2004	Grade and Pay
57	Global Competition and Shipping Industrial Relations: Australia and the US Compared	Donn, C.B. ; Morris, R.	Le Moyne College ; University of Western Sydney	Journal of Industrial Relations.	2001	Grade and Pay
58	Into murky waters: Globalisation and deregulation in Germany's shipping employee relations	Klikauer, T. ; Morris, R.	University of Western Sydney	Employee Relations	2002	Employee Relations
59	Middle managers' role in safeguarding OHS: The case of the shipping industry	Bhattacharya, S. ; Tang, L.	Plymouth University ; Cardiff University	Safety Science.	2013	Employee Relations
60	Exploring predictors of organizational identification: Moderating role of trust on the associations between empowerment, organizational support, and identification	Erturk, A.	Düzce University	European Journal of Work & Organizational Psychology.	2010	Employee relations
61	International Enforcement Of Union Standards In Ocean Transport	Rowan, R.L.; Northrup, H.R. ; Immediata, M.J.	University of Pennsylvania ; Industrial Research Unit	British Journal of Industrial Relations.	1977	Employee Relations
62	Realistic recruitment An empirical study of the cruise industry.	Raub, S. ; Streit, E.M.	Ecole Hoteliere De Lausanne ; Inn of the Anasazi	International Journal of Contemporary Hospitality Management	2006	Recruitment
63	The future shortage of seafarers: will it become a reality?	Leggate, H.	London Metropolitan University	Maritime Policy & Management	2004	Recruitment
64	Get yourself a proper job girlie!': recruitment, retention and women seafarers	Thomas, M.	Cardiff University	Maritime Policy & Management	2004	Recruitment
65	Working unusual hours and its relationship to job satisfaction: a study of European maritime pilots	Andresen, M. ; Domsch, M.E. ; Cascorbi, A.H.	Helmut Schmidt-University ; FH Nordakademie	Journal of Labor Research. Fall	2007	Related with Human Resource in Maritime

66	Computer Management Systems in Maritime Organization	Stefan, G. ; Valentina, M.	Constanta Maritime University ; Andrei Saguna University	Constanta Maritime University Annals Year	2013	Job Evaluation ; Human Resource Planning
67	Implementation of a Human Resource Management Course at a Shipping Company	Alina-Lucia, B. ; Aurel, B.	Constanta Maritime University ; CMA Ships	Constanta Maritime University Annals	2014	Learning and Development
68	Assessing financial impact of maritime ergonomics on company level: a case study	Österman, C. ; Rose, L.	Linnaeus University ; KTH The Royal Institute of Technology	Maritime Policy & Management The flagship journal of international shipping and port research	2014	Performance Management
69	Gemi İşletmeciliğinde Etkinlik ve Performans Göstergeleri: Gemi Sahibi İşletmede Bir Uygulama	Palamut, M. ; Çaylan Özer, D.	Dokuz Eylül University	Verimlilik Magazine	2016	Job Evaluation
70	Increased Awareness for Maritime Human Factors through e-learning in Crew-centered Design	Praetorius, G. ; Kataria, A. ; Petersen, E.S. ; Schröder-Hinrichs, J.U. ; Baldauf, M. ; Kähler, N.	World Maritime University ; Lyngsø Marine, Lyngsø Alle ;DNV GV SE	Procedia Manufacturing	2015	Learning and Develeopment
71	Professionalization of the Shipping Industry via Postgraduate Education	Ng, A.K.Y. ; Koo, A.C. ; Pallis, A.A.	The Hong Kong Polytechnic University ; University of Aegean	Ocean & Coastal Management	2010	Learning and Develeopment,
72	The Issues of Consciousness and Conscience in the High Tech Maritime World	Russo, A. ; Urlić, I. ; Popović, T. ; Dvornik, J.	University of Split ; NGO Healthy City Split	Nase More-International Journal of Maritime Science & Technology	2013	Learning and Develeopment ; Health and Safety
73	Involving Users in a Ship Bridge Re-Design Process Using Scenarios and Mock-Up Models	Österman, C. ; Berlin, C. ; Bligård, L.O.	Linnaeus University ; Chalmers University of Technology	International Journal of Industrial Ergonomics	2016	Learning and Development
74	Leadership Development Training as Method to Increase SeafarerCompetitivenes	Surugiu, F. ; Dragomir, C.,	UNKNOWN	Annals of DAAAM & Proceedings	2010	Learning and Development
75	Cultural Diversity, Manning Strategies and Management Practices in Greek Shipping	Theotokas, I. ; Progoluaki, M.	University of the Aegean	Maritime Policy & Management The flagship journal of international shipping and port research	2007	Recruitment ; Selection ; Human Resource Planning
76	Crew Resource Management for Teams in the Off Shore Oil Industry	Flin, R.H.	The Robert Gordon University	Journal of European Industrial Training	1995	Job Design ; Learning and Development

APPENDIX 2

Subscribed Databases of the Dokuz Eylul University Library

1	**ACM (ASSOCIATION FOR COMPUTING MACHINERY)**	29	**KARGER**
2	ACS (American Chemical Society)	**30**	Kazancı
3	AIP (American Institute of Physics)	**31**	Mary Ann Liebert
4	Annual Reviews	**32**	MathSciNet
5	APS (American Physical Society)	**33**	Micromedex
6	ASCE (American Society of Civil Engineers)	**34**	OCLC (Online Computer Library Center)
7	ASTM Standards (American Society for Testing Materials)	**35**	OECD (Organisation for Economic Cooperation and Development)
8	Beck Online	**36**	OVID
9	BMJ (British Medical Journal)	**37**	Oxford Grove Music Online (GMO)
10	Britannica Online	**38**	Oxford University Journal
11	Cambridge Journals Online	**39**	Project Muse
12	ClinicalKey	**40**	ProQuest Central
13	Cochrane	**41**	ProQuest Elektronik Tezleri- ProQuest Dissertations & Theses Global
14	EBSCOHost	**42**	RSC (Royal Society of Chemistry)
15	Emerald Management Plus	**43**	SAGE Journals
16	GeoRef	**44**	Science Online
17	GSW (GeoScienceWorld)	**45**	ScienceDirect
18	Heinonline	**46**	Scopus-Atıf Veri Tabanı
19	HukukTürk	**47**	Springer Link
20	ICE (Institution of Civil Engineers)	**48**	Swisslex
21	IEEE Xplore Digital Library (Institute of Electrical and Electronics Engineers)	**49**	Taylor & Francis Online
22	Informa Healthcare	**50**	Turnitin-TEZ İntihal Analiz Programı
23	IOP (Institute of Physics)	**51**	Türkiye Atıf Dizini
24	İdealonline Süreli Yayın Elektronik Veritabanı	**52**	Ulrich's Periodicals Directory
25	İktisat İşletme ve Finans Dergisi	**53**	UpToDate Anywhere
26	iThenticate-Makale, bildiri vb. yayınlar için intihal analiz programı	**54**	Web of Science-Atıf Veri Tabanı
27	JCR (Journal Citation Reports)	**55**	WestLaw
28	JSTOR (Journal Storage)	**56**	Wiley Online Library

MARINE SCIENCE EFFECTS FOR FUTURE OF THE MARITIME TRANSPORTATION AT THE TURKISH STRAITS

Hasan Bora Usluer[1], Güler Alkan[2]

ABSTRACT

Maritime transportation is the most eligible solution about international trade transportation not only the world sea area but also the Turkish Sea Area. Due to the Technological progress, population growth, increasing human living standards and general needs, rapid industrialization, researching new energy sources forced to develop about maritime transportation standards. The Turkish Straits sea area is consist of Strait of the Istanbul (Bosphorus), Strait of the Canakkale (Dardanelle) and also Sea of the Marmara. The Turkish Straits have really importance from the history because of the geopolitics, strategic and geographic situations and also being the gate that connected the Asian and Europe continents. Besides all these importances, Turkish Straits have really different geographic infrastructure. In this way, many factors must be taken into consideration in the marine sciences. Most of the time, meteorological, hydrographic, Oceanographic conditions due to serious risk factors for marine transportation consist of. For these circumstances, need to deeply survey at the Turkish Strait about marine science, find all the risk factors at the end need to shown by the charts on the bridge of the ships and coastal facility for use all the mariners and should be surveyed and investigated for the future maritime transportation on the Turkish Straits. All These results could have chance to make future maritime transportation and safety navigation planning, management and their policies for Turkish Straits. With this working, try to explain the marine science and their surveys importance for future maritime transportation planning decrease the collisions which aimed at the minimizing shipping accident and protect all the straits shoreline by the regulations and protecting marine environment at the Turkish Straits.

Keywords – Turkish Straits, Marine Science, Maritime

MARINE SCIENCE OVERVIEW

Marine sciences and effects are really importance about mariners and maritime transportation. Marine Science has got many sub-divisions like hydrography, oceanography, meteorology, climatology, marine geology and geophysics etc. Many questions have about maritime science but the important one is ’’What is working Marine Science for?’’. Surely the answers are following, measure and describe bodies of sea for mariners, maritime safety and also maritime transportation by use all sub-divisions datas. All these sub-divisions measures gains are as following, depth of sea, seabed profile, current, velocity, salinity, ecosystem, environment dynamics, pollutions datas etc. Apparently, marine sciences are important parts of the maritime and environment. All the marine science disciplines should be known during the maritime transportation.

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Hydrography

Hydrography is the science that measures and describes the physical features of bodies of sea and the land areas adjacent to those bodies of sea. In according to International Hydrographic Organization-IHO definition, Hydrography is the branch of applied sciences which deals with the measurement and description of the physical features of oceans, seas, coastal areas, lakes and rivers, as well as with the prediction of their change over time, for the primary purpose of safety of navigation and in support of all other marine activities, including economic development, security and defense, scientific research, and environmental protection. [1]- [2] Hydrographers conducts hydrographic surveys to measure the depth and bottom configuration. All hydrographic datas are used to update nautical charts and develop hydrographic models; increasingly, are used for multiple purposes, through the integrated seas and coast by eligible programs. The main data type common to all hydrographic surveys is the depth. Of additional concern to many surveys is the nature of the seafloor material like sand, mud, rock due to implications for anchoring, dredging, structure construction, pipeline and cable routing, and fisheries habitat, pollutions and also environmental solutions. [2]

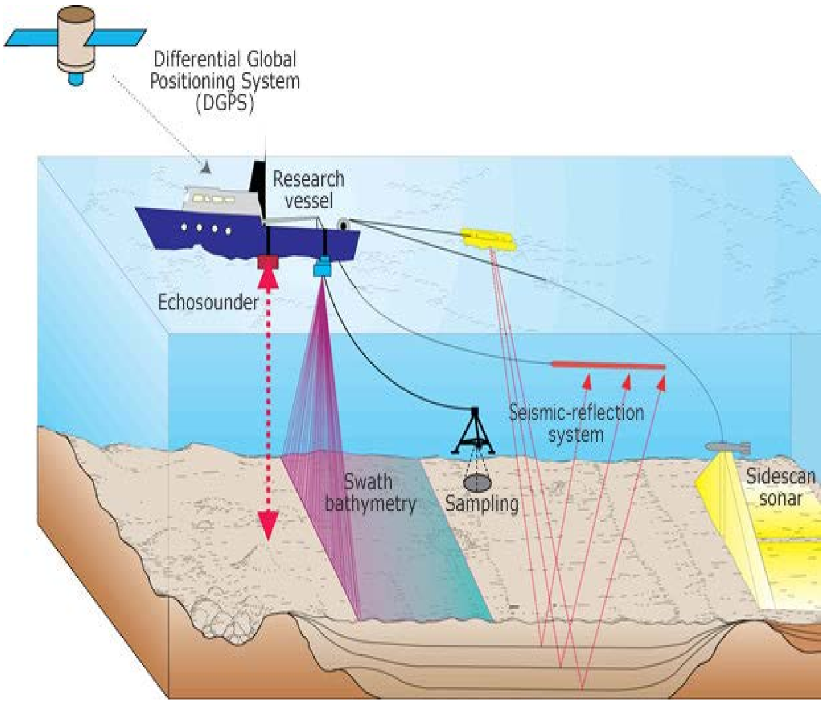

Figure 1. Hydrographic survey ship in charge on area.

Oceanography

Oceanographic survey is finding the mistic secrets of the seas. And also, Oceanography covers a wide range of topics, including marine life and ecosystems, ocean circulation, plate tectonics and the geology of the sea floor, and the chemical and physical properties of the ocean. Just as there are many specialties within the medical field, there are many disciplines within oceanography. [3]-[4] Biological oceanography and marine biology study plants and animals in the marine environment.

Chemical oceanography and marine chemistry study the composition of seawater, its processes and cycles, and the chemical interaction of seawater with the atmosphere and sea floor. Geological oceanography and marine geology explore the ocean floor and the processes that form its mountains, canyons, and valleys. Physical oceanography study the physical conditions and physical processes within the ocean such as waves, currents, eddies, gyres and tides; the transport of sand on and off beaches; coastal erosion; and the interactions of the atmosphere and the sea. [4]

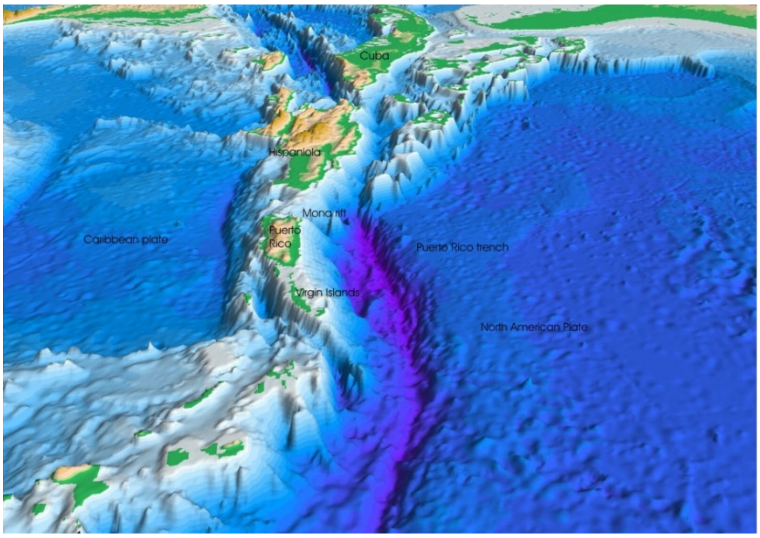

Figure 2. Oceanographic side scan sonar processed datas.

Meteorology

Meteorology, the study of the earth's atmosphere, is a component of Earth system science. The temperature, wind, and precipitation that we observe and experience impact, and are impacted on by, various scales. Weather, which is at one end of the meteorological spectrum, generally refers to short-term fluctuations which include less than a couple of weeks, while the climate is characterized by longer time scales from months to years. On short time scales - convection, like cloud cover, humidity, soil moisture, can all impact a forecast while climate is impacted by solar variations, volcanic eruptions, and changes in the sea circulation. [4]

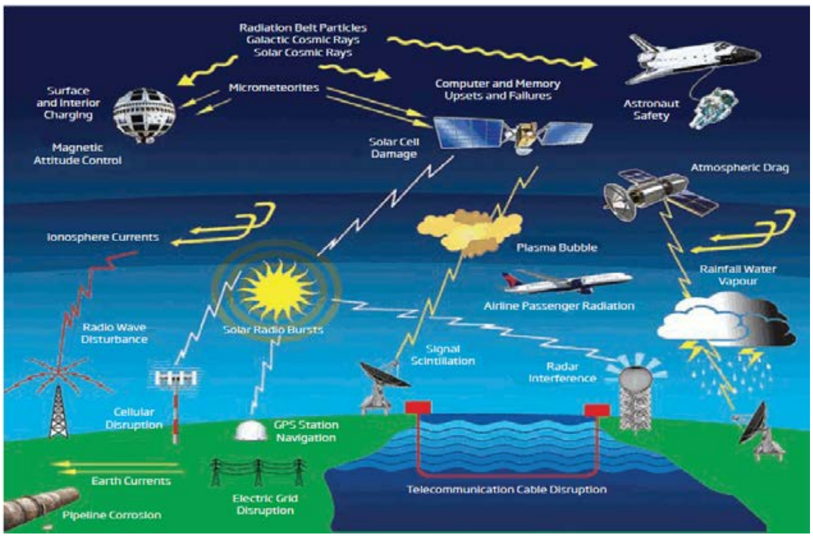

Figure 3. Meteorologic survey receive circle.

The Other Marine Sciences General Overview

Marine biogeochemical research of oceans as transporters and processors of chemical elements that are essential to the functioning of the planet, such as carbon, nitrogen, phosphorus, oxygen, sulfur, silicon and iron. Marine biogeochemical is to determine how these elements, which are mobilized by natural and anthropogenic sources, are distributed and flow among the water masses, the seabed, particulate matter, living organisms, and the food webs of which these organisms form part. Particular attention is paid to the processes that occur across the interfaces between compartments which includes are water-particles, water-organisms, water-sediment, water-atmosphere. The environmental conditions of the past are also studied through the geochemical “footprints” stored in the seabed. Marine geosciences generally research geomorphology, sediment dynamics, geochemical flows, stratigraphy and tectonics of coastal regions, continental margins and ocean basins at all spatial and temporal scales. Marine geosciences also research includes the analysis of present-day sedimentary processes in response to natural and anthropogenic phenomena, the study of the morphology and structure of the seabed, and the assessment of geological hazards in coastal zones, continental margins and basins. In order to improve the general management of the seabed, some applications of this research line address issues such as the vulnerability of coasts, marine pollution, coastal and offshore facilities, oil and gas exploration, geological hazards, climate change and associated changes in sea level. [5]

Figure 4. Marine biology sample area.

THE TURKISH STRAITS OVERVIEW

The Turkey has a Turkish Strait sea area which has the gate that connected the Asian and Europe continental. Also this sea area consists of Strait of the Istanbul (Bosphorus), Strait of the Canakkale (Dardanelle) and also Sea of Marmara. The Straits of Istanbul and Strait of Canakkale are connecting the Black Sea with the Aegean Sea through by Sea of Marmara. The Turkish Straits has a really importance from the history because of the geopolitics, strategic and geographic situations. These importances, especially strategic one is that the only water route between the Mediterranean Sea and the Black Sea, so the Turkish Strait sea area has been the site of significant settlement area and also city of Istanbul for a long time in the past. All part of the sovereign sea territory of Turkey and subject to the regime of internal waters. The Turkish Straits have been governed by the Montreux convention, since the 1936. [6]

From past to recent years this gate is the most important trade way of the world cause of the oil and oil products. Throughout the history, this situation due to the geographical location, has lead to conflicts between Turkey and the countries both coasting and not coasting the Black Sea in terms of political, economic and strategic interests. Straits separating Turkey's land into two as Asian side and European side resulted in the facts that Turkey's territorial integrity and independence are directly related to the legal regime which the straits are subject to. [6]-[7] In Montreux Conference, representative of Romania, Nicolae Titulescu's expression "Straits are the hearts of Turkey, but also lungs of Romania" affirms the importance of the Straits. [6]-[8]

İstanbul Strait (Bosphorus)

Istanbul Strait is important narrow waterway and also linking Black Sea with the Agean Sea by The Marmara Sea and also separates northern of the sea area European and Asian continents. Istanbul Strait is one of the most important routes of oil transportation, as it connects the Black Sea and the Mediterranean. Also it has most busy and dangerous maritime traffic line like the Malaka Strait. It has really different and special geographic, hydrographic, oceanographic and meteorological conditions. It is not only important narrowest straits of the world but also has sharp turns more than 10 times. 17 Nm length of the Istanbul Strait's European coastline is nearly 55 km, Anatolian coastline is 35 km. Istanbul Strait sea bottom topography reveals many banks, holes, shallows and also sinks. [9]

Figure 5. Istanbul Strait satellite view.

Canakkale Strait (Dardanelle)

The Strait of Canakkale is about 37 nautical miles long and is generally straightforward, with the exception of two significant turns, near the City of Canakkale, where the Strait reaches its narrowest width about 1,300 metres. Navigation is less dangerous than in the Strait of Istanbul, although strong currents numerous eddies and counter currents are experienced throughout the strait. A limited number of passenger and car ferries run daily between Canakkale on the Asian side and Eceabat and Kilitbahir on the European side. [9]

Figure 6. Canakkale Strait satellite view.

The Marmara Sea

The Marmara Sea joins the Istanbul Straits to the Canakkale Straits and sea area distance is about 110 miles, and does not pose any significant navigational hazards to vessels. It approaches to the two straits tend to be more congested than the open sea approaches. The approach to Canakkale Strait has limited anchorage space, and that space is close to the traffic lanes. The Marmara Sea is an intracontinental basin 275 km long and 80 km wide formed as a result of pull-apart tectonics along the North Anatolia Fault.[10]

Figure 7. The Marmara Sea satellite view.

MARINE SCIENCE EFFECTS OF THE STRAIT ON THE SELECTED SAMPLE AREA

The defined position sea area is consist of one area which is between Bebek and Kandilli. This area cell limits have been taken into account with 41-04.45 & 29-02.85 and 41-04.75 & 29-03.35 coordinates values. Speed and direction values of currents take into consideration each different sea layers which consist of values in the range of 0-10 meters, 10-20 meters, 20-30 meters.

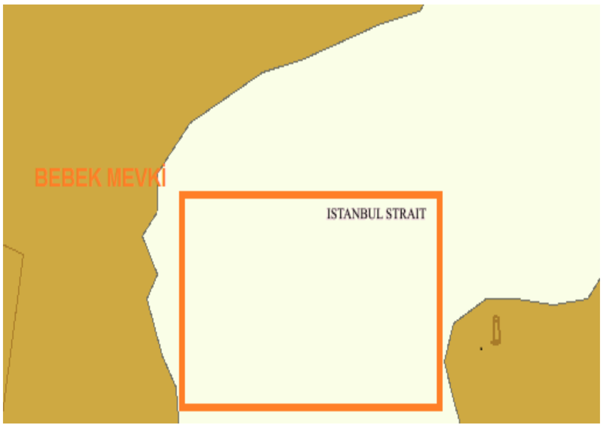

Figure 8. Sample Area Screen from ENC.

The Current through the Istanbul Strait can well be compared to two rivers flowing reciprocally one above the other in the same river bed which has a depth of 40 to 90 meters. [11]

The surface current in the Istanbul Strait (Bosphorus) is similar in character to that which would be produced by a great jet water, under high pressure directed from the narrow and irregular channel and does not everywhere fill the whole width of the strait and takes the shortest route from point to point. The character of the current alters when its strength changes due to any cause and if it is stronger than usual it becomes a faster and narrower band, which sets into and across the wider parts of the strait as a thinner jet. [11]

Experienced in years by the local and international transportation seafarers that Istanbul Strait current is stronger in the afternoon than in the forenoon. Also the current is weakest from the northern entrance. This part influence current is less than a one knot. Also many physically effects may occur in the strait like a different direction current flow and partially vortex which name is orkoz. Orkoz can effect different depth area like 10-20 meters that same draft vessel can be easily affected on this sea block. Generally Orkoz is triggered by depression which settle near or going on or going over the sea area and strong wind which comes from south and north depends on the seasons. It pushed the surface water layer towards the Black Sea to the Marmara Sea. This layer pile up and make a slope of the surface being upwards with turning to the shoreline and coastline. When the Orkoz is stronger at the season can effect negatively to the vessel during the voyage at the strait and causes many obstructions for the maritime safety.

METHODOLOGY AND PROCESS

Turkish Strait Sea Area has two different current regimes. In this study, three different layers evaluated according to two current regimes. Because mainly two different type of current are effective at Turkish Strait Sea Area, especially Istanbul Strait.0-10 meters depth area has been taken into account for surface currents. Two of the distinct characteristics of the Istanbul Strait are different density and current strength. As is well known Black Sea has less salinity surface water, and also is carried into the Marmara Sea at the surface, while underlying bottom water from the Marmara Sea.

All the datas are obtained from Turkish Navy, Office of Navigation, Hydrography and Oceanography. The office surveyed all the Turkish Strait sea area at 2005, 2006 and 2007. In this study, MATLAB process programme and related modules were used. At equal intervals determined for the selected area. The calculationed and processed according to defined matrix which was specified by the selected area coordinates.

Table 1. Sample area surface coordinates and values

BEBEK AREA SURFACE CURRENT (0-10 METRE)

LAT	LONG	LAT ORIGINAL			CALCULATED	LONG ORIGINAL			CALCULATED	DIRECTION	VALUE	DATE
41-04,75	29-02,85	41	0,06667	0,0125	**41,07916667**	29	0,03333	0,01417	**29,0475**	23.34	1.8 KNOTS	WINTER 2005
41-04,75	29-02,9	41	0,06667	0,0125	**41,07916667**	29	0,03333	0,015	**29,04833333**	68.20	2.0 KNOTS	
41-04,75	29-02,95	41	0,06667	0,0125	**41,07916667**	29	0,03333	0,01583	**29,04916667**	34.19	1.8 KNOTS	
41-04,75	29-03,0	41	0,06667	0,0125	**41,07916667**	29	0,05	0	**29,05**	228.26	2.0 KNOTS	
41-04,75	29-03,05	41	0,06667	0,0125	**41,07916667**	29	0,05	0,00083	**29,05083333**	250.04	2.0 KNOTS	
41-04,75	29-03,1	41	0,06667	0,0125	**41,07916667**	29	0,05	0,00167	**29,05166667**	252.00	1.8 KNOTS	
41-04,75	29-03,15	41	0,06667	0,0125	**41,07916667**	29	0,05	0,0025	**29,0525**	245.51	2.0 KNOTS	
41-04,75	29-03,2	41	0,06667	0,0125	**41,07916667**	29	0,05	0,00333	**29,05333333**	250	2.0 KNOTS	
41-04,75	29-3,25	41	0,06667	0,0125	**41,07916667**	29	0,05	0,00417	**29,05416667**	242	2.0 KNOTS	
41-04,75	29-03,3	41	0,06667	0,0125	**41,07916667**	29	0,05	0,005	**29,055**	223.06	2.0 KNOTS	
41-04,75	29-3,35	41	0,06667	0,0125	**41,07916667**	29	0,05	0,00583	**29,05583333**	248.11	2.0 KNOTS	
41-04,7	29-02,85	41	0,06667	0,0117	**41,07833333**	29	0,03333	0,01417	**29,0475**	297.18	1.8 KNOTS	
41-04,7	29-02,9	41	0,06667	0,0117	**41,07833333**	29	0,03333	0,015	**29,04833333**	282.20	2.0 KNOTS	
41-04,7	29-02,95	41	0,06667	0,0117	**41,07833333**	29	0,03333	0,01583	**29,04916667**	210.21	2.4 KNOTS	
41-04,7	29-03,0	41	0,06667	0,0117	**41,07833333**	29	0,05	0	**29,05**	205.53	2.2 KNOTS	
41-04,7	29-03,05	41	0,06667	0,0117	**41,07833333**	29	0,05	0,00083	**29,05083333**	235.39	1.8 KNOTS	
41-04,7	29-03,1	41	0,06667	0,0117	**41,07833333**	29	0,05	0,00167	**29,05166667**	55.45	1.8 KNOTS	
41-04,7	29-03,15	41	0,06667	0,0117	**41,07833333**	29	0,05	0,0025	**29,0525**	45.51	1.6 KNOTS	
41-04,7	29-03,2	41	0,06667	0,0117	**41,07833333**	29	0,05	0,00333	**29,05333333**	243.51	2.0 KNOTS	
41-04,7	29-3,25	41	0,06667	0,0117	**41,07833333**	29	0,05	0,00417	**29,05416667**	244.52	1.6 KNOTS	
41-04,7	29-03,3	41	0,06667	0,0117	**41,07833333**	29	0,05	0,005	**29,055**	240.33	1.6 KNOTS	
41-04,7	29-3,35	41	0,06667	0,0117	**41,07833333**	29	0,05	0,00583	**29,05583333**	246.17	1.6 KNOTS	
41-04,65	29-02,85	41	0,06667	0,0108	**41,0775**	29	0,03333	0,01417	**29,0475**	33.01	2.0 KNOTS	
41-04,65	29-02,9	41	0,06667	0,0108	**41,0775**	29	0,03333	0,015	**29,04833333**	35.01	2.0 KNOTS	
41-04,65	29-02,95	41	0,06667	0,0108	**41,0775**	29	0,03333	0,01583	**29,04916667**	35.13	2.0 KNOTS	
41-04,65	29-03,0	41	0,06667	0,0108	**41,0775**	29	0,05	0	**29,05**	246.02	1.8 KNOTS	
41-04,65	29-03,05	41	0,06667	0,0108	**41,0775**	29	0,05	0,00083	**29,05083333**	244.47	2.0 KNOTS	
41-04,65	29-03,1	41	0,06667	0,0108	**41,0775**	29	0,05	0,00167	**29,05166667**	240	2.0 KNOTS	
41-04,65	29-03,15	41	0,06667	0,0108	**41,0775**	29	0,05	0,0025	**29,0525**	240.04	2.0 KNOTS	
41-04,65	29-03,2	41	0,06667	0,0108	**41,0775**	29	0,05	0,00333	**29,05333333**	249.57	1.8 KNOTS	
41-04,65	29-3,25	41	0,06667	0,0108	**41,0775**	29	0,05	0,00417	**29,05416667**	253.44	1.8 KNOTS	
41-04,65	29-03,3	41	0,06667	0,0108	**41,0775**	29	0,05	0,005	**29,055**	240.46	2.1 KNOTS	
41-04,65	29-3,35	41	0,06667	0,0108	**41,0775**	29	0,05	0,00583	**29,05583333**	251.44	2.0 KNOTS	
41-04,6	29-02,85	41	0,06667	0,01	**41,07666667**	29	0,03333	0,01417	**29,0475**	17.25	1.6 KNOTS	
41-04,6	29-02,9	41	0,06667	0,01	**41,07666667**	29	0,03333	0,015	**29,04833333**	355.21	1.6 KNOTS	
41-04,6	29-02,95	41	0,06667	0,01	**41,07666667**	29	0,03333	0,01583	**29,04916667**	24.02	1.8 KNOTS	
41-04,6	29-03,0	41	0,06667	0,01	**41,07666667**	29	0,05	0	**29,05**	244.44	1.8 KNOTS	
41-04,6	29-03,05	41	0,06667	0,01	**41,07666667**	29	0,05	0,00083	**29,05083333**	232.40	2.0 KNOTS	
41-04,6	29-03,1	41	0,06667	0,01	**41,07666667**	29	0,05	0,00167	**29,05166667**	250.52	2.1 KNOTS	
41-04,6	29-03,15	41	0,06667	0,01	**41,07666667**	29	0,05	0,0025	**29,0525**	252.36	1.8 KNOTS	
41-04,6	29-03,2	41	0,06667	0,01	**41,07666667**	29	0,05	0,00333	**29,05333333**	248.41	1.8 KNOTS	
41-04,6	29-3,25	41	0,06667	0,01	**41,07666667**	29	0,05	0,00417	**29,05416667**	255.11	1.8 KNOTS	
41-04,6	29-03,3	41	0,06667	0,01	**41,07666667**	29	0,05	0,005	**29,055**	244.24	1.6 KNOTS	
41-04,6	29-3,35	41	0,06667	0,01	**41,07666667**	29	0,05	0,00583	**29,05583333**	252.21	2.0 KNOTS	
41-04,55	29-02,85	41	0,06667	0,0092	**41,07583333**	29	0,03333	0,01417	**29,0475**	317.59	1.8 KNOTS	
41-04,55	29-02,9	41	0,06667	0,0092	**41,07583333**	29	0,03333	0,015	**29,04833333**	281.52	2.0 KNOTS	
41-04,55	29-02,95	41	0,06667	0,0092	**41,07583333**	29	0,03333	0,01583	**29,04916667**	329.15	1.6 KNOTS	
41-04,55	29-03,0	41	0,06667	0,0092	**41,07583333**	29	0,05	0	**29,05**	251.02	2.1 KNOTS	
41-04,55	29-03,05	41	0,06667	0,0092	**41,07583333**	29	0,05	0,00083	**29,05083333**	240.47	2.0 KNOTS	
41-04,55	29-03,1	41	0,06667	0,0092	**41,07583333**	29	0,05	0,00167	**29,05166667**	247.04	2.2 KNOTS	
41-04,55	29-03,15	41	0,06667	0,0092	**41,07583333**	29	0,05	0,0025	**29,0525**	245.18	1.8 KNOTS	
41-04,55	29-03,2	41	0,06667	0,0092	**41,07583333**	29	0,05	0,00333	**29,05333333**	232.32	2.0 KNOTS	
41-04,55	29-3,25	41	0,06667	0,0092	**41,07583333**	29	0,05	0,00417	**29,05416667**	248.16	1.6 KNOTS	
41-04,55	29-03,3	41	0,06667	0,0092	**41,07583333**	29	0,05	0,005	**29,055**	248.55	1.8 KNOTS	
41-04,55	29-3,35	41	0,06667	0,0092	**41,07583333**	29	0,05	0,00583	**29,05583333**	250.35	2.0 KNOTS	
41-04,5	29-02,85	41	0,06667	0,0083	**41,075**	29	0,03333	0,01417	**29,0475**	276.02	2.2 KNOTS	
41-04,5	29-02,9	41	0,06667	0,0083	**41,075**	29	0,03333	0,015	**29,04833333**	232.29	2.4 KNOTS	
41-04,5	29-02,95	41	0,06667	0,0083	**41,075**	29	0,03333	0,01583	**29,04916667**	235.50	2.2 KNOTS	
41-04,5	29-03,0	41	0,06667	0,0083	**41,075**	29	0,05	0	**29,05**	227.52	2.4 KNOTS	
41-04,5	29-03,05	41	0,06667	0,0083	**41,075**	29	0,05	0,00083	**29,05083333**	227.13	2.4 KNOTS	
41-04,5	29-03,1	41	0,06667	0,0083	**41,075**	29	0,05	0,00167	**29,05166667**	231.07	2.0 KNOTS	
41-04,5	29-03,15	41	0,06667	0,0083	**41,075**	29	0,05	0,0025	**29,0525**	237.49	2.2 KNOTS	
41-04,5	29-03,2	41	0,06667	0,0083	**41,075**	29	0,05	0,00333	**29,05333333**	245.30	1.8 KNOTS	
41-04,5	29-3,25	41	0,06667	0,0083	**41,075**	29	0,05	0,00417	**29,05416667**	239.34	2.0 KNOTS	
41-04,5	29-03,3	41	0,06667	0,0083	**41,075**	29	0,05	0,005	**29,055**	240.01	2.0 KNOTS	
41-04,5	29-3,35	41	0,06667	0,0083	**41,075**	29	0,05	0,00583	**29,05583333**	240.50	1.6 KNOTS	
41-04,45	29-02,85	41	0,06667	0,0075	**41,07416667**	29	0,03333	0,01417	**29,0475**	11.21	2.0 KNOTS	
41-04,45	29-02,9	41	0,06667	0,0075	**41,07416667**	29	0,03333	0,015	**29,04833333**	335.34	1.8 KNOTS	
41-04,45	29-02,95	41	0,06667	0,0075	**41,07416667**	29	0,03333	0,01583	**29,04916667**	338.13	1.8 KNOTS	
41-04,45	29-03,0	41	0,06667	0,0075	**41,07416667**	29	0,05	0	**29,05**	216.24	2.4 KNOTS	
41-04,45	29-03,05	41	0,06667	0,0075	**41,07416667**	29	0,05	0,00083	**29,05083333**	225.32	2.4 KNOTS	
41-04,45	29-03,1	41	0,06667	0,0075	**41,07416667**	29	0,05	0,00167	**29,05166667**	228.25	2.4 KNOTS	
41-04,45	29-03,15	41	0,06667	0,0075	**41,07416667**	29	0,05	0,0025	**29,0525**	217.52	2.0 KNOTS	
41-04,45	29-03,2	41	0,06667	0,0075	**41,07416667**	29	0,05	0,00333	**29,05333333**	222.54	2.0 KNOTS	
41-04,45	29-3,25	41	0,06667	0,0075	**41,07416667**	29	0,05	0,00417	**29,05416667**	198.58	2.2 KNOTS	
41-04,45	29-03,3	41	0,06667	0,0075	**41,07416667**	29	0,05	0,005	**29,055**	220.39	2.2 KNOTS	
41-04,45	29-3,35	41	0,06667	0,0075	**41,07416667**	29	0,05	0,00583	**29,05583333**	209.08	2.0 KNOTS	

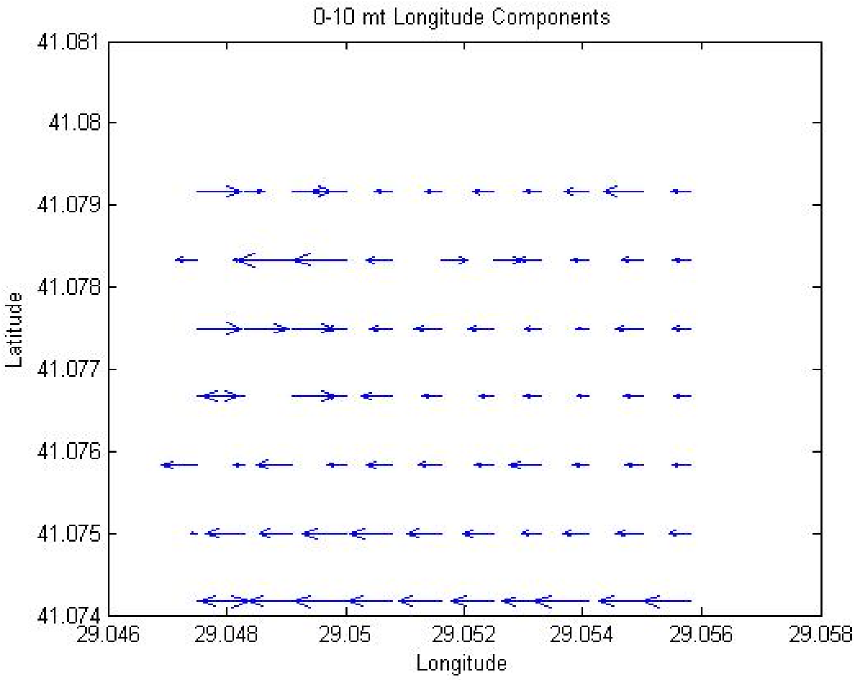

Figure 9. Prediction Analiyse Latitude Datas

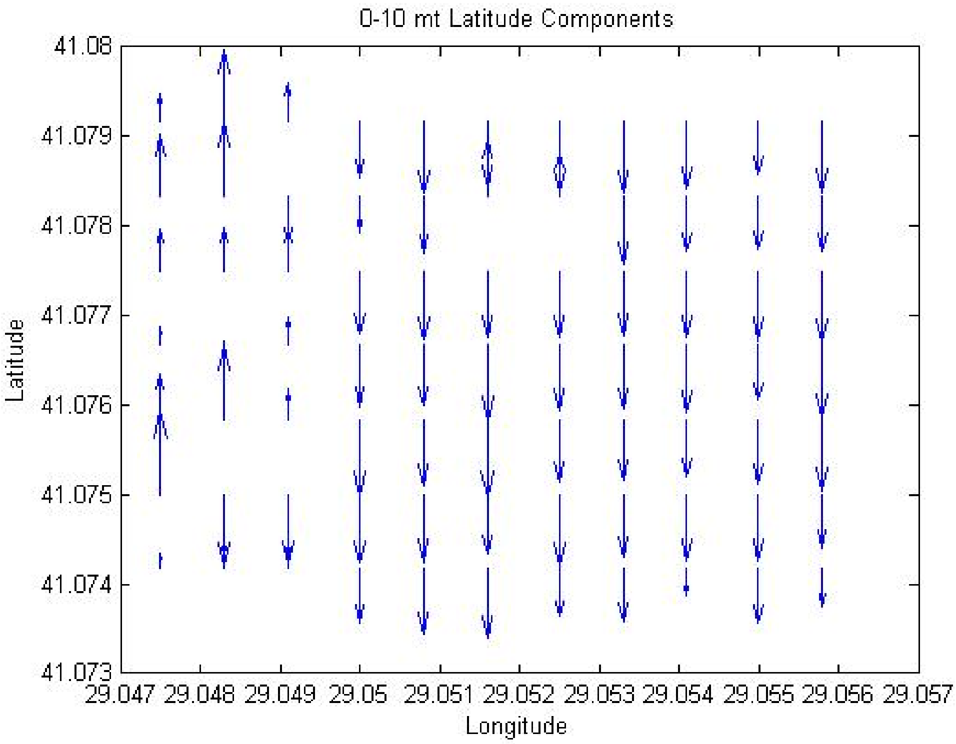

Figure 10. Prediction Analiyse Longitude Datas

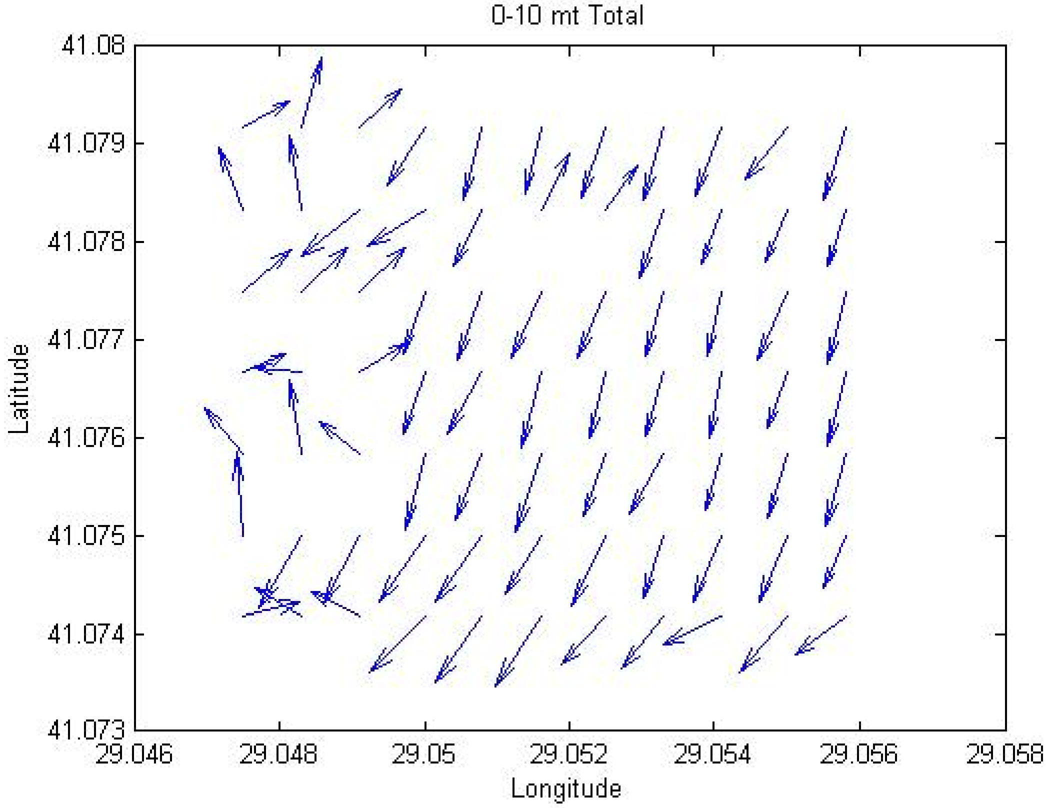

Figure 11. Prediction Analiyse Flow Datas

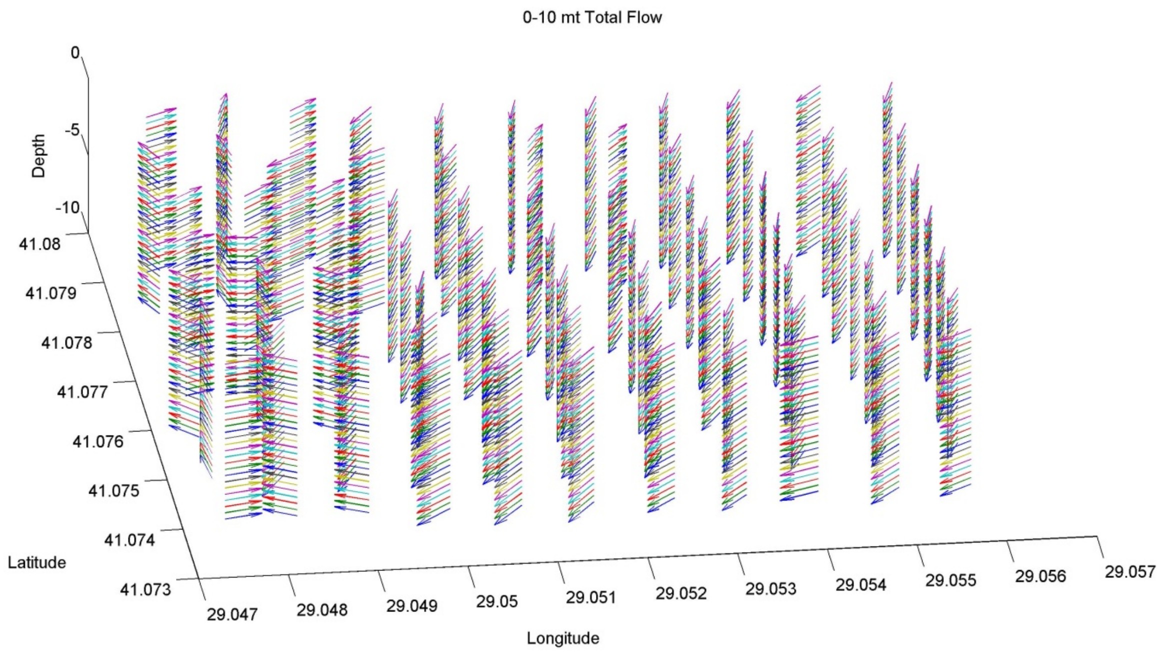

Figure 12. Result 3D screen

CONCLUSION

As well-known that, Maritime transportation is the most important transportation kind about international trade transportation. In this context, due to the technological progress, population growth, increasing human living standards and general needs, rapid industrialization, researching new energy sources forced to develop about maritime transportation standards. The Turkey has very strategically position for the world transportation. The Turkish Strait Sea Area, especially Istanbul Strait is most critical seaway and passage not only connected Asia and Europe continents but also geographic specifics like shape and narrowness turning and influences many marine effects. Besides all these importance's, Turkish Straits have really different geographic infrastructure. In this way, many factors must be taken into consideration in the marine sciences. Most of the time, meteorological, hydrographic, oceanographic conditions due to serious risk factors for marine transportation consist of. For these circumstances, need to deeply survey by use all marine sciences at the Turkish Strait, find all the risk factors at the end need to shown by the charts on the bridge of the ships and coastal facility for use all the mariners and should be surveyed and investigated for the future maritime transportation on the Turkish Straits.

All these surveys and their results could have chance to make future maritime transportation and safety navigation planning, management and their policies for Turkish Straits for Turkey and all the traders countries. Safe navigation is the main principle about maritime and also safe navigation in the Istanbul Strait is the main matter of the vital importance to the Turkey and international trade which the all mariners nations. Therefore the dangers posed by ever increasing shipping traffic not only to the inhabited areas but also environmental conditions. The marine science and their surveys importance for now and future maritime transportation planning decrease the collisions which aimed at the minimizing shipping accident and protect all the straits shoreline by the regulations and protecting marine environment at the Turkish Straits.

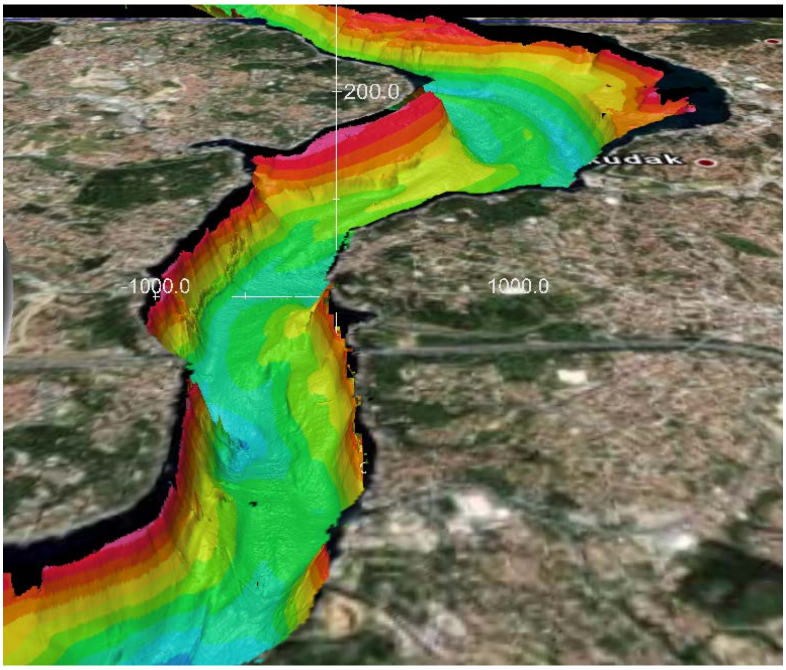

Figure 13. Part of 3D screen of the Istanbul Strait.

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ON THE ECONOMICS OF UNIMODAL TRANSPORTATION COSTS FOR VARIOUS MODES

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ABSTRACT

Cargoes can be generally shipped by highway, railway or maritime transportations. Airway transportation is also an alternative transportation mode for moving goods however it is not mainly selected by the decision makers due to high costs, while maritime transportation is the most widespread mode for shipping of cargoes in the World. Cost is a significant determinant for mode choice in transportation of low time-valued goods and it should be calculated accurately before decision makings. An economic analysis approach for unimodal transportation costs has been presented in this study and calculation of unit and specific transportation costs in highway, railway and maritime transportations have been made by utilizing from the model. In the case of transportation cost calculations, investment costs, operational and maintenance costs, fuel and lubricants costs and external costs related with accidents, pollution and noise have been considered. The comparison of these calculated costs for different modes of transport have been shown in graphs by taking into account fullness ratio of the vessels, capacity of marine vehicles and route length. It is clearly seen from the figures that investigated parameters directly effects the costs of transportation and should be emphasized.

Keywords – Economic Analysis, Maritime, Mode Choice, Unimodal Transportation

INTRODUCTION

Transportation is generally defined as the movement of cargoes, passengers, animals, etc. from origin point to destination point. Cargoes are transported with highway, railway, maritime, airway or pipelines. In some cases, combinations of these unimodal alternatives have been selected for cargo movement. Maritime transportation is the main transportation mode for since it enables to ship more capacity at the same time over long distances at low transportation costs. Cost is a significant factor for mode choice.

Unit and specific transportation costs in highway, railway and maritime transportations have been calculated and compared by using Levelised Cost Method in this study. 10000 DWT general cargo ship for the maritime, a freight train with a capacity of 700 tons for the railway and a truck with a capacity of 25 tons for the highway have been selected for the evaluation of economic and ecological parameters in order to calculate transportation costs.

According to the literature review passenger transportation, Sahin and Kesgin [1] and Alkan et. al. [2] used levelised cost method for the transportation of passengers. Additionally, Ust and Turan [3] calculated the transportation of six passenger vessels operating between Besiktas & Uskudar by

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using this method. On the other hand, levelised cost method is appropriate for cargo transportation calculations. Sahin et. al. [4, 5] applied the method to highway, railway, maritime and combined transportation modes in Turkey and compared them. Turan et. al. [6] designated the transportation mode that maintains minimum cost between İstanbul and Denizli and intermodal seaway-highway transportation has become the most cost-effective mode in this route. Sahin et al. [7] also developed an approach for intermodal transportation considering handling and storage costs in their study.

In addition to above studies, Pilot and Pilot [8], Prakash et. al. [9], Al-Khayyal and Hwang [10] studied about the minimization of total transportation cost problem in their studies. Allan et. al. have used this method for wave and tidal energy costs, Khalaf and Redhab [11] for power and water plant and Agashichev [12] made analysis with levelised cost method. for integrated co-generative system.

For railway cost calculations, Gattuso and Restuccia [13] also presented a model comprising of investment, equipment and operational costs and compared some regional railway operating costs in France, Germany and Italy. Clark et. al. [14] investigated the determinants of transportation costs in the USA and mentioned about the effects of these parameters on maritime transportation. They emphasized that in addition to route length, cargo volume, etc., the increase in port efficiency will also lead to decrease the transportation costs.

In addition to above studies, Levinson and Gillen [15] investigated the theoric and empirical studies in the literature regarding highway transportation and derived a model considering user, congestion, accidental, environmental, noise costs.

Junior and D'Agosto [16] have also studied on the transportation alternatives in the scope of financial and environmental costs for hazardous materials and designated the most efficient mode of transport. In the light of the study, highway transportation is found as currently, the most utilized mode for these kinds of cargoes is highway transportation, however railway and especially long-distance pipeline transportation is more efficient compared to highway transportation.

ECONOMIC MODEL FOR UNIMODAL TRANSPORTATION

During the formation of economic cost model for unimodal transportation, investment, fuel/lubricants, operation/maintenance and external costs of a vessel have been taken into account. These costs have been calculated with the economic model presented by Sahin et. al. [4, 5].

A. Investment cost per unit of cargo (U_c):

In this study, selected vehicles are a general cargo ship with a capacity of 10000 DWT for the seaway, a freight train with a capacity of 700 tons for the railroad and a truck with a capacity of 25 tons for the highway have been considered for the investment cost of vehicles. The unit cargo investment cost, U_c, calculated with the below equation [4, 5]:

$$U_c = \frac{\left\{ \sum_{t=1}^{n} I_c \left[(1-\frac{t-1}{n})i + \frac{1}{n} \right] (1+r)^{-t} \right\} \left[2L + V_s Z_{sa} \right]}{2 Y_k Y_d V_s \left(8760 - Z_{bt} - Z_{bk} \right) \sum_{t=1}^{n} (1+r)^{-t}} \quad (1)$$

Moreover, the investment cost per unit cargo, U_c, for maritime transportation has been calculated subject to DWT of the vessels with the Equation 2. The sale prices of the vessels have been investigated and given in Table 1. [17].

Table 1. Sale prices for recently built vessels

DWT (tons)	Sale Price (M. USD)
1,000	2.50
2,000	3.25
2,500	4.00
3,200	5.60
3,300	5.20
4,000	6.50
5,000	8.50
5,500	9.30
5,843	10.00
6,500	9.00
9,200	10.90
20,000	20.30
23,800	26.54

Investment cost subject to DWT is [17];

$$I_c = 1000000x0.0116xDWT^{0.7621} \tag{2}$$

whereby, unit investment cost is derived with the following expression [17];

$$U_c = \frac{\left\{\sum_{t=1}^{n} 11600 DWT^{0.7621}\left[\left(1-\frac{t-1}{n}\right)i+\frac{1}{n}\right](1+r)^{-t}\right\}\left[2L+V_s Z_{sa}\right]}{2\left(Y_k Y_d\right)V_s\left(8760-Z_{bt}-Z_{bk}\right)\sum_{t=1}^{n}(1+r)^{-t}} \tag{3}$$

In the above formula, I_C is investment cost, Y_k is cargo capacity, Y_d represents fullness ratio, L is route length, V_s is service speed of vehicle, Z_{sa} is waiting time between sequential trips, Z_{bt} is annual maintenance-repair time, Z_{bk} is annual idle time and i is the interest rate

B. Operational and maintenance costs per unit of cargo (U_m):

Operational and maintenance costs per unit of cargo (U_m) can be calculated with the following expression [4, 5]. C_{mo} is annual operation and maintenance costs, e_m is escalation rate for future operational and maintenance costs, is insurance percentage (% I_c), e_s is the escalation rate for future insurance cost.

$$U_m = \frac{\left\{\sum_{t=1}^{n}\left[C_{mo}(1+e_m)^t + \left(s\, I_c(1-\frac{t}{n})\right)(1+e_s)^t\right](1+r)^{-t}\right\}\left[2L+V_s Z_{sa}\right]}{2Y_k Y_d V_s\left(8760-Z_{bt}-Z_{bk}\right)\sum_{t=1}^{n}(1+r)^{-t}} \tag{4}$$

C. Fuel and lubricant costs per unit of cargo (U_f):

Fuel and lubricant costs per unit of cargo, U_f, can be formulated as [4, 5]:

$$U_f = \frac{\left(B_f P_f + B_o P_o\right) L \sum_{t=1}^{n}\left[(1+e_f)^t (1+r)^{-t}\right]}{\left(Y_k Y_d\right)\left[\sum_{t=1}^{n}\left[(1+r)^{-t}\right]\right]} \tag{5}$$

where B_f is fuel consumption per km (main+aux.), P_f is fuel price, B_o is lubricant consumption per km (main+aux.), P_o is lubricant price, e_f is escalation rate for future fuel cost.

D. External costs per unit of cargo

The external costs per unit of cargo can be estimated as [4, 5] by considering c_{ac}, c_p and c_n, are specific cost of accidents, the specific cost of pollution caused by emission and the specific cost of pollution caused by noise, respectively. e_x is the escalation rate in the external costs, while Y_d^* is reference fullness ratio used for the calculation of specific external costs,.

$$U_{ex} = \frac{\left(c_{ac} + c_p + c_n\right) L \sum_{t=1}^{n}\left(\frac{1+e_x}{1+r}\right)^t}{\left(1+e_x\right) \sum_{t=1}^{n}\left[(1+r)^{-t}\right]}\left(\frac{Y_d^*}{Y_d}\right) \tag{6}$$

According to above expression, as a conclusion, U_T, is formulated as below;

$$U_T = U_c + U_m + U_f + U_{ex} \quad (\$/\text{ton}) \tag{7}$$

Finally, specific cost is as follows;

$$U_L = U_T / L \tag{8}$$

COMPARISON OF TRANSPORTATION COSTS FOR VARIOUS MODES

A cost analysis has been done with the application of levelised method for maritime, highway and railway transportation modes. Unit and specific transportation costs have been calculated subject to the economic and ecological parameters given in Table 2. For specific cost of accident, pollution and noise, data from Sahin et.al. [5] have been used and given in Table 2. Technical and economic data for 10000 DWT cargo vessel, 25 tons truck and 700 tons freight train are also given in Table 2. Average economic lifetimes have been accepted as 20, 10 and 20 years respectively.

Table 2. Economic and ecological parameters for maritime, highway and railway transportation vehicles [17]

	Symbol	Unit	10000 DWT Cargo Ship	25 tons truck	700 tons freight train
Investment cost	I_c	$	12,967,552	120,000	9,494,400
Average economic lifetime	n	year	20	10	20
Insurance percentage (Ic%)	s	$	0.00733	0.04250	0.00527
Cargo capacity	Y_k	ton	9000	25	700
Annual maintenance-repair time	Z_{bt}	hour	300	720	1460
Daily idle time	Z_{bk}	hour/da	3	14	9
Fuel consumption per km (Main+Aux.)	B_f	liter/km	24.07	0.4	7
Lubricant consumption per km (Main+Aux.)	B_o	liter/km	0.11	0.003	0.05
Fuel price	P_f	$/liter	0.26	2.123	2.123
Lubricant price	P_o	$/liter	1.8	8	8
Annual operation-maintenance cost	C_{mo}	$/year	750,000	30,000	710,000
Interest rate	i		0.08	0.08	0.08
Discount rate	r		0.1	0.1	0.1
Escalation rate for future operational-maintenance cost	e_m		0.03	0.03	0.03
Escalation rate for future fuel cost	e_f		0.05	0.05	0.05
Escalation rate for future insurance cost	e_s		0.03	0.03	0.03
Escalation rate for future external cost	e_x		0.03	0.03	0.03
Waiting time between sequential trips	Z_{sa}	hour	9.00	6.00	12.00
Specific cost of accident	c_{ac}	$/ton-km	6.00E-05	3.30E-03	4.00E-04
Specific cost of pollution	c_p	$/ton-km	3.85E-04	4.50E-04	1.10E-04
Specific cost of noise	c_n	$/ton-km	0.00E+00	2.20E-04	1.50E-04
Reference fullness ratio for specific external costs	Y_d^*		0.7	0.7	0.7

DISCUSSIONS & CONCLUSIONS

Unit transportation costs and specific transportation costs for maritime, highway and railway transportation modes have been calculated and given in Table 3 utilizing from Levelised Cost Method presented in the previous chapter.

During calculations, in addition to economic and ecological parameters of the vehicles, escalation rate for future fuel cost which is an important factor for cost determination has been assumed as 5%, route length has been considered as 1000 km and service speed for 10000 DWT cargo ship is 22 km/h, 35 km/h for freight train and 70 km/h for truck. Fullness ratios of the vehicles have been altered from 10% to 100% with 10% steps.

Table 3. Economic and ecological parameters for maritime, highway and railway transportation vehicles

	Maritime Transportation		Highway Transportation		Railway Transportation	
Y_d	U_T ($/ton)	U_L (U_T/L)	U_T ($/ton)	U_L (U_T/L)	U_T ($/ton)	U_L (U_T/L)
0.1	32.37	0.032	606.33	0.606	566.71	0.567
0.2	16.19	0.016	303.17	0.303	283.83	0.284
0.3	10.79	0.011	202.11	0.202	189.22	0.189
0.4	8.09	0.008	151.58	0.152	141.91	0.142
0.5	6.47	0.006	121.27	0.121	113.53	0.114
0.6	5.40	0.005	101.06	0.101	94.61	0.095
0.7	4.62	0.005	86.62	0.087	81.09	0.081
0.8	4.05	0.004	75.79	0.076	70.96	0.071
0.9	3.60	0.004	67.37	0.067	63.07	0.063
1.0	3.24	0.003	60.63	0.061	56.77	0.057

Cost of unit cargo for maritime, highway and railway transportation modes have been illustrated in Figures 1, 2 and 3. The ratio of investment, fuel/lubricants, operational and maintenance and external costs is also analyzed with the figures. According to the figures, it is clearly seen that fuel cost has the highest effect on the transportation cost.

Fullness ratio of the vessel changes from 20% to 100% in the figures and it is presented that the increase on the fullness ratio of the vessel causes a decrease in the unit transportation due to the scale of economics. Cost reduction rate is more in lower fullness ratios compared to higher ratios [17]. Therefore operating the vessels with more cargo is important in order to prevent high costs.

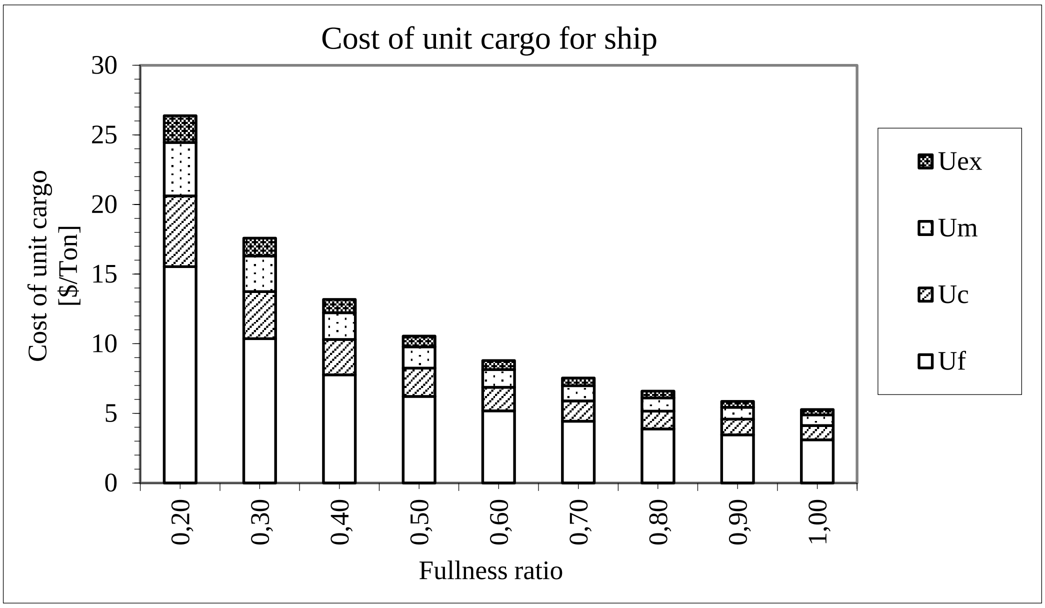

Fig. 1. Alteration of investment, fuel/lubricants, operational and maintenance, external and total transportation cost per unit of cargo with respect to fullness ratio for 10000 DWT cargo ship (Maritime Transportation; L=1000 km)

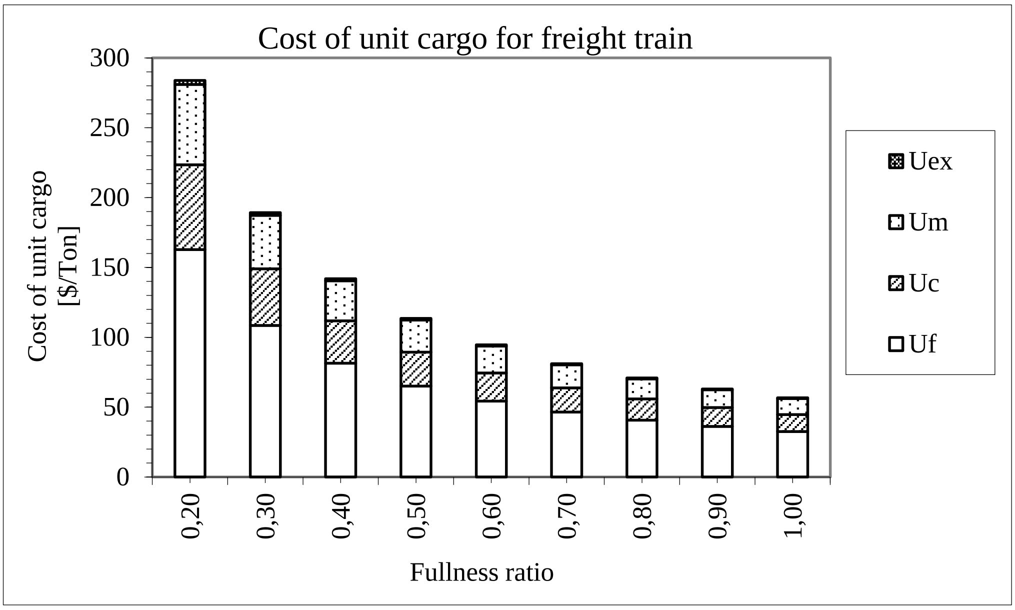

Fig. 2. Alteration of investment, fuel/lubricants, operational and maintenance, external and total transportation cost per unit of cargo with respect to fullness ratio for 700 tons freight train (Railway Transportation; L=1000 km) [17]

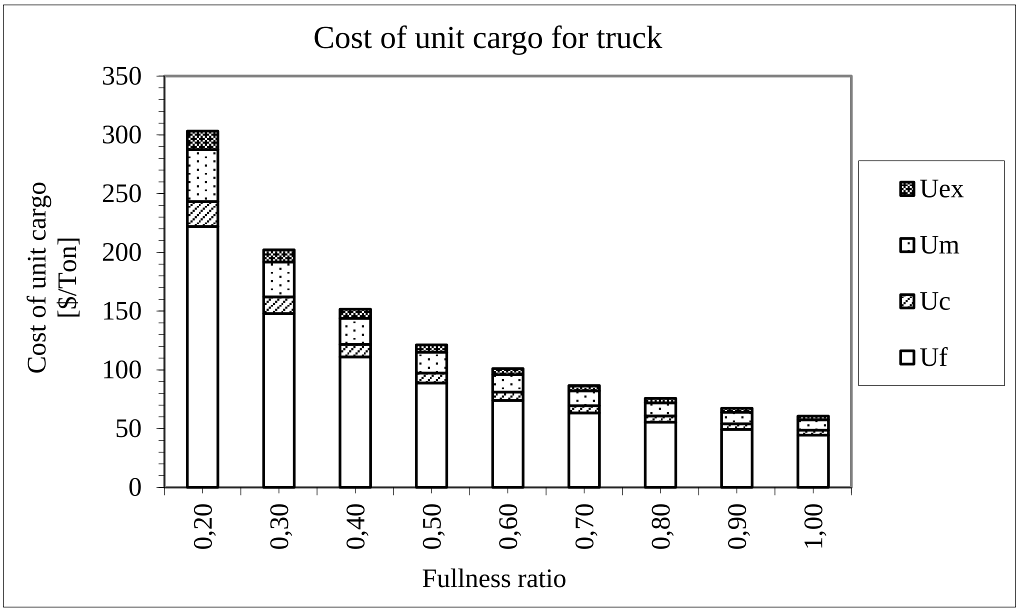

Fig. 3. Alteration of investment, fuel/lubricants, operational and maintenance, external and total transportation cost per unit of cargo with respect to fullness ratio for 25 tons truck (Highway Transportation; L=1000 km) [17]

It is also observed that maritime transportation is the first alternative for transporting cargoes with the minimum unit and specific costs in 1000 km route length. Second alternative is railway and the last alternative is highway transportation mode. It is shown that maritime transportation should be selected where applicable and in the case of transportation period could be ignored.

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PILOT-VTS OPERATOR RELATIONSHIP: CAN VTS OPERATOR ADVISE TO PILOT?

Cahit İSTİKBAL[1]

ABSTRACT

Captain-Pilot relationship can be called as classical as it comes through centuries and based on "trust". But, however, as the maritime technologies evolved and VTS started to be used as an effective risk reduction tool, another type of relationship also emerged. This is VTS and Pilot relationship. This is not an easy relationship as many conflicts having been experienced throughout the world between these two parties. The main base of conflict rises from providing of "advise" to the Captain; because the main role of the pilot is to advise the captain whereas one of the main tasks of VTS operator is to provide navigational assistance to the ships. IALA describes this service as follows: "The navigational assistance service is especially important in difficult navigational or meteorological circumstances or in case of defects or deficiencies. This service is normally rendered at the request of a vessel or by the VTS when deemed necessary." The demand of a vessel takes the priority here but, some cases VTS operator may find it necessary to give navigational assistance service (NAS) to the ship. No explanation is given with regard to the case when the pilot is onboard. But, the IMO VTS Guidelines clearly states that the use of navigational assistance service is "to assist on-board navigational decision-making and to monitor its effects". Therefore, advise is not an instruction to follow, instead the onboard team should take the final decision. On the other hand, same guidelines state that in such a situation "Care should be taken that VTS operations do not encroach upon the boatmaster's responsibility for safe navigation, or disturb the traditional relationship between boatmaster and pilot, where applicable." Therefore, this paper brings into agenda and discusses that in cases where the pilot onboard the ship, VTS operator may provide information could provide information to the pilot within the scope of collaboration and cooperation and "advise" to the pilot unless asked.

Keywords: Master-Pilot relationships, Pilot-VTS Operator relationship, VTS, Pilot

INTRODUCTION

Pilotage is one of the oldest professions in the world. As old as maritime history. As soon as mankind started to use the sea for transportation, perils of the sea have been a major concern. A mariner's boat sank, ran aground, hit invisible rocks or went adrift in unfamiliar waters. In the history of mankind, every profession has emerged because of a need. It was the same in the case of Pilots. Over time sailors navigating in unfamiliar waters used the guidance of local fishermen, local sailors or the natives of the region. Pilots in ancient times, just as they are today, were classified under two main groups - "deep sea pilots" and "coastal pilots". Deep sea pilots used to pilot the boats from the start of the voyage until the end. They were responsible for navigation. We learn from ancient literature that pilots during those times were very good sailors and remained onboard for long

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periods. This further demonstrates that pilots, even in those ancient times, were expert navigators who piloted boats for the whole duration of a voyage most of the time.

The maritime pilot's role is to assist the Master of a vessel during the ship's passage to and from a berth in a given pilotage area, by providing local knowledge of navigational and operational matters combined with specialist ship-handling experience [1]. The pilot is entirely familiar with the special regulatory requirements and unique conditions that exist in his specific pilotage area, and with which the Master of the vessel cannot be expected to be fully conversant. The pilot is wholly familiar with all the local factors that might affect the navigation of the ship. These may include strong tidal flows, recent shoaling, ferry activities, dredging operations and other hazards. The maritime pilot also provides an essential communications link with the port authorities, maritime traffic services (VTS), tugboats, boatmen and other ships. Maritime pilots not only supply pilotage to ships; but also provide a public service by contributing to the overall safety of maritime traffic and by ensuring the protection of the environment. Maritime pilots are one of the main elements for providing maritime safety in high risk marine environments.

Unlike the VTS system, which is positioned on-shore, pilots are positioned right on the target, carrying out their duty on the bridge of the ship, just at the very heart of operations. The basic advantage of a pilot being onboard of the ship is that a pilot feels the ship, her interaction with the sea; he/she has eye-to-eye contact with the ships' navigational team, and sees the capabilities and possible incapability of the ship. These, in the author's opinion, are what make a maritime pilot different from any other element in a high-risk marine environment.

On the other hand; VTS Services, in similar with pilotage services, have the ship as customer as well as the public interests. But there is a major difference: pilot's service location is the bridge of the ship, but VTS render it's services from a remote location. This provide advantages and disadvantages to both parties; and forms the main platform of conflicts between them, too.

Here are some basic facts that forms the framework of this paper:

1. VTS, provides information related to the DYNAMIC factors of its responsible area. Information on STATIC factors already available to the traffic.
2. VTS operations and shore based pilotage are different things. Shore Based Pilotage should be performed only under force-majeures and should be performed by maritime pilots. On the other hand, VTS operations aims more to provide necessary information rather than giving instructions regarding how to navigate the vessel.
3. Pilots are open to new technologies as well as keeping up with the conventional nature of their profession coming legendarily throughout the centuries, which basicly relies on "knowledge, experience and reliability".
4. There are different types of VTS ; VTS can be provided by various providers, such as ports, harbours, and coast guard, and pilot organizations. Providing VTS by pilot organization is not a sine-qua-non, but it would effective and positioning a pilot in a VTS center is welcomed firmly by almost all authorities.

For ships navigating in the high seas, safekeeping the ship in a pre-decided course is the primary concern for the Operator on duty. Other concerns, meteorological changes and their effects on the ship, other ships in the vicinity and interaction with such traffic do not play a primary role in the ship's navigation because there are usually not many ships around in the high seas. Ship's deck officers take care of the navigation on the bridge and ship's master manages his other important functions related to the ship.

But in some particular sea areas that order totally changes. In coastal waters, harbour approaches, congested sea areas, narrow waterways; which we can call "high risk marine environment" in general; safe navigation of the ship and interaction with the other traffic elements becomes extremely important. Ship's master is on the bridge in such areas; and most probably a local pilot accompanies him/her in providing safe navigation to the vessel in such areas. But; such internal sources need to work together with some external sources; and vessel traffic services play an important role in that regard.

Maritime pilots, are one of the basic elements that providing "maritime safety" in "high risk marine environments". Unlike the VTS system which is positioned on the shore, pilots are positioned right on the target carrying out their duty on the bridge of ship; just at the heart-beat. They feel the ship, contact eye-to-eye with the ships' navigational team, and see the capabilities and possible incapabilities of the ship. And, I think, these are what makes a maritime pilot different from any other element in a high-risk marine environment. Making this distinction at the beginning is, I think, extremely important, because, should not we do this, we can not get on the correct track and cannot appropriately assign the duties of elements providing service for safety and efficiency in any high risk marine environment.

Pilots are also one of the units that use the service provided by a VTS. And VTS use the reports and information provided by maritime pilots. This is clearly stated in IMO Resolution A.857(20): "The VTS Authority should consider, where appropriate, the participation of pilot both as a user and provider of information"

In recent years, there has been a remarkable technologic advance in "remote-controlling" the vessels from the shore. "Shore-Based Pilotage", "Advanced Navigational Assistance", "Innovative Portable Pilot Assistance" came out to assist pilots and/or ships bridge personnel in navigating the ship safely. These advances brought us up to a delicate point: are we involving in and relying on virtual world too much and blanking out real life conditions? Since the implementation of AIS in all ships in 2008, the philosophy of VTS has radically changed. In order to prevent wrong assumptions and to make a correct assessment, at this stage, we need to look at this issue from a wider perspective: What is the importance of each element for others in a high-risk environment? How they see each-other, how (and why) they need each other and how the advance in technology will affect this relationship? In the safety chain, which starts from shore facilities and ends onboard the ship, or vice versa, ships bridge team and pilot play the most important role; we can say, they are the "vital safety link".

Every ship has her own information resources: Radar, ECDIS, VHF, various navigational publications, pilot books, guides to port entrances etc. As well as their advantages, all of these resources have the same weak point: they can not be expected to be updated to the very last moment. A VTS, as a dynamic source in the responsible area, is the most updated and dynamic source of information. This information may include the position and type of other ships in the area, meteorological or hydrological outlook, any malfunction of the navigational aids such as lights, light buoys etc. By the implementation of AIS system, all of these dynamic information and warnings will be available to all ships in a certain area and that will eliminate the voice communications burden on both sides. We can say that, in the near future, VTS systems will be almost "silent"; on the contrary to the actual conditions today.

VTS may reduce ship delays through better management of the traffic and this is one of the most important aspects of effectiveness that is expected from a VTS from the ship's side.

VTS OPERATOR: AN ADVISOR or INSTRUCTOR?

The IMO guidelines on VTS state that, "The competent authority is the authority made responsible, in whole or in part, by the Government for the safety, including environmental safety and efficiency of the vessel traffic and the protection of the environment." "The VTS Authority is the Authority with responsibility for the management, operations and co-ordination of the VTS, the interaction with participating vessels and the safe and effective provision of the service."

Competent Authority of a Coastal State has the responsibility for the safety of navigation around the coastline of its jurisdiction. That responsibility is often delegated to a VTS or other Authority, which in turn is responsible for managing the coastline in the area or areas concerned. If the area is within territorial waters, and a risk assessment has determined that the volume of traffic or the degree of risk justifies such services, then a VTS can be established. It is important to note that, at present a VTS may only be made mandatory in sea areas within the territorial seas of a coastal State. If the area is in international waters, such as Straits for example, a Reporting System can be established and be subsequently adopted by the IMO, (Resolution A.851(20)) [2].

"The Government or Competent Authority should ensure that the VTS Authority is provided with sufficient staff, appropriately qualified, suitably trained and capable of performing the tasks required, taking into consideration the type and level of services to be provided and current IMO Guidelines on the recruitment and training of VTS operators. "A VTS Operator is an appropriately qualified person performing one or more tasks contributing to the services of the VTS." Since the adoption of Resolution A857(20), IALA have published the internationally accepted IALA Model Courses for VTS personnel. MSC Circ.1065 brings attention to all the IALA V103 Model Courses for training and qualifying VTS Operators (VTSOs).

The IMO definition of VTS in Resolution A.857(20) states that, "Vessel traffic service (VTS) - a service implemented by a Competent Authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and to respond to traffic situations developing in the VTS area". So when a VTS is established it needs to have the capability to interact with vessel traffic and respond as and when necessary not only to developing traffic situations but prior to their development also. This means that VTSOs have a duty of care to monitor and look after the safety of navigation in their VTS area.

SOLAS V regulation 11.6 states, "Any adopted ship reporting system shall have the capability of interaction and the ability to assist ships with information when necessary." Like a VTS, the authority managing the SRS also has the right to interact with vessel traffic, assisting with information as and when necessary.

SOLAS V regulation 12.3 states that, "The use of VTS may only be made mandatory in sea areas within the territorial seas of a coastal State." Both a VTS and SRS contribute to safety of life at sea, safety and efficiency of navigation and/or protection of the marine environment. Both can interact with vessel traffic and both provide an Information Service. SOLAS V regulation 12.1 has additional wording, "... adjacent shore areas, work sites and offshore installations from possible adverse effects of maritime traffic."

Resolution A.857(20) section 2.1.2 states that, "A clear distinction may need to be made between a Port or Harbour VTS and a Coastal VTS. A Port VTS is mainly concerned with vessel traffic to and from a port or harbour or harbours, while a Coastal VTS is mainly concerned with vessel traffic passing through the area. A VTS could also be a combination of both types. The type and level of service or services rendered could differ between both types of VTS; in a Port or Harbour VTS a navigational assistance service and/or a traffic organization service is usually provided for, while in a Coastal VTS usually only an information service is rendered."

Our point of interest here is the Navigational Assistance Service (NAS) and it’s appropriate application to ships having or not having a pilot on board.

IMO Resolution A.857(20) already approves and currently only recognises, Navigational Assistance Service (NAS) as one of three types of service that a VTS can provide to vessel traffic. IMO have used carefully chosen words by stressing that, "when the VTS is authorized to issue instructions to vessels, these instructions should be result-oriented only, leaving the details of execution, such as course to be steered or engine manoeuvres to be executed, to the master or pilot on board the vessel." In other words, one should not instruct a ship what specific course to steer or what specific speed to proceed at. NAS itself can be provided through an Information Service (INS) using the correct terminology, being guided by Resolution A.918(22) 'Standard Marine Communication Phrases' (SMCP). Information provided by a VTS should at all times be based on fact whereas advice is based on a professional opinion [3].

According to Captain Terry Hughes, who is a VTS expert with IALA accreditation; “there is much confusion over the term 'Navigational Assistance Service', with different interpretations on what it actually means including, dare I say, Shore Based Pilotage (SBP). When NAS is provided by a Pilot from a VTS centre it is NOT SBP, as an act of pilotage can only be carried out by a Pilot on board a ship itself. How NAS is provided, who provides it and when, is up to the VTS Authority, the ship's Master or both. It is a service to assist onboard navigational decision- making and to monitor its effects. The key words here are assist and monitor”.

Captain Terry Hughes emphasizes the distinction between Shore Based Pilotage and Navigational Assistance Service. NAS is something else than SBP, but in the practical world, VTS operators, o most cases, can not easily make this distinction.

Navigational Assistance Service is also authorized by regulations issued by the Government of Turkey. Article 6 of “The Regulation on the Establishment and Operational Procedures of Vessel Traffic Services” states the following: “Navigational Assistance Service will be rendered under difficult navigational or meteorological conditions or in the case of defect or deficiencies upon demand by the shipmaster or when deemed necessary by the VTS Operator. Navigational assistance service will be on advisory basis and result-oriented. VTS Operator will assist the Shipmaster in decision-making by providing following information within the VTS service area: information on speed over ground and course being steered; reports on the position, identity and intentions of other traffic; notifications to the ships and any other factors that may influence the vessel’s transit.”

The description in the Turkish regulation is more clear than the one that was made n IMO A.857(20). It sets the duty of VTS Operator by assisting the “Shipmaster” in “decision making process” and “providing information” is the method in doing so. Advisory basis and being result-oriented also underlined. No reference made to the Master-Pilot relationship as VTS Operator is not authorized to give advice to the Pilot onboard by the Turkish Regulation.

The same article 6 of Turkish Regulation mentioned above also states the following:

"The beginning and termination of the Navigational Assistance Service (Date and time) will be recorded in the log book by the agreement between ship and the VTS Center."

The Navigational Assistance Service is a grey area at which IALA seems to have issued conflicting statements in their latest Guideline (1089) on the Provision of Vessel Traffic Services. IALA's text tends to directly command to the vessel but still emphasizes to "assist the decision-making process of bridge team" which, in practical terms, has little or no value. Let's go through the lines from above mentioned Guideline:

"A Navigational Assistance Service is a service that provides essential and timely navigational information to assist in the on board navigational decision-making process and to monitor its effects. It may also involve the provision of navigational advice and/or instruction."

"The Navigational Assistance Service is especially important in difficult navigational or meteorological circumstances or in case of defects or deficiencies."

"A Navigational Assistance Service is an important supplement to the provision of other navigational services, such as pilotage. Navigational Assistance Service may be provided at the request of a vessel, irrespective of whether a pilot is on board, or when a navigational situation is observed and intervention by the VTS is deemed necessary."

The scope and method of this assistance when the pilot is onboard requiring more detail as VTS and Pilotage are mostly overlapping in their respective service areas. From this perspective, the IALA document has no description on the method in which professional judgement of pilots to be supported by the VTS Operator, and how. Many VTS Operators interpret this kind of text as they are entitled to give "advice or instruction" to the pilot as well.

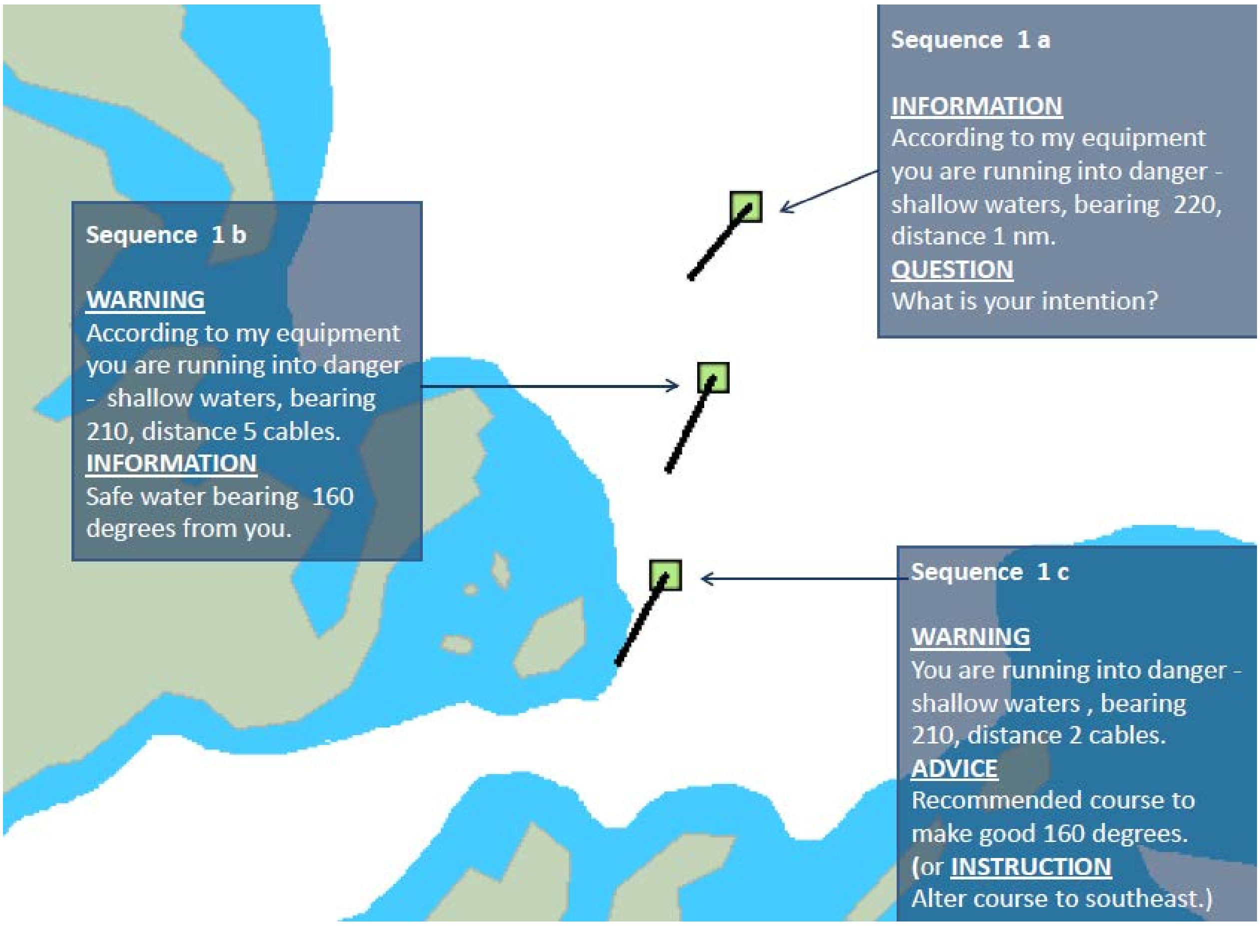

Figure 1. Example of VHF communication with Message Markers between VTS and ship during NAVIGATIONAL ASSISTANCE SERVICE (IALA Guide 1089)

IMO Guidelines on VTS, the Resolution A.857(20) associated with SOLAS regulation V/8-2 and describe the principles and general operational provisions for the operation of a vessel traffic service (VTS) and participating vessels and states the following:

“When the VTS is authorized to issue instructions to vessels, these instructions should be result-oriented only, leaving the details of execution, such as course to be steered or engine manoeuvres to be executed, to the master or pilot on board the vessel. Care should be taken that VTS operations do not encroach upon the master's responsibility for safe navigation, or disturb the traditional relationship between master and pilot.”

Despite the guidance status of IALA 1089 Guidelines, the IMO Resolution does have binding force as it has the reference of a mandatory Convention, the SOLAS. Still, IMO document selects more careful language regarding the rendering of NAS especially in cases when a pilot is on board, whereas the IALA is not following this attitude. The IALA Document (1089) is, in fact, expected to be a more detailed version of A.857 and in parts delivers on this purpose but; no reference made regarding the non-disturbance principle to the traditional relationship between master and pilot in the NAS section. It is interesting to see IALA takes a different path on this part.

IMO is well clear on what was intended in this proposition. Master and pilot have a relationship coming throughout the centuries and based on expertise and trust. F.F.Weeks from the University of Plymouth describes the VTS Operator and Pilot from the place where shipmasters sit as follows [4]:

“To the captain, VTS is a shore organisation which is trying to tell him what to do, using unqualified personnel to do it. It wants to control him and his ship, but take no responsibility or liability for doing it. Remote and not friendly like those nice pilots”.

In my professional life, I heard this kind of complaints on many occasions from the ship masters. Most of the time masters’ complaint was the VTS Operator not assessing properly the situation their ships were in. This is an accepted argument also by IMO which resulted in leaving the decision-making process and last word to say to the bridge team.

IALA has identified that IMO Recommendation A.857 (20) is in urgent need of amendment and has set out a roadmap towards an update to be presented to IMO. This includes recognition that ‘The types of services need to be more clearly defined as they currently are a source for continuous debate’. It is expected that IALA will ask for amendments in accordance with their document 1089, which makes no reference to traditional relationship between the Master and the Pilot.

PILOTS’ DUTY: GIVING ADVICE

Pilot’s definition and duties are put forward mostly in National regulations rather than International. The main international document on Pilots is the famous A.960(23), which has two annexes: Annex One is on the “Training and Certification” and Annex II is on the “Operational Procedures of Pilots”, other than Deep Sea Pilots.

Despite the specific paragraph in the Annex II titled “Duties of master, bridge officers and pilot” the IMO document does not make any definition on the main duties of the Pilot and his “reason d’etre” on the bridge. Even the statement made at the first paragraph of Annex I cannot meet this need:

“It is recognised that pilotage requires specialised knowledge and experience of a specific area and that States with many diverse waterways and ports have found it appropriate to administer pilotage on a regional or local basis.”

Despite the fact that being the main role of Pilot to professionally advice to master, the word “Advice” or any type of synonym is not used throughout the IMO Resolution.

The Regulation on Pilots enforced by the Turkish Government, entitled as “Regulations of Competencies, Trainings, Certifications and Working Standards of Maritime Pilots” defines the “Duties of Pilot” in Article 22 as follows:

“Pilot advises the Master on the navigation of the vessel by using his professional knowledge and experience. In forcing conditions Pilot can provide this advice from another ship or from the shore. But, if the navigating waters fall within the authorization of a VTS, the advices given to other ships or manoeuvring agreements between the vessels they piloted done under the information of this VTS.”

The role of pilot to “Advise and Assist” to Master, and, Pilot’s enforcement by the “Competent Maritime Pilot License” is clearly defined in the Turkish Regulation.

The German Pilotage Act, as amended in 2010, also, begins with the "Definition of Pilot" at the first article, which is, as follows:

"A maritime pilot is an officially licensed professional adviser with the necessary local and nautical skills to guide ships outside ports on the maritime waterways and over the sea. The maritime pilot does not belong to the ship's crew."

The following articles are also from the German Act regarding the "advice duty" of Pilot:

"The maritime pilot shall advise the master in respect of the vessel's navigation. The advice may also be rendered from another ship or from shore."

"The master remains responsible for the vessel's navigation even if he allows direct orders of the maritime pilot in respect of the vessel's navigation."

"In the case of more than one maritime pilot assisting only one of them shall advise the master. The others shall assist the advising pilot. The master shall be informed prior to the pilotage, who will act as advising pilot."

The duties of pilot to advice is defined as many national legislations throughout the world. According to George Quick, this is not the case in North America, as he makes the following statement:

"Confusing the issue on checks and balances in the relationship is the mistaken perception that the pilot is aboard in an advisory capacity. This is not true in actual practice in pilotage waters or in the law as applied in North America. The pilot "conducting" the ship gives all the directions concerning the ships movement and it is the master who may advise the pilot as to the capabilities of the ship or its equipment or crew. If the master was actually giving the directions with the pilot's advice the ship would not be under pilotage and in compliance with the local laws The distinction is important because if the pilot were merely an advisor whose assessment could be accepted or rejected at will he could not fulfil his role as an independent judge of acceptable risks. He might be persuaded to go along contrary to his personal judgment under the belief that the master would have the final or ultimate responsibility for accepting the pilot's advice in the event of an accident.Although no American legal decision has ever held that compulsory pilotage was advisory in nature, confusion on this issue could undermine the pilot's perception of his role. The "pilot as advisor" myth persists reinforced by the entry in some log books "Proceeding to master's orders and pilots advice" that could have its basis outside our legal system in some decisions of the courts in Continental Europe" [5].

The term in resolution A.857 mentioning the "Traditional relation between the Master and Pilot" needs clarification, and in doing so, the term mentioned above by Capt. Quick "Proceeding to master's orders and pilot's advice" might be a good point to begin with. The actual scenario in most pilotage performance is so that the pilot takes the "con" of the ship. The legal description of this is so that pilot gives the advice and master –if in agreement- passes this to as an order. The advice to be converted to order is mostly a route to be steered or an engine command, which is directly related to safe conduct of a vessel. This important cooperation led master a pilot to a relationship based on trust and confidence which has in years become traditional. But, how this can be "disturbed" by NAS provided by a VTS?

The wording of IALA 1089 paper giving us some hints. In the whole text of paper there is no cooperation with the Pilot onboard is being mentioned. It remains in question whether there is adequate –if not any- cooperation between the international body of pilots, the IMPA and the producer of the paper, IALA.

DISCUSSION

A VTS providing Navigational Assistance Service needs further clarification and distinction and this issue has already been accepted by the main actors. On the other hand; concentrating more on NAS increasingly cause more and more VTS services around the world evolve towards a direction in which the main task of a VTS, “providing information” is being taking out the common practice.

In the daily practice, any ashore listener of radio communications between the ship and VTS would have the impression that the Ship is the information provider and VTS is providing less –if any- information to the ship but mostly instructing the ship on what to do; most of the time without the message marker of Advice or Instruction being used.

This might be due to evolving of reliable information sources other than VTS made available to decision makers on the bridge which has the capacity to convert the future VTS to a silent one.

Most VTS operators tend to advice to ships even if the pilot is on board. In a cooperative climate this could be an acceptable situation by the master and the pilot; but human relations has its own importance and manner gains importance here.

There is an apparent conflict between the pilot’s task to provide “advice” to the master and the VTS Operator’s task to provide advice or instruction to the pilot or master-especially in cases when this is not requested by the latter.

In most cases of conflict providing information could be enough; but at sea, the word “safety” is very broad as a concept. How VTS operator will decide if the situation requires an information provision or an advice or an instruction? In the restricted waters or ports where VTS’s and pilots usually operate, any situation-with a short consequence- can lead to a dangerous situation and there is much difficulty for the VTS operator to make a precise assessment on the course of action: an information, advise or instruction? To get rid of the responsibility, the latter might be preferred in most cases.

From the pilot’s perspective; most interventions by the VTS are not based on sound necessity. Pilots usually welcome the provision of information but same could not be said when it comes to receiving advice or instruction; as they are the professionals officially authorized by the Government to provide advice.

Looking at the IALA Guide of 1089 for a further clarification; the following lines worth noted:

“When the VTS observes a developing situation (e.g. a vessel deviating from a recommended route) and deems it necessary to intervene, it is likely that, under such circumstances, the immediate priority will be placed on providing the necessary assistance before attempting to formally negotiate the commencement of navigational assistance. However, once the immediate situation has been resolved, the continuation or completion of the service should be subsequently clarified and the use of the checklist considered.”

Here, IALA proposes a "direct intervention" of VTS Operator to the ship's "decision making" which is by-passing the initial formalities -such as the commencement of the procedure- due to the time limitation. A direct intervention in an 'instruction' format will bring the questioning of the quality of this instruction; there could be cases it helps the maritime safety but there could also be cases that it might lead to a VTS assisted accident. The liability issue also, needs to be visited here after a concrete intervention of shore to the ship.

Another aspect is the appropriateness of remote decision making. In A.857 (20) it was clearly put forward that the authority of decision making belongs to the Ship's bridge team. What VTS does provide –in any format of NAS- was classified in assistance to decision making. The new IALA proposal in Guide 1089 goes one step forward and leaves very little or no margin to decision making on the bridge.

Having submitted a paper to IALA's VTS Committee on it's 41^{st} session, Commodore Barry Goldman, a etired Royal navy officer, proposes another solution. Suggesting the removal of "Navigational Assistance" from the list of services which VTS provide, Goldman states the following:

"The lack of consistency between ports in service declaration is evidence that the current terminology gives rise to confusion between a 'Navigational Assistance Service' as a VTS procedure providing navigational assistance as defined and recognised by IALA, and a 'Remote Pilotage Service' as a pilotage service providing navigational assistance as locally authorised by national pilotage regulations. Looking to the future, this confusion could be much more elegantly overcome by removing the term Navigational Assistance Service from the IMO Recommendation on VTS as a type of service altogether leaving 'Traffic Organisation Service' and 'Information Service' as the two main types of service that a VTS Authority might provide. The provision of navigational assistance (again, no capitals) at the request of a vessel or by the VTS when deemed necessary should still be recognised within IMO and IALA doctrine, but simply as a VTS technique or procedure that any VTS Centre should be prepared to deliver under such circumstances. Redefining navigational assistance in the IMO Resolution should require that training in navigational assistance continues to be given to all VTS Operators, but that it is a 'procedure' rather than a 'service'."

"IALA has identified that IMO Recommendation A.857 (20) is in urgent need of amendment and has set out a roadmap towards an update to be presented to IMO. This includes recognition that 'The types of services need to be more clearly defined as they currently are a source for continuous debate'. A redraft offers a timely and golden opportunity to remove NAS as a VTS 'Service', thus simplifying service provision and removing the current terminological confusion over NAS in the minds of many mariners, VTS Operators, VTS Authorities and even Competent Authorities" [6].

In a paper submitted to IALA by International Harbour Masters' Association also favoured the removal of NAS from the Services of VTS. In their paper the following statement was made:

"Current VTS service provision is mandated by the IMO within Resolution A.857(20). The need to update this Resolution has been recognised and a task to update the Resolution forms part of the current work plan. The recently issued IALA Strategy Paper recognises that confusion exists over service provision and identifies at its Annex B that "The types of services need to be more clearly defined as they currently are a source for continuous debate". IALA has also invited the IMO Sub-Committee to note that "some IMO Member States, co-sponsored by IALA, may consider a submission to the Maritime Safety Committee with a proposal for the review of resolution

A.857(20)”. The current task of submitting a proposal for an update to Resolution A.857(20) to IMO is, therefore, a unique opportunity to address the confusion over NAS.”

In conclusion, it can be said that there is a wide consensus amongst the stakeholders in the sector that the navigational assistance service provided by VTS is not clearly defined and leads to confusion.

It further creates conflicts and has the potential to disturb the traditional relationship between the master and the pilot.

This paper aimed to assist the review efforts of A.857 (20) in the light of current practices.

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APPLICABILITY OF REMOTELY OPERATED VEHICLES IN UNDERWATER MAINTENANCE SYSTEMS OF SHIPS: A LOW-COST HULL CLEANING ROBOT

Onur GÜNAY[1]

ABSTRACT

Sea transportation is the backbone of international trade and it has some crucial issues. One of these issues is greenhouse gases that are related with atmospheric pollution. Recently, a considerable literature has grown up around the theme of decreasing greenhouse gas emissions and improving fuel efficiency of ships. One of the main obstacles of propulsion efficiency of ships is marine biofouling on ship hulls and removing organisms from ships. In the traditional system the cleaning of ship hull is carried out in dockyard or by divers in harbor. This progress substantially causes time loss for ships and shipowners besides high risks and high cost. Recent studies proved that underwater robots have an increasing popularity in terms of cleaning ship hull surfaces. This paper presents a robotized visual inspection and hull cleaning system. For this study a low-cost hull cleaning robot is designed and aimed for observation in shipping maintenance systems. Theoretical and practical applications of robotic technologies are examined.

Keywords: Underwater Robots, ROVs, Hull Cleaning, Ship Maintenance Systems

INTRODUCTION

Sea transportation via ships is a major industry which emits greenhouse gases. For the year 2012, total shipping emissions exceeded 900 million tones CO_2 and maritime CO_2 emissions are projected to increase considerably in the next decades [1]. Greenhouse gas emissions are related with atmospheric pollution. Considerable literature has grown up around the theme of decreasing greenhouse gas emissions and improving fuel efficiency of ships. Marine biofouling on ship hulls is one of the main obstacles of propulsion and fuel efficiency of ships.

The accumulation of living organism (biofouling) and non-living substances on submerged surface of the ships, increases ships total frictional resistance and reduces ship total propulsion efficiency. Frictional resistance is equivalent to approximately 80% of total resistance in slow-speed ships like oil tankers and as much as 50% in high-speed vessels like container and cruise ships [2]. If a ship has fouling surfaces, the propulsion requires more power demand in same service speed due to the friction and this causes more fuel consumption. Aertssen [3] showed that moderate fouling in ferry's submerged surface increases the power requirements by 30%. Wilne [4] supports that without any attempt to use Anti-Fouling (AF) coating, shipping would require 40% more power.

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Different conditions of hull affect total ship resistance as shown in Table 1. Schultz [5] experimentally obtained the data of the resistance force change **(ΔRT)** and the rate of the resistance force change **(%ΔRT)** according to different ship hull surface conditions and different velocity values. In the light of the experimental results, it is seen that in the condition of heavy calcareous fouling while the velocity of the model (V) is 7.7m/s, ΔRT is equivalent to 162 kN. It has a rate of 80% .

Table 1. The change in total resistance with a range of representative coating and fouling conditions according to Schultz study [5]

	ΔRT (kN) **V=7.7 m/s**	**%ΔRT** **V=7.7 m/s**	**ΔRT(kN)** **V=15.4m/s**	**% ΔRT** **V=15.4 m/s**
Typical as applied AF coating	4.6	2	46	4
Deteriorated coating or light slime	23	11	118	10
Small calcareous fouling or weed	69	34	305	25
Heavy calcareous fouling	162	80	677	55

In a traditional system the ships' hull cleaning operations are carried out in dock yards or by divers in harbors. This progress substantially causes time loss for ships and ship owners. Besides, it includes high risks and high cost. In last decades, remotely operated vehicles (ROVs) are used for various missions especially for ship hull cleaning operations in shipping industry. ROVs are unmanned and tether controlled system which provide efficient and cost effective solutions instead of conventional methods. For instance, they are used for cleaning the ships' hull surface. This paper suggests a low-cost hull cleaning robot system for the ship repair industry.

TRADITIONAL HULL CLEANING METHODS

Blasting and anti-fouling coating operations in the shipyard are crucial issues and ship-owners pay more attention on these subjects. The hull cleaning processes in shipyard are described as; flat bottom cleaning, hull blasting, blasting primer, hull degreasing, high pressure fresh water cleaning and hosing down[6]. These progresses substantially cause time loss for ships and shipowners. Also, they involve remarkably risky operations and their price is markedly high.

The hull cleaning process has a large share in ship repair and maintenance industry. The notable example of this situation is Tari's study [6]. Tari examined 71 different shipyard bills that received for repair and maintenance in different countries. Total bills are evaluated per ships' repair costs according to DWT rates. The largest share is hull cleaning, painting and antifouling coating, as shown in Figure 1.

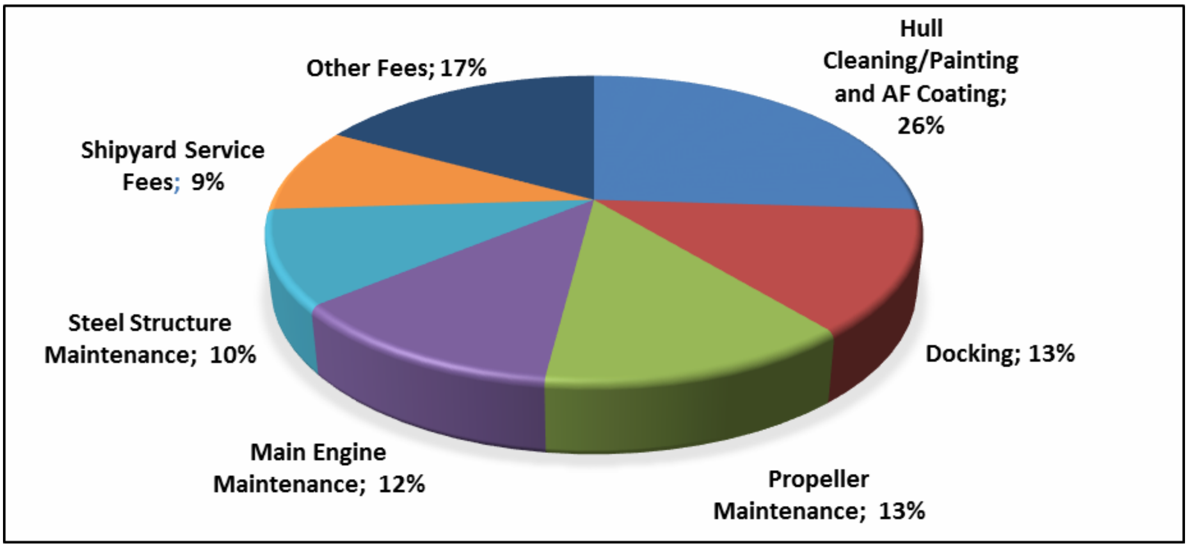

Figure 1. Shipyard repair and maintenance costs [6]

A LOW-COST HULL CLEANING ROBOT

This study aims to introduce a low-cost hull cleaning robot design. An Underwater Hull Cleaning Robot (UHCR) system is proposed. Underwater Hull Cleaning Robot (UHCR) consists of four main groups. These are main frame, battery pack, thrusters and electronic hardware. The lithium-polymer (Li-Po) battery pack is located on the vehicle and stores all of the power capacity for submerging, positioning and hull cleaning operations. UHCR also uses 4 brushless DC(direct curent) motors for moving in water environment and it uses a high torque dc motor to rotate brush. UHCR is controlled by a remote control system and human operator can directly manage motors and camera view via data and signal line in real-time. In general, remote control underwater robots have tethered system because radio frequency (RF) waves penetrate only a few wavelengths into water due to water's high attenuation of its energy [7].Unlike wireless terrestrial communication, UHCR's control system prefers to communicate via tether in water. The design scheme of hull cleaning underwater robot, proposed in this study is illustrated in Figure 2. All aspects of design principles are the following;

- The weight of UHCR should be minimized for a person to launch and pull body frame out of the water (A total body frame material is 7 kg in the air).
- During cleaning operation, the robot moves along the ship hull while brushing surface.
- The cleaning brush is fixed to UHCR's body frame and UHCR moves along the ship submerged surface with rotating brush.
- Center of gravity (CG) and center of buoyancy (CB) must pass through the same vertical axis and center of gravity must be below the center of buoyancy. On the other hand, the body is not in equilibrium, and will rotate to bring CB and CG into vertical alignment.
- UHCR have positive buoyancy in beginning. If there is an emergency situation (battery's out or situation of thrusters break down), UHCR automatically moves to surface.
- Robot has only one camera to record images before and after cleaning. The operator can control the robot and monitor the hull cleaning operation in real-time.

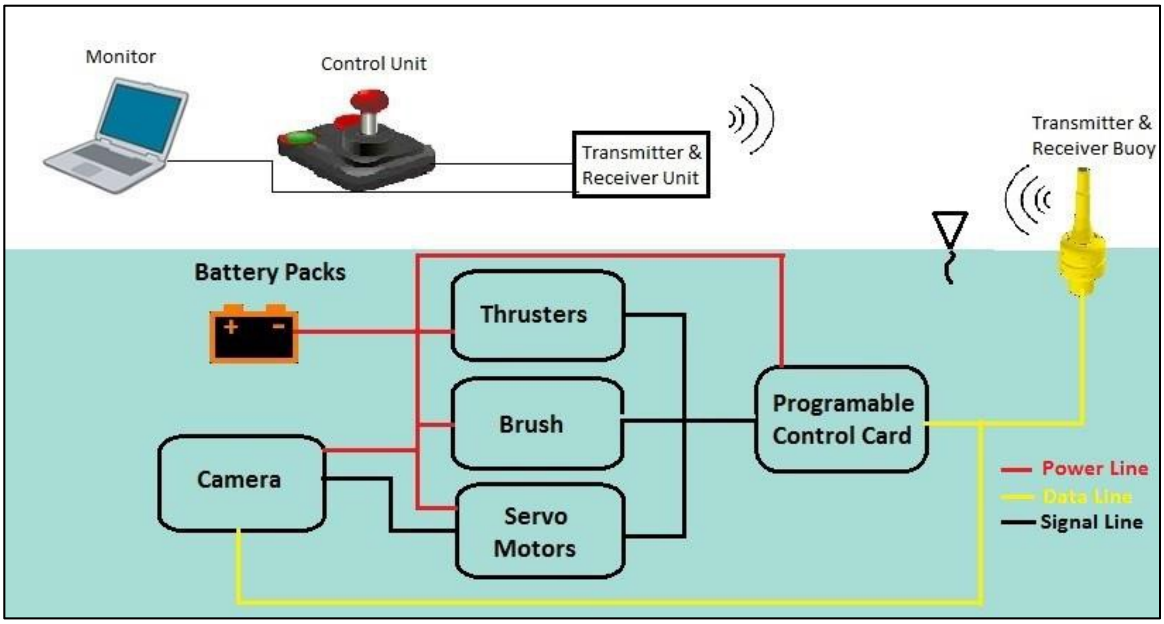

Figure 2. Underwater Hull Cleaning Robot (UHCR) block diagram [Source: Authors]

Submerging Thrusters and Battery Capacity Evaluation

UHCR have positive buoyancy in beginning and it is submerged into water by force of 2 brushless thrusters. As a crucial equipment, submerging thrusters must work during all cleaning and positioning operations. Submerging thrusters consume more electric power than other thrusters and equipment. Because of the positive buoyancy, UHCR provides an opportunity to submerge with additional weight. Thus, UHCR's density can be determined same as water.

The friction force substantially increases while submerging so it must be calculated to choose the capacity of thrusters and batteries. The required power can be calculated as;

$$P = F_s . V \tag{1}$$

where P is required power for submerging, V is cruising speed, F_s is resistant force. F_s is directly related with density of water (ρ=1030kg/m^3), UHCR's horizontal cross-stream area (A), maximum cruising speed (V) and drag coefficient (C_d). C_d (drag coefficient) depends on environmental conditions [8]. We can assume 'C_d=1.5' and 'V=1.5 m/s' (As assumptions for flat plate C_d=1.2, for open frame structure C_d is more than 2, for sharpen surface like a torpedo C_d=0.4), and the formula is as follows;

$$F_s = \frac{1}{2}\rho A V^2 C_d \tag{2}$$

The resistant force can be calculated as;

$$F_s = (0.5)x1030kg/m^3 x0.29m^2 X\,(1.5m/s^2)^2 x1.5 \tag{3}$$

$$F_s = 504.05\ N$$

The required power can be calculated as;

$$P = 504.05\ N\ x\ 1.5\ m/s = 756\ Watt\ (total\ thrust\ power) \tag{4}$$

Adequate thrust power for each thruster is;

$P_{thruster}$=756Watt/2=378 Watt (each thruster) (5)

Submerging thrusters provide their energy from 2 12V-LiPo (lithium-polymer) battery package. Each one is 10 Ah (amperxhour). Thrusters consume the highest energy among the other modules so the minimum work-hour performance of underwater hull cleaning robot should be evaluated.(I is the Ampere which consume each thruster)

I=P/V (6)

I=378W/12V =31.5 Ampere

Minimum Working Time (hour) =Li-Po Capacities (Ah)/I (Ampere) (7)

Minimum Working Time=10/31.5=0.317 hours

Minimum Working Time=0.317hours x60 minutes/hour=19.02 minutes

The system can work for 19 minutes at maximum power consuming conditions. If needed, additional lithium-polymer batteries can be added which weigh approximately 1 kg.

Hydrostatics and Stability Conversion

UHCR's frame is made of plexiglass and total frame weighs 7kg in air. It also provides approximately 22 kg buoyant force in water. As a positive buoyant vehicle, UHCR allows to carry equipment up to 15 kilograms.

Center of gravity (CG), as a center of the total gravity forces and center of buoyancy, as the geometric center of total volume are the key factors for robots' stability. Center of gravity (CG) and center of buoyancy (CB) must be located on the same vertical axis and center of gravity must be below the center of buoyancy. On the other hand buoyant forces and gravity forces create a righting moment for UHCR (Figure 3).

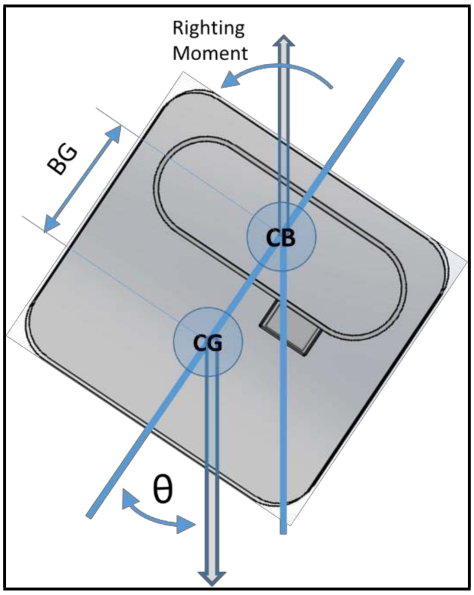

Figure 3 Righting moment[7]

In Figure 3; BG represents the distance between CG and CB, θ represents the angle of trim, M represents the righting moment and W represents the total weight of the system.

$$M = W x BG \sin\theta \qquad (8)$$

Depending on this theory UHCR has significant buoyant volumes which are located on the topside and a heavy equipment is located on the bottom side. This design principle makes the system stable. Thus the structure can be controlled easily. This study is based on these principles and the design is developing accordingly.

Body Frame, Brush and Cleaning System

This study aims to introduce an UHCR design. Body frame of the robot is made of plexiglass which enables a combination of strength, transparency, lightness and processability. UHCR frame includes three main parts; ellipsoidal floatation body and two solid plexiglass plates. The thickness of body frame has been chosen as 8mm.

Underwater cleaning system is the combination of brush and high torque DC motor. The cleaning brush which is fixed to UHCR's body frame makes a rotary motion and UHCR moves along the ship's submerged surface. Cleaning system also uses spring mechanism to absorb the impact effect that occurs between the robot and the ship's hull. In Figure 4, the general arrangement layout of UHCR is illustrated.

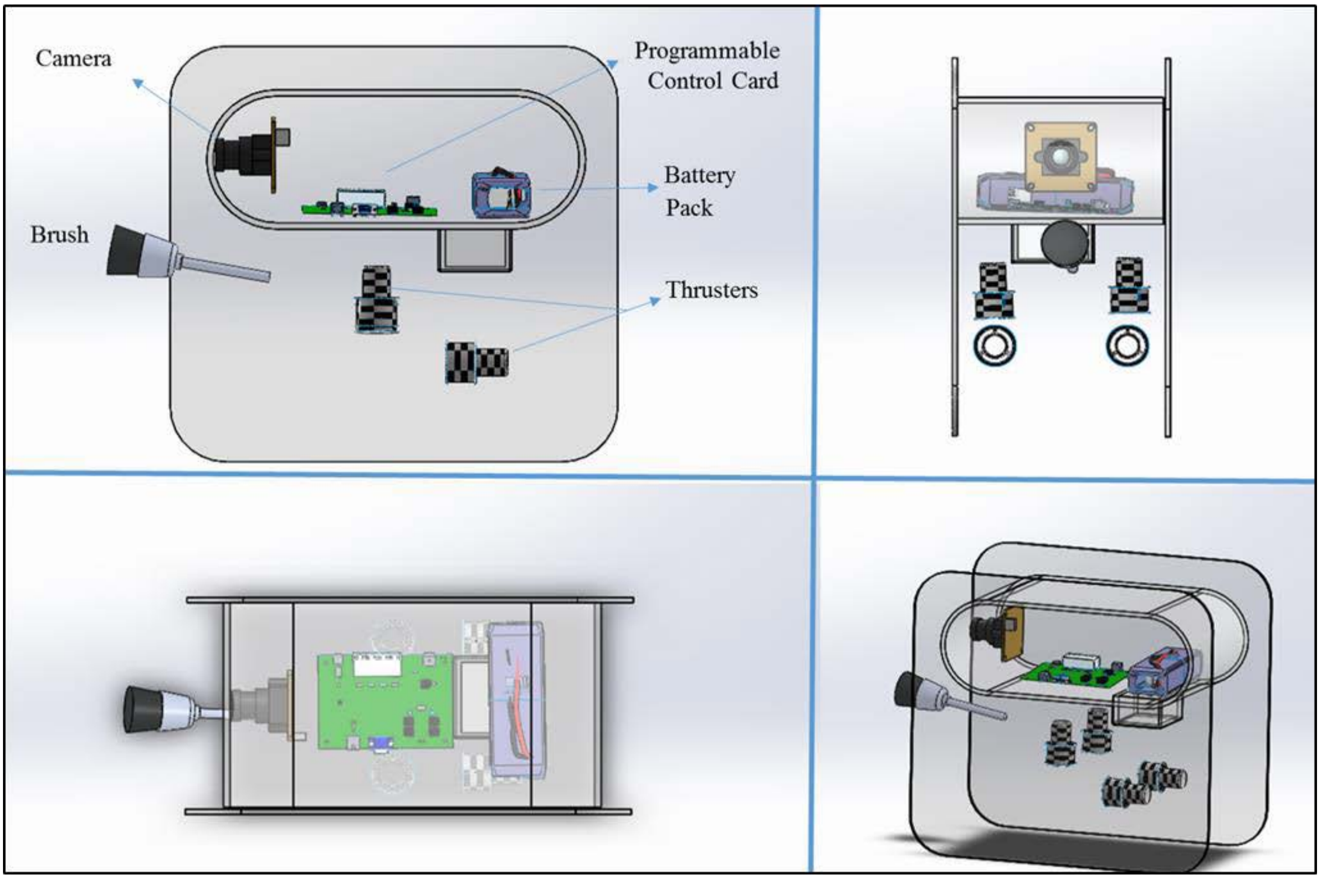

Figure 4. General Arrangement Layout [Source: Authors]

The proposed UHCR is designed to be a compact and modular system. With this design perspective, UHCR's hardware and structural configuration is easy mountable. For instance if there is a need, UHCR can be used for searching and rescue operations by adding sonar sensor modules. This features make the design more useful and effective in a wide range of various marine applications than previous designs.

CONCLUSION

In this paper, a low cost underwater robot, which has a ship hull cleaning function, has been proposed and developed in theoretical and practical ways. The proposed novel design aims to clean ship hull surface via low cost, time saving and easy controllable methods. This system has to be developed for experiments and scientific studies. It has been obviously seen that robots are good alternatives as a full-time workers in shipping industry especially for new current ship repair and maintenance profession. In this study, theoretical calculations are evaluated. Experimental studies have to be performed and the results must be presented for further discussions.

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HULL FOULING EFFECT ON PROPULSION SYSTEM COMPONENTS

Çağlar Dere[1], Çağatay Kandemir[2], Burak Zincir[3], Cengiz Deniz[4]

ABSTRACT

With the decreasing of freight rates by the economical narrow pass, ships stay at anchorage for longer times by ship owners or management companies. This situation has a boosting effect on the impetus of hull fouling of the ship. Drag resistance of the ship increases considerably, if smoothness of the hull is distorted by various type of seawater clams and other marine creatures. By the increasing drag force of the hull, operating conditions change and this affects components of propulsion systems starting from propeller to thrust bearings, crankshaft and shaft bearings, cylinder pressures, combustion parameters, system frictions and turbocharger operating conditions respectively. In this study, exposure rate of propulsion system components under the influence of increased hull resistance is analyzed based on expert opinions by using simple additive weighting method. Experts give points to affection degree, maintenance difficulty, and maintenance frequency of the components criteria, and affection level of these components are found. By the calculation of these three criteria points, total affection factor is found 0,201, 0,191, 0,167, 0,159, 0,145, and 0,137, respective to crankshaft, cylinder cover, thrust bearings, propeller, piston and their elements, and turbocharger. These results show that hull fouling highly affects crankshaft. Cylinder cover, thrust bearings, propeller, piston and their elements, and turbocharger follows crankshaft after. The aim of the study is to show the negative effect of hull fouling on main engine and propulsion system, and raise awareness of ship owners and management companies.

Keywords – hull fouling, ship propulsion, fouling effect, propulsion components

INTRODUCTION

Hull fouling negatively affects commercial interest of ship owners or operators, and effective and efficient operation of ships. With the increasing age of the ship, passing time from last hull cleaning, and longer waiting time at anchorage due to nowadays' commercial situation boosts hull fouling rate. Fouling increases the mass and hull friction resistance of the ship, and affects hydrodynamic characteristics, operating speed and maneuverability of the ship [1]. Drag resistance of the ship increases considerably, if smoothness of the hull is distorted by various type of seawater clams and other marine creatures. Ship resistance is increased by the more water is dragged forward along with the ship [2].

At the design stage of a ship, propulsion system and machinery calculations are done via using the initial parameters of the keel and addition of sea and engine margins to determine maximum power

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output of the main engine. By the increasing drag force of the hull, operating conditions change, and ship speed reduces or required power increases to achieve same ship speed. Schultz indicated that the effect of light and heavy slime negatively impacts ship performance up to 19% [3]. Also, Anderson referred that by the increase in hull roughness from 130 microns to 280 microns the required power to provide same operating speed increases between 0,40 to 4,6% [4].

Operating condition changes by the hull fouling affects components of propulsion systems starting from propeller to thrust bearings, crankshaft and shaft bearings, cylinder pressures, combustion parameters, system frictions and turbocharger respectively. In this study, exposure rate of propulsion system components under the influence of increased hull resistance is analyzed based on expert opinions. Consideration of the given points by the experts, both importance factor of the main engine and propulsion system components, and exposure level of these components are found.

PROPULSION COMPONENTS OF A SHIP

The increase of hull resistance by the fouling of ship body not only results in operational loses such as reduction of speed, deficient fuel efficiency, but also results permanent damages in propulsion components.

How can propulsion components affected by the fouling of the body? By the increasing of fouling degree of the hull, required thrust increases naturally to move the ship at the same speed. Also increasing of roughness or ship displacement and sea conditions can cause increase of ship resistance. All propulsion system components, components of production and transmission of the power, between main engine to propeller are exposed to higher power tension conditions than designed.

Propulsion system take the limitations from machinery and bearings. That is called operational limit for propulsion system. In modern two stroke main engines maximum cylinder pressure can reach around 130-140 bars and mean effective pressure is about 18-18.5 bars with the contribution of new technological materials. Producing more power to meet the required torque for propulsion with the same engine means, increasing of this values and push or surpass the existing limitations. It causes overloading and result in cracks, broken parts or any damage risk raises for propulsion components while running extreme conditions.

Propeller

Flow regime around the propeller is directly related with the hull and flow around hull. With the fouling of the hull, flow regime in the after body of the ship is blemished and flow characteristics through to propeller decay the wake characteristic which is the fundamental criteria in the design of the propeller for interaction with the ship's hull. With the increase of hull fouling propeller power demand increases. Generated power from main engine cannot run propeller at planned rpm in fouled hull ships. Main engine must be operated higher load conditions, which means overload conditions for both machinery and propeller, to meet rpm desired, moreover machinery limitations could be exceeded it all depends percentage of fouling degree [5]. Overloading of propeller may cause erosion and cavitation effects on propeller surfaces.

Thrust Bearings

Propeller transfers axial power, torque, to thrust to move the ship. This force has an opposite reaction naturally and must be coupled with ship's hull. Because machinery foundation is not designed to handle such a big horizontal force. This coupling task is undertaken by thrust bearings to carry out absorbing fluctuating forces or vibrations generated by propeller. By the increase of power to move the ship severity of such forces and vibrations gets larger and causes harmful effects on these bearings.

Crank-Shaft & Main Bearings

In reciprocating engines vertical forces from piston rod are transferred to circular motion by crank-shaft. Main bearings are crucial support component to crank-shaft to handle with these forces. Pressure in the cylinder is transmitted via crosshead and result in as a torque when multiplied with the area of piston head. Hence, increasing of in cylinder pressures increase forces on the crank-shaft and also bearings. For this reason main engine has torque limitations at higher output engine powers because of main bearing limitations.

Piston Assembly

Piston head, compression and lubrication rings and piston rod can be called as piston assembly. The main purpose of this component is transmit power to crank-shaft that induced in combustion chamber.

There is two ways to achieve increasing power of the engine. First one is about dimensions, such as increasing number of cylinders or increasing swept volume of cylinders. This way impossible for operation. Another way is increasing in cylinder pressure like maximum pressure and mean effective pressure. Friction of the piston rings related with pressure in cylinder and lubrication regime. Pressure and temperature of combustion increases together. By the increase of these values wearing and damage risk of piston rings increases.

Cylinder Cover

In two stroke large marine engines, cylinder cover is placed upwards of the each cylinder block to enclose the combustion chamber. This component also has another function that, fuel injectors and exhaust valves mounted in it. Fuel injector number can be more than one for each.

To operate main engine at same speed to meet higher propulsion power, injected fuel for per cycle must be increased. It is the only compensatory action that can be done at operation to increase output power in cylinders. With the increase of fuel index, combustion parameters increase such as temperature and pressure. Cover is exposed higher temperatures and gets difficult cooling these parts. Operating at higher loads is not affordable and could have harmful effects on cylinder cover, exhaust valve and fuel injectors.

Turbocharger

Removing burned gasses out of the cylinder and let scavenge air into cylinder in a short time period while piston around bottom dead center, Turbo-Charger (T/C) is crucial component to achieve this phenomena in large diesel marine engines. Pressure and temperature of the exhaust gases are important parameters to drive the turbine. In large marine diesel engines exhaust gases pass to exhaust manifold from cylinder before turbine and let T/C constant pressure mixture to run it at steady state conditions. Unfortunately T/C system cannot supply sufficient air to main engine while running half and low loads, besides, because of designed running conditions for maximum efficiency optimum pressure must be supplied for optimum speed of T/C system. As mentioned before demanding more power from engine only can be achievable by the increasing of the pressure in cylinders. Increasing of the combustion parameters raise pressure and temperature the after combustion that means overloading of the T/C system too. Running T/C system at inappropriate or poor conditions, such as high temperature, pressure or higher speed than designed may cause lack of effectiveness or damages.

SIMPLE ADDITIVE WEIGHTING

Simple additive weighting method (SAW) is one of the most widely used Multi-Criteria Decision Making (MCDM) methods. It is also known as weighted linear combination model and it is very simple to be utilized. It uses aggregation of the criteria outcomes. An evaluation score is obtained for each alternative by multiplying them with the criteria weightings which were already assigned by the decision makers (or experts) [6]. In order to find most affected machinery component; the Formula (1) which is below could be used according to SAW.

$$A^{*} = \left\{ u_i\ (\boldsymbol{x}) \mid \max u_i\ (\boldsymbol{x}) \mid i = 1\ 2,...,\mathrm{n} \right\}, \tag{1}$$

As a calculation step for obtaining weighted scores for each alternative, also the Formula (2) could be used;

$$u_i\ (\boldsymbol{x}) = \sum_{j=1}^{n} wj\ rij\ (x), \tag{2}$$

Where $u_i\ (\boldsymbol{x})$ indicates the utility of the *i*th alternative and i=1,2…n; wj denotes the weights of jth criterion, while $rij\ (x)$ is the normalized obtained scores of the ith alternative regarding to jth criterion. In this study there are six alternatives to be evaluated with respect to the three criteria. Expert judgments are asked for the following conditions which are taken into account in further steps.

C_1) Negative affection degree of the relevant ship machinery components due to hull wearing is asked to the experts' numerical expressions.

C_2) Difficulty degree of the relevant ship machinery component when routine maintenance is to be carried out.

C_3) Maintenance frequency of time for the relevant ship machinery component regarding to its scheduled period.

The considered machinery components are; crankshaft, piston and its elements, propeller, cylinder cover, thrust bearing and turbocharger. Three experts from academia, and three experts from the shipping industry who spent their valuable years to the sector are expressed their opinions. They are shown in the Table 1 for the condition 1 (affection degree of the component).

Table 1. Numerical expert judgments with respect to the condition 1.

Machine Component	Affection Degree
Crankshaft	5,0
Pistons and their elements	4,3
Propeller	3,0
Cylinder Cover	2,3
Thrust Bearings	4,3
Turbocharger	3,7

For condition 2 and 3, see also Table 2 and Table 3, respectively. The numbers are obtained as taking the averages of all scores for each criterion and each alternative. For third condition, it is suggested to the experts to take advantage from related catalogues or another data about maintenance frequencies while making their judgments.

Table 2. Numerical expert judgments with respect to the condition 2.

Machine Component	Maintenance Difficultness
Crankshaft	8,3
Pistons and their elements	3,0
Propeller	8,3
Cylinder Cover	1,7
Thrust Bearings	7,0
Turbocharger	5,0

Table 3. Numerical expert judgments with respect to the condition 3 (as benefit attributes).

Machine Component	Maintenance Period of Time
Crank Shaft	10,0
Pistons and their elements	4,0
Propeller	20,0
Cylinder Cover	1,0
Thrust Bearings	20,0
Turbocharger	10,7

The values in the Table 3 means that for i.e; cylinder cover needs maintenance for each 0,5 dimensionless time period; while thrust bearings should be gone under maintenance for every 9 dimensionless time period. So, these values are considered as benefit attributes, as the Table 1 and 2 are cost attributes. All values of the Table 3 are taken reciprocal for transforming them into cost attribute at Table 4.

Table 4. Numerical expert judgments with respect to the condition 3 (as cost attributes).

Machine Component	Maintenance Frequency
Crankshaft	0,2
Pistons and their elements	0,6
Propeller	0,1
Cylinder Cover	2,2
Thrust Bearings	0,1
Turbocharger	0,2

The weights of criteria are also proposed to experts' consultancies. The weights are obtained for C_1, C_2 and C_3 are 0.4, 0.4 and 0.2, respectively.

Table 5. The normalized values.

Machine Component	Condition 1 *(0,4)*	Condition 2 *(0,4)*	Condition 3 *(0,2)*
Crankshaft	0,22	0,25	0,065
Pistons and their elements	0,19	0,09	0,16
Propeller	0,13	0,25	0,03
Cylinder Cover	0,10	0,05	0,65
Thrust Bearings	0,19	0,21	0,03
Turbocharger	0,16	0,15	0,06

For normalization process, classical normalization is used which makes the sum of all values equal to “1” for each criterion. The normalized values are shown in Table 5. In order to reach final results, all values are aggregated according to Formula (2). These final results are listed in the Table 6.

Table 6. Results.

Machine Component	Total Affection Factor
Crank Shaft	0,201
Pistons and their elements	0,145
Propeller	0,159
Cylinder Cover	0,191
Thrust Bearings	0,167
Turbocharger	0,137

Calculation results show that crankshaft has the highest total affection factor with 0,201, due to higher affection degree and maintenance difficulty than other machinery components. Secondly cylinder cover has higher total affection factor than other machinery components, excluding crankshaft. However affection degree and maintenance difficulty is lower than other machinery components, maintenance frequency is more higher than others with 2,2, and this ensures cylinder cover to be at the second place at total affection factor. Total affection factors of propeller and thrust bearings are close to each other, but thrust bearings get the third place by the calculation results of affection degree, maintenance difficulty and maintenance frequency. Remaining components get 0,159, 0,145, and 0,137 which are propeller, piston and their elements, and turbocharger, respectively.

CONCLUSION

Almost all of the maritime sector know the negative effect of hull fouling on ship performance. But there are not any adequate study about negative exposure of propulsion system components by hull fouling. In this study, hull fouling effect on propulsion system components are investigated by handling the subject from affection degree, maintenance difficulty, and maintenance frequency of the components.

Simple additive weighting method is used to evaluate experts opinions for each criteria. Three experts from academia, and three experts from the shipping industry expressed their opinions. From the results of experts opinions, affection degree of crankshaft is the highest with the point of 5,0. Piston and their elements, and thrust bearings get 4,3 point. Turbocharger, propeller, and cylinder cover gets 3,7, 3,0, and 2,3 respectively. Maintenance difficulty of propulsion system components are determined by the expert results as crankshaft and propeller with 8,3 points, thrust bearings with

7,0 points, turbocharger with 5,0 points, piston and their elements with 3,0 points, and cylinder cover with 1,7 points. Experts gave points to each component for maintenance frequency criteria by using both their experience and also engine catalogues or other supportive documents. Cylinder cover, piston and their elements get 2,2 and 0,6 points respectively. Crankshaft and turbocharger get 0,2 points, and propeller and thrust bearings get 0,1 points. By the calculation of these three criteria points, total affection factor is found 0,201, 0,191, 0,167, 0,159, 0,145, and 0,137, respective to crankshaft, cylinder cover, thrust bearings, propeller, piston and their elements, and turbocharger. These results show that hull fouling highly affects crankshaft. Cylinder cover, thrust bearings, propeller, piston and their elements, and turbocharger follows crankshaft after.

This study shows that hull anti-fouling methods are more important than known. Anti-fouling paints have to be done effectively at dry dock periods of ships, and hull underwater cleaning has to be done at needed intervals to prevent negative effects of fouling on propulsion system components at the long time period.

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INVESTIGATION OF MARINE PROPELLER NOISE FOR STEADY AND TRANSIENT FLOW

Savas Sezen[1], Ali Dogrul[2], Sakir Bal[3]

ABSTRACT

Marine propeller is one of the dominant noise sources in marine vessels. The aim of this study is to predict the hydrodynamic performance and then the noise spectrum of a three blade marine propeller by a commercial computational fluid dynamics (CFD) code based on finite volume method. Steady and unsteady analyses have first been performed to determine the hydrodynamics characteristics of the propeller. Later on, Ffowcs William Hawkings equations have been employed to predict the propeller noise (total sound pressure) under non-cavitating condition. Several hydrophones have been positioned around the propeller as receivers which enable to evaluate far field propeller noise. The influence of different acoustic sources generated by propeller on the far field noise has been shown by monopoles and dipoles without taking quadrupole noise into account.

Keywords – acoustics, computational fluid dynamics (CFD), propeller noise.

INTRODUCTION

Nowadays, noise detection and reduction are one of significant design criteria. Especially, noise reduction becomes necessary for maritime engineering. Although semi empirical and empirical formulations are used for past studies related to acoustical calculations, computational aero-acoustic studies gain importance with the development in computer technology and calculation capability. Since the experimental studies are not cost effective, computational acoustics become a significant tool.

Underwater noise resources on marine vessels have mainly divided into sub-categories: engine noise, flow noise and noise generated by the propeller [1]. Noise isolation equipment is used to reduce noise by engine. To decrease hydrodynamic noise that is generated by the flow, proper hull design is needed. Noise of propeller is undoubtedly a dominant noise on marine vessels. Reducing the propeller noise is especially important for detection of vessels position and velocity. Due to this reason, not only hydrodynamic properties but also acoustic performance should also be taken into consideration for propeller design.

Changes in sonar technology and rapid improvements in war ships have considerably important role to enhance acoustic characteristics of modern vessels. Noise generated by the propeller has critical importance for underwater discovery and it is also related with the survivability of vessels. Propeller noise is mainly divided to two sub-categories: cavitation noise and non-

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cavitation noise. Propeller noise occurs due to pressure difference on blades. Propeller generates pressure waves via four different ways [2],[3].

- Displacement of water with rotating propeller blades,
- Pressure difference between front and back sides of propeller,
- Sharply pressure drop due to cavitation on front and back sides of propeller,
- Process of beginning, developing and damping of cavitation.

The first and second items above could occur with cavitation and without cavitation but these have only effects without cavitation. The other items occur under cavitation condition of propeller. In addition, propeller noise is divided into three sources of noises due to propeller loading, thickness and turbulence. On lower Mach numbers, noise due to turbulence is ignored and total noise is calculated by propeller loading and thickness.

Recently, Haimov et al. [4] have investigated experimentally propeller noise in model scale under non-cavitation conditions in a towing tank. For scaling up from experimental results of model to full propeller, cavitation impact in towing tank could not be observed correctly. It is stated that acoustical calculations made in atmospheric pressure tank give a best solution under cavitation conditions. These experimental results have been validated with CFD analysis. Ekinci et al. [5] have investigated hydrodynamic features of model propeller and noise prediction has been made by empirical formulations which are improved for low frequency. Hydrodynamic characteristics of DTMB4119 propeller and Seiun-Maru HSP propeller have been compared with both potential based LSM (Lifting Surface Method) and CFD code. Noise based on propeller blade sheet cavitation has been investigated with empirical formulations. In addition, this method has been applied under uniform and non-uniform flow conditions. Bagheri et al. [6] have investigated both acoustical performance and hydrodynamic features of a five bladed propeller under cavitation conditions. To start sheet cavitation on blade, either number of revolutions has been increased or pressure has been reduced under a certain value. It has been observed that rapid pressure drop is more effective than increasing of number of revolution at the outset of the cavitation. On the experimental study, number of revolutions has not been changed and velocity of inflow has been changed between 0-3.6 m/sec. This CFD study which is based on FW-H formulations has been validated with experimental results. According to the results, the difference between cavitation and non-cavitation noise has been observed as approximately 5-20 dB. Atlar et al. [7] have investigated noise of model propeller which belongs to fishing vessel experimentally in Emerson Cavitation Tunnel. Seol et al. [8] have studied propeller noise under non-cavitation conditions numerically at low frequency range. Ye et al. [9] have studied noise of three-bladed-propeller and the noise at the propeller shaft axis. Lidtke et al. [10] have investigated propeller noise which belongs to commercial vessel and cavitation has been modeled with Schnerr-Sauer model. For cavitation condition, time-dependent change in URANS model could not have predicted totally and cavitation at the tip vortex area could not have been observed as well. Therefore, it has been stated that LES method is more suitable for observing cavitation. Krishna et al. [11] have studied turbulent flow under time-dependent cavitation conditions at commercial software ANSYS Fluent by using LES and Eddy Viscosity model on full scale propeller. Far field noise has been calculated with FW-H formulations in time domain. Acoustical performance of propeller has been evaluated at different number of revolutions. Also, numerical results have been validated with experimental results. Seol et al. [12] have investigated non-cavitation and cavitation noise of propeller numerically. The non-cavitation noise has been predicted using time-domain acoustic analogy and boundary element method. Additionally, they have developed computational methods for the analysis of the propeller surface cavitation noise. The flow field has been analyzed with potential based panel method and then the time-dependent pressure datum has been used as the input for Ffowcs-Williams Hawkings formulation to estimate far field acoustics. Bagheri et al. [13] have studied acoustical performance of DMTB4119 propeller and a four bladed propeller under cavitation and non-cavitation conditions at different number of revolutions and they also have investigated effect of cavitation on total noise.

In this work, it is aimed to carry out some numerical analyses for prediction of hydrodynamic and hydro-acoustic performance of the well-known benchmark case, DTMB4119 propeller. The flow around the model propeller has first been simulated in a steady manner and performance characteristics have been obtained with a good agreement with the experimental data. Unsteady RANS analyses have then been performed and FW-H acoustic module has been employed for prediction of hydro-acoustic noise level of the propeller under non-cavitating conditions. The numerical results have been presented for different revolution numbers.

MATHEMATICAL FORMULATION

For the numerical analyses, the governing equations are the continuity equation and the well-known RANS equations for the unsteady, three-dimensional, incompressible flow. The continuity can be given as;

$$\frac{\partial U_i}{\partial x_i} = 0 \tag{1}$$

While the momentum equations are expressed as;

$$\frac{\partial U}{\partial t} + \frac{\partial \left(U_i U_j\right)}{\partial x_j} = -\frac{1}{\rho}\frac{\partial P}{\partial x_i} + \frac{\partial}{\partial x_j}\left[\nu\left(\frac{\partial U_i}{\partial x_j} + \frac{\partial U_j}{\partial x_i}\right)\right] - \frac{\partial \overline{u_i' u_j'}}{\partial x_j} \tag{2}$$

In momentum equations, U_i states the mean velocity while u_i' states the fluctuation velocity components in the direction of the Cartesian coordinate x_i. P expresses the mean pressure, ρ the density and ν the kinematic viscosity.

The well-known k-ε turbulence model is employed in order to simulate the turbulent flow around the propeller precisely. During the analyses, Reynolds stress tensor is calculated as follow;

$$\overline{u_i' u_j'} = -\nu_t\left(\frac{\partial U_i}{\partial x_j} + \frac{\partial U_j}{\partial x_i}\right) + \frac{2}{3}\delta_{ij} k \tag{3}$$

Here, ν_t is the eddy viscosity and expressed as $\nu_t = C_\mu k^2 / \varepsilon$ while C_μ is an empirical constant ($C_\mu = 0.09$). k is the turbulent kinetic energy and ε is the turbulent dissipation rate. In addition to the continuity and momentum equations, two transport equations are solved for k and ε:

$$\frac{\partial k}{\partial t} + \frac{\partial\left(k U_j\right)}{\partial x_j} = \frac{\partial}{\partial x_j}\left[\left(\nu + \frac{\nu_t}{\sigma_k}\right)\frac{\partial k}{\partial x_j}\right] + P_k - \varepsilon \tag{4}$$

$$\frac{\partial \varepsilon}{\partial t} + \frac{\partial\left(k U_j\right)}{\partial x_j} = \frac{\partial}{\partial x_j}\left[\left(\nu + \frac{\nu_t}{\sigma_\varepsilon}\right)\frac{\partial \varepsilon}{\partial x_j}\right] + C_{\varepsilon 1} P_k \frac{\varepsilon}{k} - C_{\varepsilon 2}\frac{\varepsilon^2}{k} \tag{5}$$

$$P_k = -\overline{u_i' u_j'}\frac{\partial U_i}{\partial x_j} \tag{6}$$

where, $C_{\varepsilon 1} = 1.44$, $C_{\varepsilon 2} = 1.92$, turbulent Prandtl numbers for k and ε are $\sigma_k = 1.0$ and $\sigma_\varepsilon = 1.3$ respectively. Further explanations for the k-ε turbulence model may be found in the paper of Wilcox [14], [15].

The aeroacoustics studies which mean induced noise by flow were firstly examined around cylinder by Strouhal in 1878 [16]. In that field, the tonal noise which was caused by wind around the cylinder was considered. In 1952, the important studies in acoustics field were studied by Lighthill [17]. In 1969, Ffowcs Williams-Hawkings expanded Lighthill's study [18]. The FW-H equation is an appropriate tool for predicting the noise generated by the complex motion of the solid bodies Today all far field noise prediction are based on the FW-H equation. On many fields such as automotive industry, offshore platforms and aeronautical, FW-H equation is used in far field noise prediction. In the early 1970s, noise predictions were in the frequency domain, after developing the computer technology, noise predictions has been evaluated on time domain. There are several formulations to solve FW-H equation in time domain. Especially, Farassat applied some formulations for the solution of the FW-H equation in the time domain. Today, Farassat formulation has been frequently adapted to several commercial soft-wares such as ANSYS Fluent and Star CCM+.

The FW-H equation is obtained for inhomogeneous wave equation by the help of the generalized derivative of continuity and momentum equation. FWH equation based on the free-space Green's function and enables to compute the sound pressure at the different observer location.

Hydrodynamic sound theory was developed by Lighthill in 1952. He developed inhomogeneous wave equation within turbulent region by rewriting Navier-Stokes equation in an exact form [11]. Lighthill's acoustic analogy is given below;

$$\left(\frac{1}{c^2}\frac{\partial}{\partial t^2}\nabla^2\right)\left[c^2\left(\rho-\rho_0\right)\right]=\frac{\partial^2 T_{ij}}{\partial x_i \partial x_j} \tag{7}$$

Lighthill acoustic analogy was developed by Ffowcs Williams & Hawkings for prediction of far field noise such as rotors, helicopters and propellers.

Ffowcs Williams & Hawkings general formulation is given below;

$$\left(\frac{1}{c^2}\frac{\partial p}{\partial t^2}\right)-\nabla^2 p=\frac{\partial q}{\partial t}-\frac{\partial F_i}{\partial x_i}+\frac{\partial^2 T_{ij}}{\partial x_i \partial x_j} \tag{8}$$

Here, T_{ij}; Lighthill stress tensor, F_i; hydrodynamic forces, c; speed of sound, p is the acoustic pressure.

Acoustic pressure consists of monopole term, dipole term and quadrupole term.

$$p(\vec{x},t)=p_T(\vec{x},t)+p_L(\vec{x},t)+p_Q(\vec{x},t) \tag{9}$$

NUMERICAL METHOD

Boundary Conditions

For CFD analyses, the initial and boundary conditions should be defined carefully depending on the flow problem. Correct boundary conditions lead the analysis to accurate results and prevent the unnecessary computational costs [19].

The computational domain consists of rotating and static regions. The inlet and outlet surfaces are velocity inlet and pressure outlet, respectively. The common surfaces between these regions are defined as interfaces. The surfaces far from the propeller are considered as symmetry planes in order to make the normal component of the velocity as zero. The propeller blades and the shaft are defined as non-slip wall. Detailed information about the boundary conditions applied in the analyses can be found in the theory guide of the commercial CFD solver [20]. Boundary conditions applied to the computational domain is given in Figure 1.

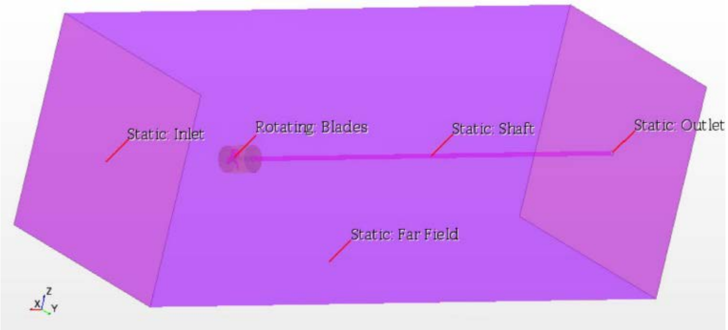

Figure 1. Boundary conditions applied to the domain

Computational Grid

The computational domain is discretized by three dimensional finite elements in compliance with finite volume method. In order to create a proper control volume, unstructured hexahedral elements are employed in the whole domain. The local mesh refinements are also made near the propeller blades to calculate the velocity and pressure fields around the blades precisely. Unstructured mesh of the computational domain is given in Figure 2.

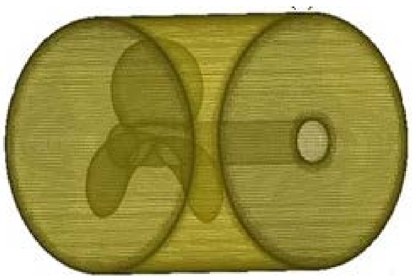

Figure 2. Unstructured mesh applied on the rotating region

Solution Strategy

The pressure field is solved by using SIMPLE algorithm which is based on pressure-velocity coupling. SIMPLE is a commonly used algorithm for calculating pressure and velocity fields in an iterative manner [21]. All governing equations are discretized using a cell based finite volume method and the advection terms are discretized with a first-order upwind interpolation scheme. Viscous effects around the propeller including the boundary layer are taken into account. Figure 3, on the other hand represents the receiver arrangement around the propeller. The receivers have been positioned both in propeller shaft axis and rotation axis. Table 1 shows the geometrical arrangement of the receivers.

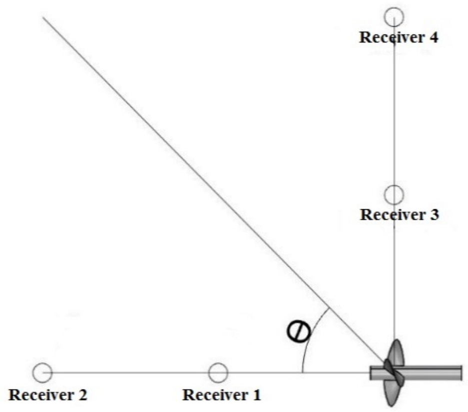

Figure 3. Arrangement of the receivers around the propeller

Table 1. Positions of the receivers

Receiver #	x (m)	y (m)	z (m)	Θ (degree)
1	1.524	0	0	0
2	3.048	0	0	0
3	0	0	1.524	90
4	0	0	3.048	90

Figure 4 represents the solution procedure for propeller acoustic problem. The procedure has been applied to get the acoustic performance of propeller.

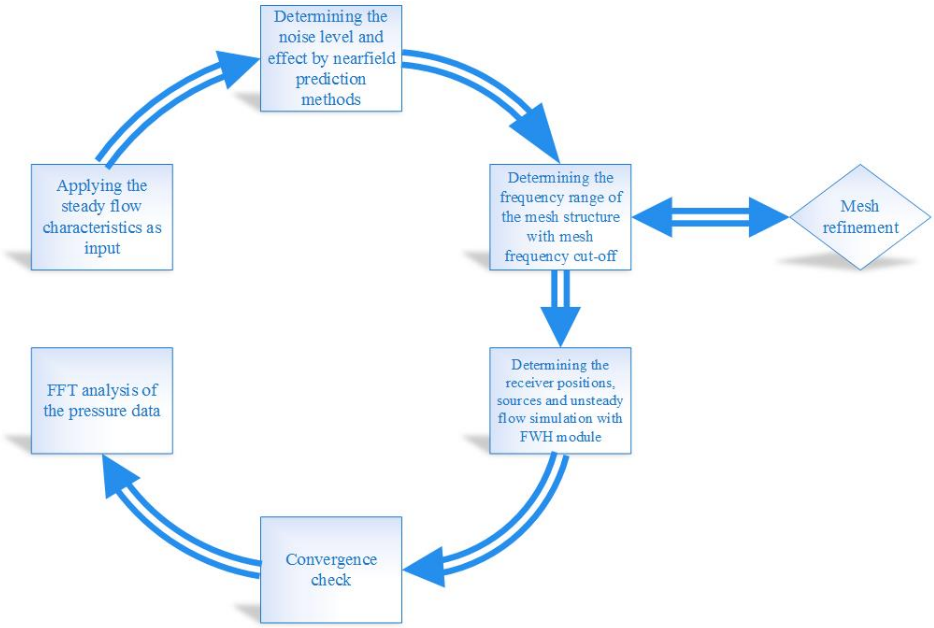

Figure 4. Solution procedure for underwater acoustics problem

RESULTS AND DISCUSSIONS

Geometry and Conditions

DTMB 4119 model propeller has been chosen for the investigation of flow and prediction of acoustical performance. Geometrical properties of the model propeller have been presented in Table 2. 3-D view of the DTMB4119 model propeller has been shown Figure 5.

Table 2. Geometrical properties of DTMB 4119

Delivered power, P_D (kW)	0.474
Advance speed (m/sec)	2.540
Model propeller revolution (rps)	10
Model propeller diameter, D (m)	0.3048
Number of blades, Z	3
Skew (degree)	0
Rake (degree)	0
Blade section	NACA66 a=0.8
Direction of rotation	Right

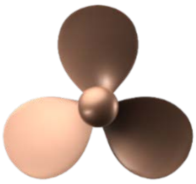

Figure 5. 3-D view of DTMB 4119 model propeller

The flow around DTMB4119 model propeller has been investigated using a RANS solver with k-ε turbulence model without time-dependency under non-cavitating conditions. Numerical results are compared with experimental measurements. As can be seen in Figure 6, CFD results are in a good agreement with the experimental ones. Velocity distributions and streamlines of the propeller are represented Figure 7.

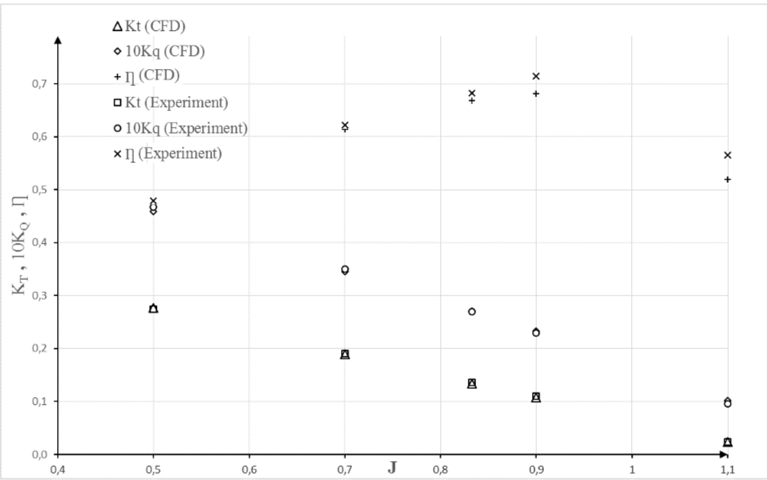

Figure 6. Open water diagram of DTMB 4119

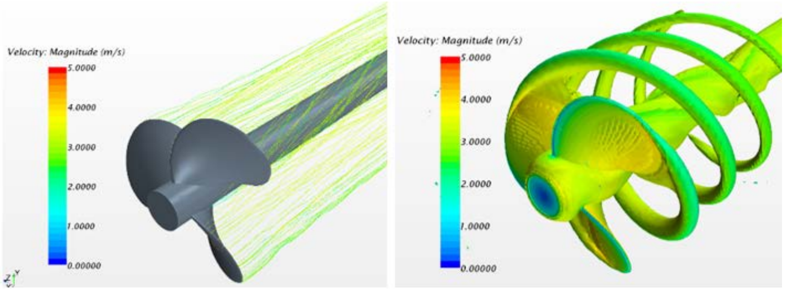

Figure 7. Streamlines and velocity distribution of DTMB 4119

After the flow around propeller is solved, acoustic pressure datum has been calculated in time domain by using FW-H formulation. Those data which are obtained in time domain are degraded on frequency domain with FFT function. Rigid Body Motion (RBM) has been chosen for time dependent acoustical analysis. The problem is considered at lower Mach number and thus quadrupole induced noise term is disregarded for noise calculations. Acoustical performance results of DTMB 4119 model propeller was compared with those of the study in literature Bagheri et al. [13]. Acoustical results of DTMB 4119 model propeller is given below in Figures 8-11.

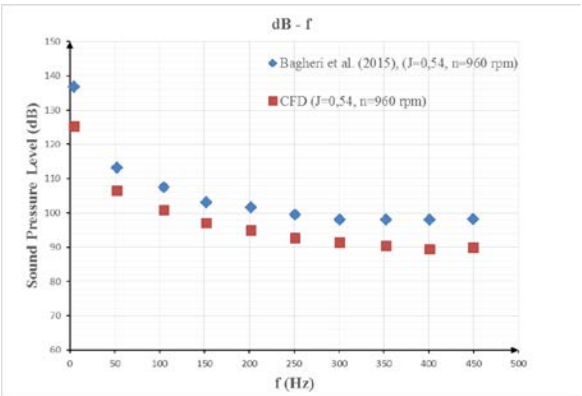

Figure 8. d=10R, θ=0º

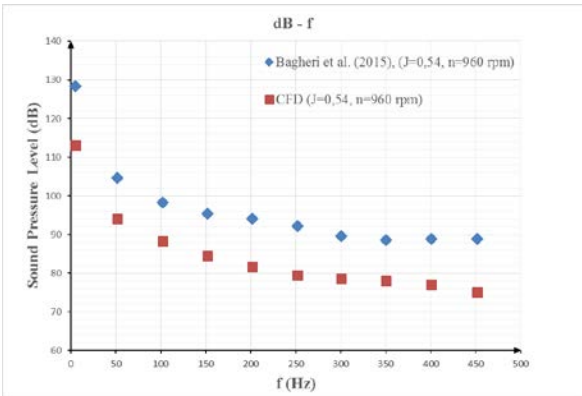

Figure 9. d=20R, θ=0º

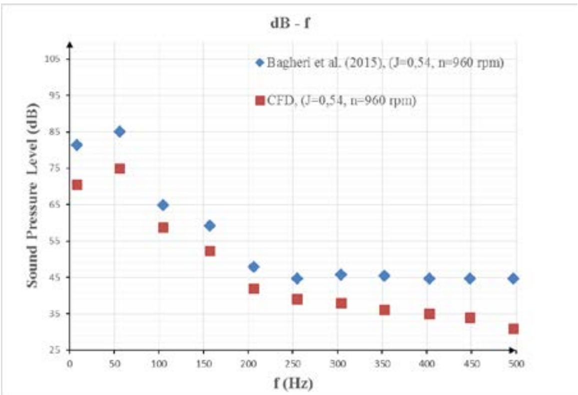

Figure 10. d=10R, θ=90º

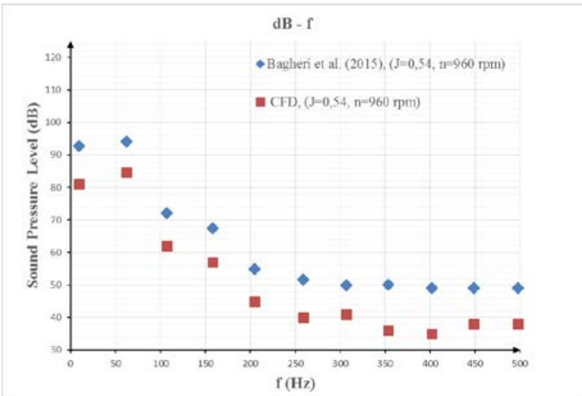

Figure 11. d=20R, θ=90º

Note that noise regime distributions have almost same pattern. Noise level of each frequency value in this study has been found less than approximately 10% according to Bagheri et al. [13]. This noise level difference could be originated from many reasons such as mesh structure, time step, propeller geometry, quadrupole noise term etc. In this present work, propeller blades have been chosen as noise sources and shaft effects have been neglected during the calculations. Total noise has thus been consisted of propeller thickness and loading.

To investigate effect of propeller revolution, acoustical performance has been compared for three different numbers of revolutions by the help of receivers which are positioned on propeller shaft axis.

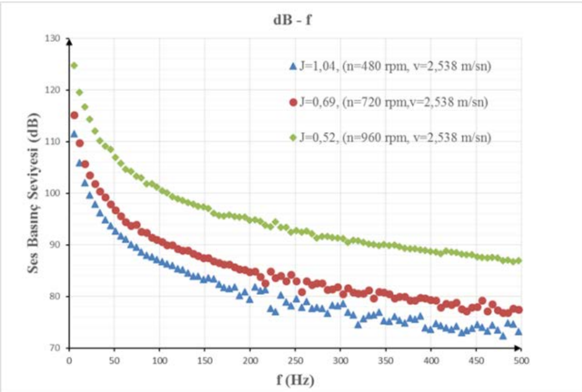

Figure 12. d=10R, θ=0º

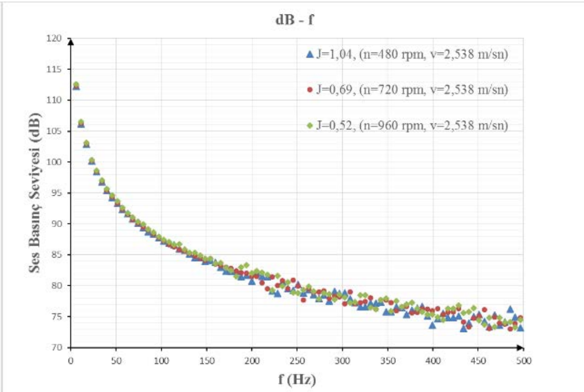

Figure 13. d=20R, θ=0º

As propeller revolution increases, noise level close to the noise source increases rapidly as is seen the Figure 12. However; as long as far away from the source, effect of increasing number of revolution on noise level decreases as is the seen Figure 13. Relationship between noise and vorticity could be established directly. As is seen the Figure 14, noise level distributions are dominant on where the vorticity magnitudes are higher. Propeller noise is mainly originated from tip vortex [22]. Vorticity on the propeller tip holds high velocity which means low pressure and low pressure leads to tip vortex cavitation which is a significant noise source caused by the propeller operating behind the ship.

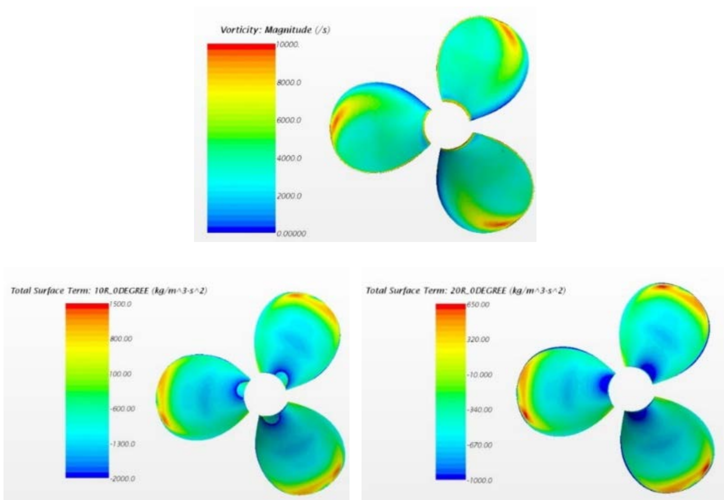

Figure 14. Vorticity and noise distributions on propeller blades (J=0.5 n=600 rpm) (d=10R, d=20R θ=0º).

CONCLUSIONS

In this paper, computational analyses of the well-known DTMB4119 propeller have been carried out in model scale. In order to validate the numerical method, steady results have been compared with the available experimental data. Unsteady analyses have been done for hydro-acoustic performance prediction of the propeller. The numerical results show that the noise level increases with an increase in propeller revolution. The main highlight of this paper is that the noise level distribution is directly related with the vorticity magnitude on the propeller blade. In near future, the cavitation will be included to the calculations by using a vortex-lattice based numerical method, a similar method presented in [23], [24].

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DETERMINATION OF THE RESISTANCE OF A DISPLACEMENT TYPE HULL FORM BY MEANS OF DIFFERENT CFD SOLVERS

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ABSTRACT

The performance of a hull form in water is a major concern for the naval architect. In most designs the main parameter to determine is resistance at a given service speed. Model test and Computational Fluid Dynamics (CFD) tools are used in this respect. Increases in computational power and more efficient software have made CFD a valuable tool for naval architects and shorten the design period to find optimal solution allowing to analyze and compare lots of alternatives. In this work, a displacement type hull form for a trawler yacht with a bulbous bow was designed and the resistance of the hull was determined by means of two different CFD software to compare the results. CFD analyzes were performed for 1/10 scaled model of original hull form with approximately 650.000 cells and k-ε turbulence model. However, fine meshes require a large amount of computation time and computational power. Also the quality of grids is as important as the total number of cells. In this work, all analyzes were performed on a personal computer. A mesh independence study was also performed to find the sufficient grid structure with minimum number of cells. The results obtained from CFD analyzes were also compared with the result of an empirical formula.

Keywords – CFD, mesh, resistance, trawler.

INTRODUCTION

Fluid dynamics is a subdiscipline of fluid mechanics that deals with fluid flow. Computational fluid dynamics (CFD) deals with solving and analyzing problems that involve fluid flows by solving the mathematical equations which control these processes with using numerical analysis. Nowadays, numerical calculations and simulations are becoming a common way for consideration of ship performance in early design stages. Although experimental approach is still very useful, it has its own limitations and model tests are long term and expensive. As a result of the advances in computer hardware, use of Computational Fluid Dynamics (CFD) is becoming the rational choice in many cases. Likewise, CFD simulations have an important role in hull form design, performance analyses and form optimization etc.

Former CFD based approaches assumed the flow as inviscid since the solution of Navier-Stokes equation was difficult to solve in the past. The recent progress of computing technology enables researchers to solve the problems by means of Reynolds-Averaged Navier-Stokes (RANS), Large

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Eddy Simulation (LES) and Direct Numerical Solution (DNS). Main drawback of LES and DNS is that they require more memory and computational powers. Therefore, RANS based solutions have been used widely in shipbuilding industry.

Flow around a ship hull is a free surface flow that a liquid comes in contact with a gas. The liquid-gas interface shows highly severe surface force and causes a complex flow. Due to its complexity several experimental and numerical studies have been performed by several researchers, reviews can be found in Wackers et al. [1], and Xing et al. [2]. Leroyer et al. presents two numerical procedures to speed up computations when dealing with a RANS solver based on the VOF method to treat the free surface [3].

In this present study, resistance analyses of a trawler yacht was performed from 6 knots to 14.6 knots (V_{max}) by using two different CFD software. Results obtained from CFD analyses were compared with the result of empirical resistance prediction method called as Holtrop-Mennen to evaluate the solution. To determine more accurate results, it has to be used a fine grid structure, especially around the bulbous bow and free surface. This should be known that a good mesh structure provides to converge to the accurate solution while increasing the computational time and power. In this work, all analyses were performed on a personal computer with average computational power.

MODELING

In this study, the trawler hull form, used for CFD analyses, was designed by using Maxsurf software. Then the hull form was exported to a 3D modeling software to make some preparations before CFD analyses. Finally, the hull and computational domain was exported to CFD software which was used for mesh generation and prescribing boundary conditions.

The general characteristics and 3D model of the hull are given in Table 1 and Figure 1, respectively.

Table 1. General Characteristics of the Hull

Waterline length, L_{WL} (m)	34.50
Beam, B (m)	7.75
Draft, T (m)	1.90
Displacement, Δ (tons)	250
Wetted surface area, WSA (m^2)	245
Power, (kW)	2 x 600

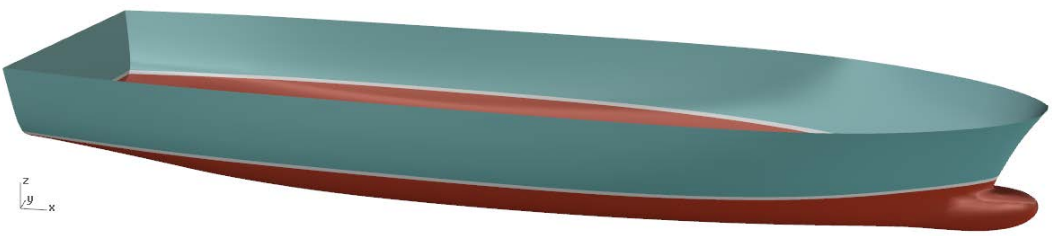

Figure 1. 3D Model of the Hull

MATHEMATICAL MODEL

In this paper, two well-known CFD solver, Numeca FINE™/Marine and Star-CCM+, was selected two realize flow simulations. Numeca has tools for different research interests. FINE™/Marine is the

CFD module dedicated to naval architects and has 6DOF incompressible flow solver, recognized as having the accuracy for types of marine applications, including free surface capturing. Numeca uses ISIS-CFD, developed by the "Ecole Centrale de Nantes" (ECN) and CNRS, for numerical calculations.

Star-CCM+ uses Volume of Fluid (VOF) model to take into consideration free surface in CFD calculations. VOF model presume two different fluids, water and air, that do not get into each other. The transport equation is solved for the volume fraction of water. Also, 6-DOF Motions can be considered during flow simulations.

Computational Domain, Boundary Conditions and Grid Structure

To realize the flow simulations and obtain accurate results, it needs to be created a computational domain with adequate dimensions and defined boundary conditions. In this work, the boundary conditions were defined as follows;

- Steady-state flow
- Reference temperature : 25˚C
- Reference pressure : 1 atm.
- Inlet : forward, top and bottom of the domain, uniform flow was given
- Outlet : backward of the domain, pressure outlet
- Walls : hull body, no-slip condition
- Symmetry : centerline boundary and side of the domain

CFD analyses were performed for 1/10 scaled model of original hull form symmetric to its centerline. The general view of computational domain and the dimensions of flow field was given in Figure 2.

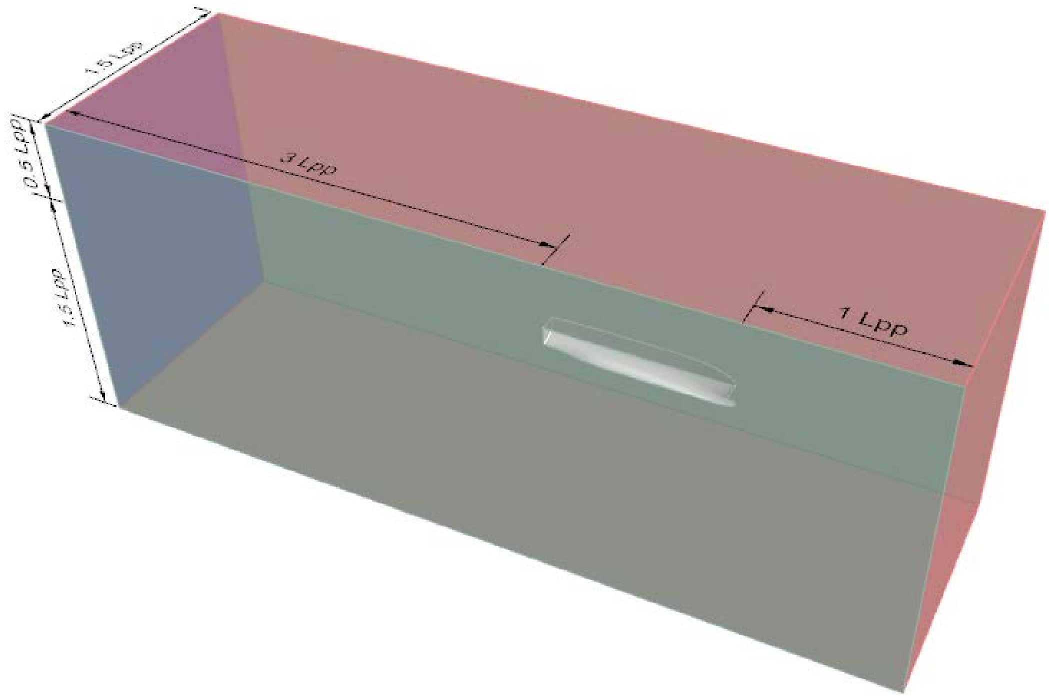

Figure 2. The General View of Computational Domain

The grid structure for CFD calculation was generated both using Star-CCM+ and Numeca FINE™/Marine software. Discretization of the flow equations requires the subdivision of the computational domain into a grid of sufficiently small cells as shown in Figure 3 and Figure 4. These figures shows the unstructured grid for the hull and whole domain. An unstructured grid provides more flexibility in geometry and grid generation. Multi-block technique was used for generation of the grid and mesh structure is clustered near the hull surfaces. It must be noticed that generation of a grid around the hull is time consuming and must be generated to describe the hull geometry sufficiently accurate.

To find the optimum number of cells, it has been performed several analyses. From the results, it can be said that mesh quality affects convergence of the solution much more compared to number of cells. However, the solution error due to poor number of cells cannot be ignored. Therefore, the practical way should be minimizing computational time while maintaining the accuracy of the results with using optimum number of cells. One of the things could be done is increasing the mesh density around the essential locations like free surface or bow and slightly decreasing towards the sides of the domain. Also for a high mesh quality, avoiding sharp angles, flat angles, distorted elements, angle between the elements, and aspect ratio, skewness angle, volume ratio are very important. In this study, after several analyses performed for grid independence, CFD analyses were performed with approximately 650.000 cells. It was tried to keep the total mesh number at a low level to be able to perform the analyses on a personal computer.

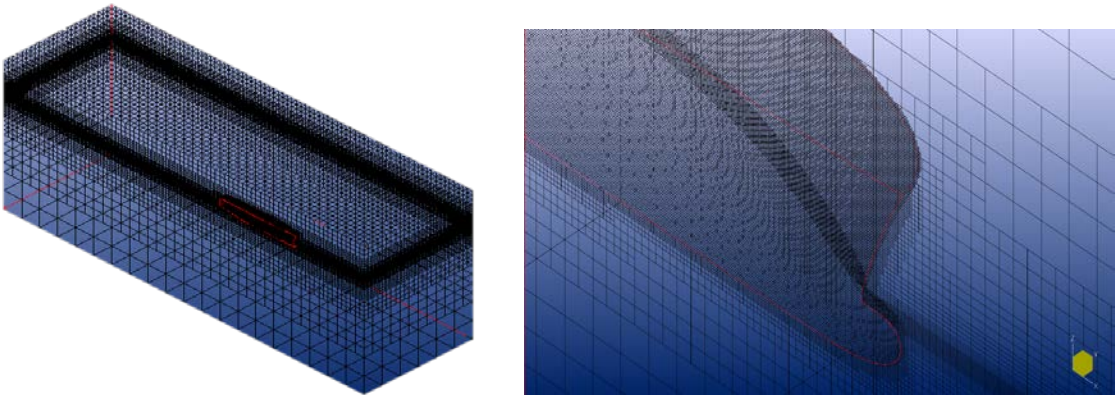

Figure 3. The Mesh Structure of Whole Domain and Clustered Mesh Structure Near Hull Surface in Numeca FINE/Marine

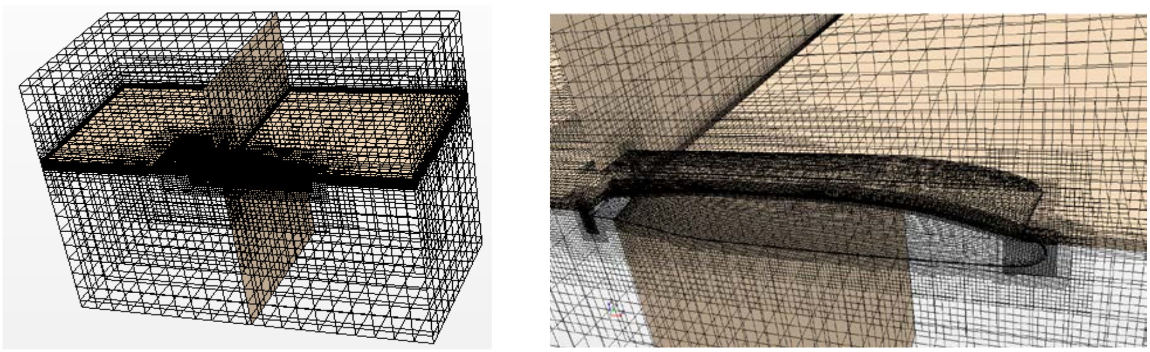

Figure 4. The Mesh Structure of Whole Domain and Clustered Mesh Structure Near Hull Surface in Star-CCM+

Turbulence Model

In this study, incompressible, 3-d, two phase flow of fluid was taken in consideration. The main problem is that it should be considered two different phases, air and sea water. Existing turbulence models are generally proposed for single phase flows and may not represent the turbulence flow with two-phase flows [4]. Parolini and Quarteroni [5]-[6] and Gorski [7] reported recent innovative aspects of the numerical models used in CFD studies based on Navier-Stokes equations.

The main equations for the fluid are the equation of continuity Equation (1) and momentum balance Equation (2) in Cartesian tensor notation.

$$\frac{\delta U\ i}{\delta xi} = 0 \tag{1}$$

$$\frac{\delta U_i}{\delta t} + \frac{\delta (U_i U_j)}{\delta xi} = -\frac{\delta P\ i}{\delta xi} + \frac{\delta}{\delta x_j}\left[\mu\left(\frac{\delta U_i}{\delta x_j} + \frac{\delta U_j}{\delta x_i}\right)\right] - \frac{\delta \overline{u_i u_j}}{\delta x_j} \tag{2}$$

The standard k-ω model is an empirical model depending upon transport equations for the turbulence kinetic energy (k) and the specific dissipation rate (ω) which can also be thought of as the ratio of ε to k. Where U_i and u_i express the mean and changing velocity component in the direction of the x_i, P the pressure, ρ the density and ν the kinematic viscosity. The Reynolds stress tensor calculated using the Boussinesq's hypothesis;

$$\overline{u_i u_j} = -v_t\left(\frac{\delta U_i}{\delta x_j} + \frac{\delta U_j}{\delta x_i}\right) + \frac{2}{3}\delta_{ij} k \tag{3}$$

As the k-ω model has been changed over the years, production terms have been added to both the k and ε equations, which reformed the accuracy of the model for predicting free shear flows. The viscosity v_t was calculated by combining turbulent kinetic energy, k, and the rate of dissipation of the turbulent energy, ε as follows,

The standard k-ε two equation turbulence model has been used to simulate the turbulent flows. The turbulent kinetic energy, k, and the rate of dissipation of the turbulent energy, ε, are:

$$\frac{\delta k}{\delta t} + \frac{\delta (k U_j)}{\delta x_j} = \frac{\delta}{\delta x_j}\left[\left(\mathrm{v} + \frac{v_t}{\sigma_k}\right)\frac{\delta k}{\delta x_j}\right] + P_k - \varepsilon \tag{4}$$

$$\frac{\delta \varepsilon}{\delta t} + \frac{\delta (k U_j)}{\delta x_j} = \frac{\delta}{\delta x_j}\left[\left(\mathrm{v} + \frac{v_t}{\sigma_\varepsilon}\right)\frac{\delta k}{\delta x_j}\right] + C_{\varepsilon 1} P_k \frac{\varepsilon}{k} - C_{\varepsilon 2}\frac{\varepsilon^2}{k} \tag{5}$$

where, production of kinetic energy $P_k = -\overline{u_i' u_j'}\frac{\delta U_i}{\delta x_j}$, $C_{\varepsilon 1} = 1.44, C_{\varepsilon 2} = 1.92\ C_\mu = 0.09$ turbulent Prandl numbers for k and ε are $\sigma_k = 1.0,$ and $\sigma_\varepsilon = 1.3$, respectively [8].

The use of standard k-ε two equation turbulence model formulation is reasonably robust and reliable near solid boundaries and recirculation regions like ship boundary layers. The pressure field is solved by using the well-known SIMPLE algorithm [9].

RESULTS AND DISCUSSIONS

In this paper, it is presented the results of the study obtained after approximately ten hours running for each analysis. Analyses were performed for 5 different model speed corresponding to 6, 8, 10, 12, 14.6 knots for original hull. Computed free surface visualization for the 3 highest speed are given in Figure 5, both for Numeca and Star-CCM+ results. As shown in the figure, it is obtained high waves around the bow. This wave elevation on the free surface is common for this type of hull forms. Figure 6 shows the free surface deformation on hull surface and Figure 7 shows the wave deformation from bow quarter.

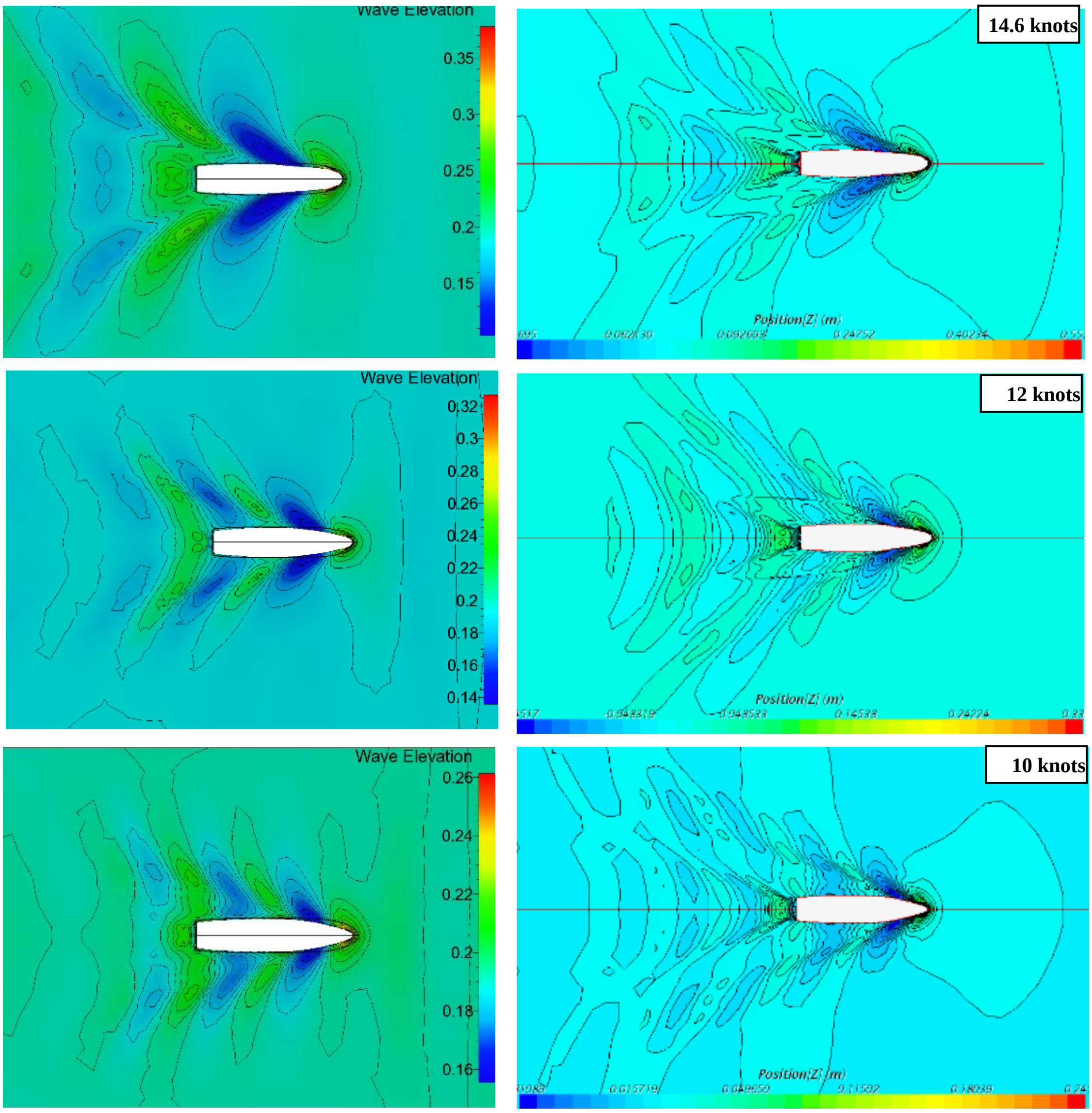

Figure 5. Computed Free Surface Visualization (left: Numeca, right: Star-CCM+)

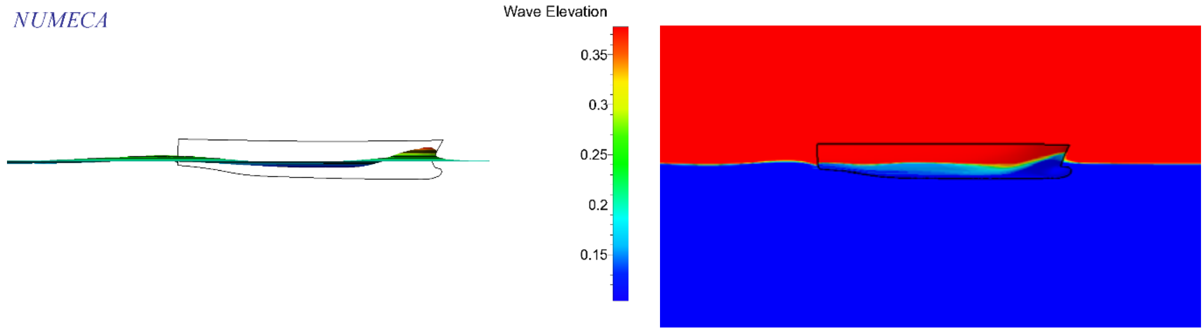

Figure 6. Free Surface Deformation on Hull Surface (14.6 knots)

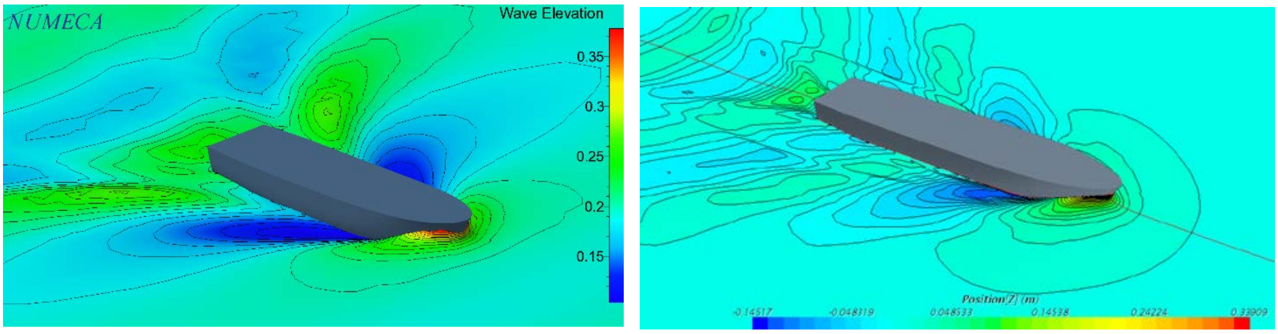

Figure 7. Wave Deformation on Free Surface from Bow Quarter (14.6 knots)

From the Froude method [1], it can be said that there are two component of the ship resistance:

$$R_T = R_F + R_R \tag{6}$$

Total resistance equal to frictional resistance and residuary resistance. Frictional resistance calculated using the Equation (7)-(8) and (9) respectively and get the remainder as the residuary resistance.

$$R_{nm} = \frac{vL}{\mu} \tag{7}$$

$$C_{Fm} = \frac{0.075}{(logRn - 2)^2} \tag{8}$$

$$R_{Fm} = \frac{1}{2}\rho S V^2 C_{Fm} \tag{9}$$

Full-scale ship residuary resistance is proportional to the scale of model and water density, following equation shows the proportion.

$$R_{Rs} = R_{Rm}\lambda^3 \frac{g_s}{g_m} \tag{10}$$

Reynold number, frictional resistance coefficient and ship frictional resistance can be calculate same as the model equations. Total power is equal to:

$$P_{Es} = \frac{R_{Ts} x V_s}{\gamma} \tag{11}$$

Using this method, full-scale ship total resistance and power can be determined. Resistance of the ship was also calculated by Holtrop-Mennen method to compare the results obtained from CFD. Compared values are given in Table 2 and Figure 8. The general propulsion efficiency was accepted as 0,6.

Table 2. Comparison of Total Resistance and Power Results

	Total Resistance (kN)		
Velocity (kn)	**Numeca FINE/Marine**	**Star-CCM+**	**Holtrop-Mennen**
14.6	43.43	43.558	47.641
12	20.419	19.421	28.088
10	12.03	10.28	17.872
8	7.83	6.112	9.942
6	4.928	3.61	6.192
Total Power (kW) @14.6 knots	1087.23	1090.43	1192.65

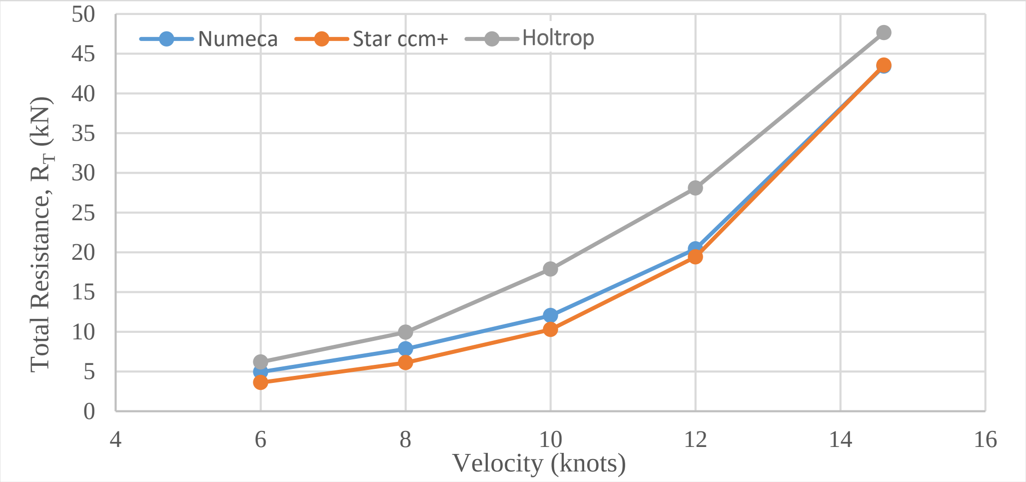

Figure 8. Computed Total Resistance Values for Different Velocities

CONCLUSIONS

The main objectives of this study are to show Computational Fluid Dynamics (CFD) analyses are still very convenient even though using a personal computer with average computational power and grid/mesh generation is the most important and most time consuming part in CFD analyses.

CFD analyses were performed from 6 knots to 14.6 knots with considering the resistance for a trawler and the study is concluded with a comparison between the CFD results and the result obtained from Holtrop-Mennen method. Although the computations were performed on a personal computer with average computational power, the results of CFD analyses are acceptable by comparison with real engine power. It can be said that, the quality of results obtained from CFD analyses mostly depends on the quality of generated mesh and convenient physical conditions. Generally, a poor quality mesh does not surely result in solver run time problems, but most important is poor quality mesh does reduce the accuracy and efficiency of the solution obtained. The important mesh characteristics, such as mesh density, aspect ratio, y+ range, volume ratio, skewness angle should be considered carefully.

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ON THE UNCERTAINTY ANALYSIS OF DTMB5415 FOR FORM FACTOR PREDICTION

Suleyman Duman[1], Ali Dogrul[2], Emre Kahramanoglu[3]

ABSTRACT

This study focuses on the assessment of form factor via uncertainty analysis. Prohaska method has been employed in order to calculate the form factor of the well-known naval surface combatant DTMB5415 designed in David Taylor Model Basin. Several computational fluid dynamics (CFD) analyses have been conducted using a commercial code based on finite volume method (FVM). The flow is considered as 3-D, incompressible, transient and fully turbulent in order to solve RANS equations. Firstly, the code has been validated with the available experimental data. Through validation, uncertainty analysis has been made. Then, flow analyses have been carried out for very low Froude numbers. During the analyses, the free surface effect has been taken into account.

Keywords - computational fluid dynamics (CFD), DTMB5415, form factor, uncertainty.

INTRODUCTION

Ship hydromechanics has been a vital subject for decades in the last century. Ship total resistance estimation has a significant role on ship operational costs. In order to estimate the ship total resistance and resistance components, experimental, numerical and empirical methods have been widely used. Especially ship form factor has to be predicted precisely in order to calculate the viscous pressure and wave resistance generated by the ship [1].

Numerical methods based on finite volume method (FVM) can be applied to simulate the flow around the ship hull using open source and commercial computational fluid dynamics (CFD) codes. Because of the difficulty on experimental investigation at lower speeds, numerical methods come into mind in order to examine the flow problem at lower Froude numbers. CFD method is versatile for estimation of ship resistance components, form factor and other flow characteristics by solving the well-known RANS (Reynolds Averaged Navier-Stokes) equations. Friction resistance of the ship is calculated by using ITTC 1957 formulation [2]. The form factor can be calculated by making low speed resistance analyses in a range proposed by Prohaska method [3]. Form factor of the ship model can be gained by several approaches such as Prohaska method applied on low speeds or single phase analyses. RANSE analyses are also performed for mostly model scale ships. By this way, it is possible to reduce computational cost and time.

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For validation of CFD methods, some widely used validation cases are first mentioned in a CFD workshop held in 2000. Three different ship models were investigated with different CFD codes and the results are presented in the study of Larsson et al. [4]. In a CFD conference held in Tokyo in 2005, it is mentioned that RANSE based resistance estimations are in good agreement with the experimental results for the benchmark vessels KCS (KRISO Container Ship), DTMB 5415 (Naval Surface Combatant) and KVLCC2 (KRISO Very Large Crude Carrier) [5].

Li et al. [6] and Wackers et al. [7] have modelled the turbulent flow around the ship by using dynamic grid structure. Li et al. have solved the flow using Baldwin-Lomax turbulence model without a wall function for the Hamburg Test Case with a dry transom. Wackers et al. have investigated the ship flow with an in-house code in a steady manner. Leroyer et al. [8] have studied an approach in order to make faster free surface CFD analyses. They have developed an original time-splitting procedure in order to reduce Courant number limitation. Kandasamy et al. [9] have investigated the free surface flow around a semi-planning catamaran with full scale and compared the results with the experimental ones. This study has shown that the numerical and experimental results are in good agreement.

For form factor prediction, Garcia [10] has studied the scale effect on the form factor and stated that the form factor is not same for model and full scale ship. Kouh et al. [11] has made some CFD analyses for different ship geometries by using double body approach in order to calculate the form factor. Degiuli [12] has investigated the form factor for blunt ships with Prohaska method and offered some coefficients. Min et al. [13] has made a study on form factor with a method offered by ITTC 1978 [14] and proposed a new calculation method. With the help of form factor, the non-dimensional wave resistance coefficient of the ship can be achieved for the desired velocities. Because the ship hull form optimization is made by mostly wave resistance parameter. Some recent studies have been made about wave resistance estimation by Dogrul [1] and Ozdemir et al [15]. CFD technique solving fully turbulent Navier-Stokes equations has been commonly used for a wide range of Froude numbers by ship hydrodynamicists in order to estimate the total ship resistance components.

Up to now there are so many studies about uncertainty analysis in engineering problems. However, most of them are based on Richardson extrapolation [16]. Besides the other methods, grid convergence index method has been employed in this work. This method firstly has been proposed by Roache [17]. After this proposal, Roache has modified his method [18] - [19]. In 2008, Celik et al has published a procedure about how GCI method can be implemented to the CFD applications [20]. Cosgun et al has carried out a numerical study about an uncertainty analysis on a CFD application via GCI method [21].

In this work, it is aimed to conduct numerical analyses with five different mesh numbers. An uncertainty analysis has been made for five different results and an optimum mesh number has been obtained at Fn=0.138 with model scale DTMB 5415, which is a well-known benchmark case developed in David Taylor Model Basin. With the help of the uncertainty study, both verification and validation of the numerical method has been done. For the uncertainty analysis, Grid Convergence Index (GCI) has been used in order to determine the optimum mesh number. Using the optimum mesh number, several unsteady analyses have been performed for the Froude numbers between 0.12 and 0.16 in order to apply Prohaska method for form factor prediction. Since Reynolds numbers are between $2x10^6$ and $3x10^6$, fully turbulent CFD analyses have been carried out.

GEOMETRY AND CONDITIONS

DTMB 5415 naval surface combatant model has been chosen for the flow investigation. The ship includes both a sonar dome and a transom stern. The ship is modelled with bilge keels. Geometrical features of the model and full scale ship have been presented in Table 1.

Table 1. Geometrical features of DTMB 5415 [22]

λ=46.588	**Model**	**Ship**
L_{BP} (m)	3.048	142.00
L_{WL} (m)	3.052	142.18
B_{WL} (m)	0.409	19.06
T_M (m)	0.132	6.15
S (m^2)	1.37	2972.6
∇ (m^3)	0.0826	8352
C_B	0.507	0.507
C_M	0.821	0.821
Froude number	0.138	0.138
Velocity (m/s)	0.754	5.153

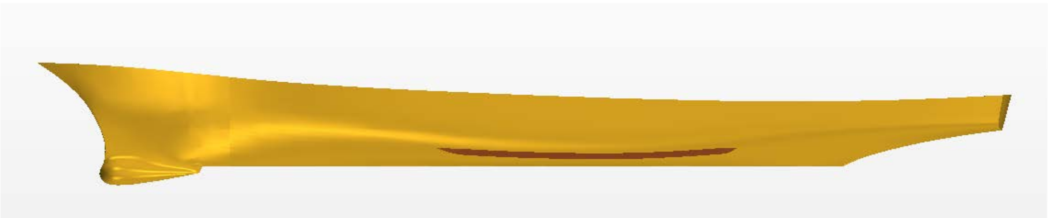

Figure 1. 3-D view of DTMB 5415 [23]

Figure 1 represents the 3-D view of the ship model with a sonar dome and a transom stern also including bilge keels. The hull form is accepted as a bare hull despite the bilge keels and the hull is also entitled as DTMB5512 in the literature [22].

MATHEMATICAL FORMULATION

For the numerical analyses, the governing equations are the continuity equation and the well-known RANS equations for the unsteady, three-dimensional, incompressible flow. The continuity can be given as;

$$\frac{\partial U_i}{\partial x_i} = 0 \tag{1}$$

While the momentum equations are expressed as;

$$\frac{\partial U}{\partial t} + \frac{\partial \left(U_i U_j\right)}{\partial x_j} = -\frac{1}{\rho}\frac{\partial P}{\partial x_i} + \frac{\partial}{\partial x_j}\left[\nu\left(\frac{\partial U_i}{\partial x_j} + \frac{\partial U_j}{\partial x_i}\right)\right] - \frac{\partial \overline{u_i' u_j'}}{\partial x_j} \tag{2}$$

In momentum equations, U_i states the mean velocity while $u_i^{'}$ states the fluctuation velocity components in the direction of the Cartesian coordinate x_i . P expresses the mean pressure, ρ the density and ν the kinematic viscosity.
The well-known k-ε turbulence model is employed in order to simulate the turbulent flow around the ship precisely. This turbulence model is applicable when there are not high pressure changes along the hull and separation near the hull. During the analyses, Reynolds stress tensor is calculated as follow;

$$\overline{u_i^{'}u_j^{'}} = -\nu_t\left(\frac{\partial U_i}{\partial x_j}+\frac{\partial U_j}{\partial x_i}\right)+\frac{2}{3}\delta_{ij}k \tag{3}$$

Here, ν_t is the eddy viscosity and expressed as $\nu_t = C_\mu k^2/\varepsilon$ while C_μ is an empirical constant ($C_\mu = 0.09$). k is the turbulent kinetic energy and ε is the turbulent dissipation rate. In addition to the continuity and momentum equations, two transport equations are solved for k and ε:

$$\frac{\partial k}{\partial t}+\frac{\partial\left(kU_j\right)}{\partial x_j}=\frac{\partial}{\partial x_j}\left[\left(\nu+\frac{\nu_t}{\sigma_k}\right)\frac{\partial k}{\partial x_j}\right]+P_k-\varepsilon \tag{4}$$

$$\frac{\partial \varepsilon}{\partial t}+\frac{\partial\left(kU_j\right)}{\partial x_j}=\frac{\partial}{\partial x_j}\left[\left(\nu+\frac{\nu_t}{\sigma_\varepsilon}\right)\frac{\partial \varepsilon}{\partial x_j}\right]+C_{\varepsilon 1}P_k\frac{\varepsilon}{k}-C_{\varepsilon 2}\frac{\varepsilon^2}{k} \tag{5}$$

$$P_k = -\overline{u_i^{'}u_j^{'}}\frac{\partial U_i}{\partial x_j} \tag{6}$$

where, $C_{\varepsilon 1} = 1.44$, $C_{\varepsilon 2} = 1.92$, turbulent Prandtl numbers for k and ε are $\sigma_k = 1.0$ and $\sigma_\varepsilon = 1.3$, respectively. Further explanations for the k-ε turbulence model may be found in the paper of Wilcox [24], [25].

NUMERICAL METHOD

Boundary Conditions

In order to make CFD analyses properly, the initial and boundary conditions should be defined carefully depending on the flow problem. Correct boundary conditions lead the analysis to accurate results and prevent the unnecessary computational costs [1].
Multiphase analyses are performed with modelling the free surface by considering that the free surface is flat in the beginning. The ship boundary is to be taken as no slip wall which dictates that the velocity components are zero on the hull surface. Slip wall and symmetry type boundary conditions require that the normal component of the velocity is to be zero. Symmetry type boundary condition enables to reduce the computational domain size and mesh number by half. Detailed information about the boundary conditions applied in the analyses can be found in the theory guide of the commercial CFD solver [26].

Computational Grid

The computational domain is discretized by three dimensional finite elements in compliance with finite volume method. In order to create the control volume, unstructured hexahedral elements are employed in the whole domain. Also local mesh refinements are made near the bow and stern, wake zone and free surface in order to well capture free surface deformations. Unstructured mesh of the computational domain and the boundary conditions are given in Figure 2 and 3. Figure 2 also represents the employed mesh refinement regions (1: ship bow, 2: ship stern, 3: free surface) in order to well-capture the free surface deformations. Mesh size of the hull surface and the growth rate is adjusted in order to keep wall y^+ values in an acceptable range. The computational domain is selected to be adequate in dimensions to simulate the ship flow properly, which is identical to the recommended dimensions of ITTC guideline [27]. Main dimensions of the computational domain is given in Table 2 by means of model ship length.

Table 2. Main dimensions of the computational domain

Length	6.4 x L_{BP}
Width	4.8 x L_{BP}
Depth	2.1 x L_{BP}

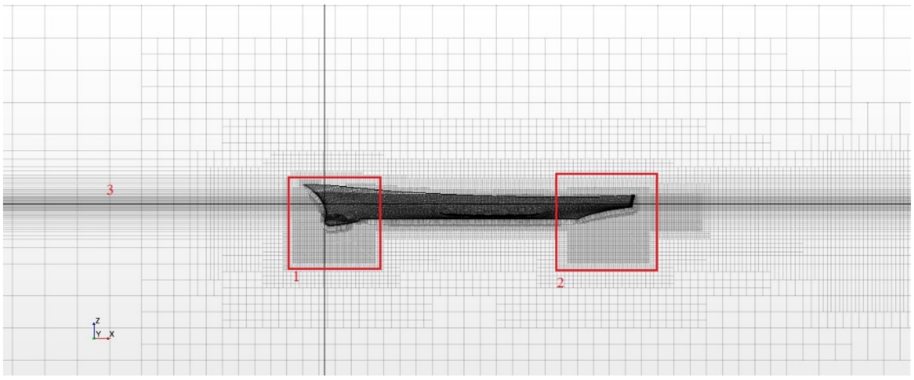

Figure 2. Unstructured mesh applied on the computational domain

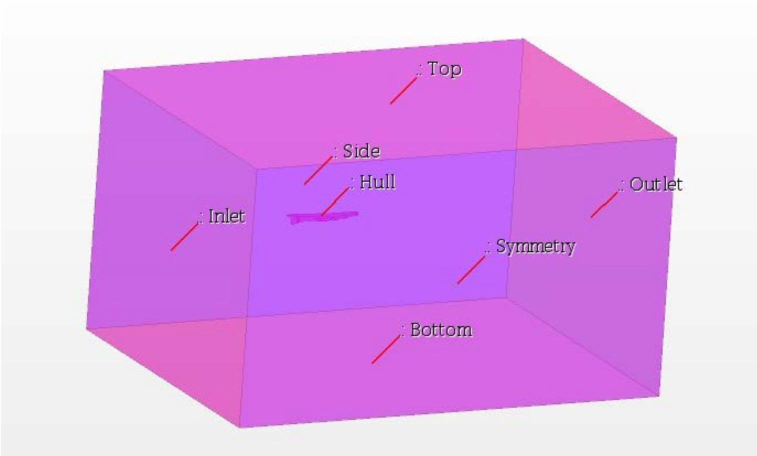

Figure 3. Boundary conditions applied to the domain

Solution Strategy

k-ε turbulence model is used in the numerical analyses conveniently because there are not high pressure gradients along the hull. Also there are no separations near the hull because the ship is nearly slender (L/B=7.45). In other words, the slenderness of the ship geometry makes the effect of boundary layer separations on the flow characteristics around the hull insignificant.

The pressure field is solved by using SIMPLE algorithm which is based on pressure-velocity coupling. SIMPLE is a commonly used algorithm for calculating pressure and velocity fields in an iterative manner [28]. All the governing equations are discretized using a cell based finite volume method and the advection terms are discretized with a first-order upwind interpolation scheme.

Because of the flow has multiphase characteristic, Volume of Fluid (VOF) is used to monitor the free surface behavior. The VOF model can model two or more immiscible fluids by solving a single set of momentum equations and tracking the volume fraction of each of the fluids throughout the domain. Open channel approach, which is available in the commercial code used in this paper, is employed to model the multiphase flow around the ship using VOF. It is crucial to track the free surface deformations in multiphase flows. Open channel boundary condition involves the existence of a free surface between the flowing fluid and the atmosphere. Viscous effects around the ship including the boundary layer are taken into account with an appropriate grid structure keeping y^+ values of the hull in a reasonable range (30-300) [1].

VERIFICATION AND VALIDATION

In this study, uncertainty analysis has been made via Grid Convergence Method. This method firstly was proposed by Roache [29] and then improved with different studies. The procedure implemented in this study has been explained below [20]:

i) Defining refinement factors

Let h_1, h_2 and h_3 are grid lengths and $h_1 < h_2 < h_3$. For this situation refinement factors:

$$r_{21} = \frac{h_2}{h_1} \qquad r_{32} = \frac{h_3}{h_2} \tag{7}$$

Refinement factors should be greater than 1.3 in accordance with experiments [20]. Grid lengths' refinement is selected as $\sqrt{2}$. However because of mesh algorithm used in analyses, when refinement factors are calculated, number of cell size has been taken into account. Therefore these values have been differentiated.

$$r_{21} = \left(\frac{N_2}{N_1}\right)^{1/3} \qquad r_{32} = \left(\frac{N_3}{N_2}\right)^{1/3} \tag{8}$$

ii) Calculation of order of p

Difference between two solution different grids can be calculated as below:

$$\varepsilon_{21} = X_2 - X_1 \qquad \varepsilon_{32} = X_3 - X_2 \tag{9}$$

At this point, convergence condition R can be examined.

$$R = \frac{\varepsilon_{21}}{\varepsilon_{32}}$$

In this study, R is calculated between 0 and 1 which means that the solution is converged monotonically.

$$s = \operatorname{sgn}\left(\frac{\varepsilon_{32}}{\varepsilon_{21}}\right) \qquad q = \ln\left(\frac{r_{21}{}^{p} - s}{r_{32}{}^{p} - s}\right) \qquad p = \frac{\left|\ln\left|\frac{\varepsilon_{32}}{\varepsilon_{21}}\right| + q\right|}{\ln(r_{21})} \tag{10}$$

iii) Calculation of extrapolated values and error terms

The extrapolated value which is explained below shows that final destination of solution in zero grid space.

$$X_{ext}^{21} = \frac{r_{21}^{p} * X_1 - X_2}{r_{21}^{p} - 1} \tag{11}$$

$$e_{21} = \left| \frac{X_1 - X_2}{X_1} \right| \qquad e_{ext}^{21} = \left| \frac{X_{ext}^{21} - X_1}{X_{ext}^{21}} \right| \tag{12}$$

iv) Finding GCI and U

$$GCI_{FINE} = \frac{FS * e_a^{21}}{r_{21}^{p} - 1} \tag{13}$$

$$\begin{aligned} U &= GCI^{21}\left|X_1\right| && \text{for } 0.95 \le p < 3.05 \\ U &= \min(GCI^{21}\left|X_1\right|, 1.25 * \Delta M) && \text{for } 0 \le p < 0.95 \\ U &= \max(GCI^{21}\left|X_1\right|, 1.25 * \Delta M) && \text{for } p \ge 3.05 \end{aligned} \tag{14}$$

ΔM is maximum difference of solution in one analysis set. According to the equation set (14), the safety factor is equal to 1.25 for this study [29]. In this study, 5 different grid space have been used as given in Table 3. In order to analyze uncertainty, three groups are created including three mesh cases.

Table 3. Numerical results for different mesh numbers

No	Analyses	Number of Element	X (N)
1	Finer	4901716	1.90079
2	Fine	2002474	1.90091
3	Medium	982638	1.95577
4	Coarse	490139	2.02665
5	Coarser	259703	2.25224

As explained above, analysis groups are selected as 1-2-3, 2-3-4 and 3-4-5. The results of uncertainty analyses are shown below in Table 4.

Table 4. Analyses sets for GCI

Analyses Set	1 2 3	2 3 4	3 4 5
r_{21}	1.3477	1.2678	1.2609
r_{32}	1.2678	1.2609	1.2358
p	20.5282	1.1638	5.1286
X_{EXT}^{21}	1.9008	1.7284	1.9247
% e_{EXT}^{21}	0.0000	9.9787	1.6123
GCI_{FINE}	0.0000	0.1134	0.0198
U	0.0686	0.2156	0.2820

GCI_{FINE} and U values are demonstrated above in Table 4. When it is aimed to observe the percentages of each set, it is around 20% for analyses set 2-3-4 and 28% for analyses set 3-4-5. These uncertainties are so large comparing with the analyses set 1-2-3. On the other hand, if the experimental value has been taken into account, it is obvious that finer mesh grid space is in good agreement with the experimental data as in Table 5. Therefore it can be said that the selection of first grid space is reasonable for this study.

Table 5. Comparison of numerical and experimental results

Analyses	X (N) CFD	X (N) EFD	% Error
1	1.90079	1.91668	0.829037711
2	1.90091	1.91668	0.822776885
3	1.95577	1.91668	2.039464073
4	2.02665	1.91668	5.737525304
5	2.25224	1.91668	17.50735647

RESULTS AND DISCUSSIONS

Form factor study has been conducted for DTMB5415 hull form in model scale after choosing the optimum mesh number via uncertainty analysis. Several unsteady analyses have been carried out for low Froude numbers in order to apply Prohaska method to the numerical results. Prohaska method describes that the wave resistance is a function of Froude number between Froude numbers 0.12 and 0.20 [3]. Numerical analyses have been performed between Froude numbers of 0.12 and 0.16 while taking the free surface into account.

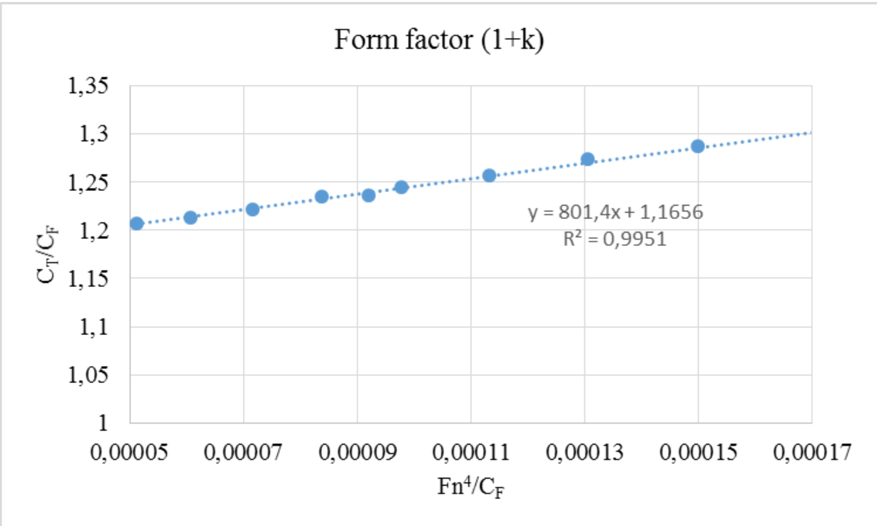

Figure 4. Form factor prediction via Prohaska method

$$C_T = (1+k).C_{F_0} + \alpha.Fn^4 \tag{15}$$

Equation 15 represents the relation between resistance coefficients and the form factor. The first term of the right hand side of the equation is the viscous resistance coefficient and the second term represents the wave resistance coefficient, where C_{F_0} is the friction resistance coefficient proposed by ITTC [2] and α is a constant. Here, according to Prohaska [3], the wave resistance is dependent on the fourth power of Froude number instead of the conventional form factor procedure which dictates that the wave resistance is negligible at low Froude numbers.

$$(1+k).C_{F_0} = C_V \tag{16}$$

$$\alpha.Fn^4 = C_W \tag{17}$$

The form factor is calculated as 1+k=1.1656 in accordance with Prohaska method within the range of $0.12 \le Fn \le 0.16$ as presented in Figure 4.

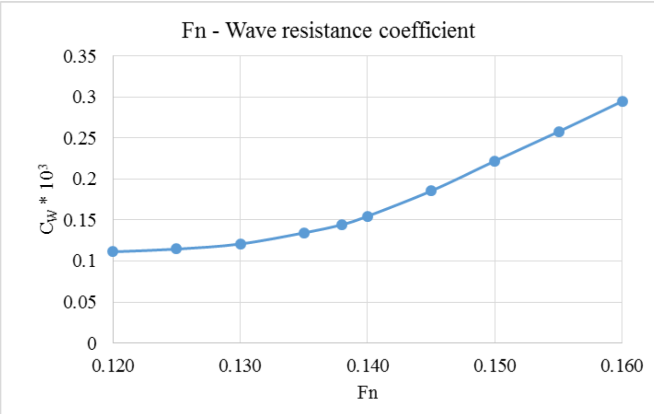

Figure 5. Non-dimensional wave resistance coefficient at different Froude numbers

Figure 5 shows the relation between Froude number and the non-dimensional wave resistance coefficient. Until Fn=0.138, there is little change in wave resistance by Froude number while after Fn=0.138 there is a linear relation between these two parameters.

CONCLUSIONS

In this study, free surface analyses of the well-known benchmark case DTMB 5415 have been conducted for model scale. In order to verify the mesh number and to validate the numerical method, uncertainty analysis have been made using GCI technique. After selecting the optimum mesh number, several free surface analyses have been carried out. With the help of the numerical results, the form factor of the model scale ship form has been found applying Prohaska method. By this work, a robust method has been proposed in order to calculate the form factor and wave resistance component of a ship by CFD method staying in an acceptable uncertainty value.
As a future work, it is aimed to perform numerical studies by also taking trim and sinkage into account. Also the analyses will be made for different scale factors in order to show the scale effect on the form factor.

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PARTIALLY PARAMETRIC MODIFICATION OF A FAST PATROL BOAT HULL FORM FOR BOW OPTIMIZATION

Buğra Uğur YAZICI[1], Bekir ŞENER[2], Serkan ÖZDEN[3]

ABSTRACT

The traditional ship design process is generally dependent on geometric modeling of the ship hull form. After creation of the ship hull form, various analysis and calculations are made by designer to obtain results whether it is suitable for class rules or other procedures. If the results are not satisfactory, the iterative design steps repeated until the desired conditions are met. The hull forms, designed with the traditional method, are usually a negotiated solution that is stand for just solving specific problem. The purpose of this paper is to introduce a methodology based Simulation Driven Design method with using new variants of current hull form. For this purpose, parametric modeling and optimization solver software called CAESES is used to create variants from the current hull form. First of all, literature search of the fast patrol boats is done to get design ranges for main ship particulars and speeds. After that, the main problem is to determine that which parameter should be the base parameter for this type of ship. At the last stage, partially hull form modification methodology is created and critical parameters are set as project objectives. Partially parametric modeling will shorten the optimization time of desired criteria defined as hydrodynamic ship performance of current hull.

Keywords – Partially parametric modeling, delta-shift functions, surface delta-shift functions, multi objective optimization, ship resistance, seakeeping, CFD.

INTRODUCTION

Design is a compromise. Ship design processes start with decisions on the basis of designer's insight and available options while the knowledge about the final product is still limited. In the initial design phase naval architects generally rely on suitable and conventional baselines or literature studies. Due to the high number of parameters that may affect each other negatively, designer should make same design steps more than once. This enforces designer to simulation-driven design in which desired parameters are part of the product and design procedure.

This paper mentions initial design decision processes and optimization process briefly. Main idea of the paper is to represent partial parametric modeling of ship bow form.

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METHODOLOGY

First of all, main problem stimulates this work is seakeeping performance of the fast patrol boats in the world market. Fast patrol boat hull form should handle harsh sea conditions without preventing these conditions from doing her defined jobs. At this point, main objectives should be specified the design space and the constraints and the mission features of the vessel. These inputs will be the base of the optimization and form variation process.

The automated multi-objective hull form optimization methodology can be examined under 4 main stages: preliminary design, parametric modeling, systematic variation and multi-objective optimization. The essential objective of the first stage is to specify the design space and the constraints, like dimensional, stability and seakeeping constraints [1].

Following a market survey and literature studies, characteristics of the hull form was revealed. The main dimensions and some non-dimensional coefficients of the parent hull form is given in Table 1. Also the parent hull form can be seen in Figure 1.

There are quite a few partially-parametric modeling techniques that have gained popularity in shape optimization. Free form deformation, shift transformation, added patch deformation and morphing can name a few. In general, partially-parametric modeling is applicable to both continuous and discrete data. For shape optimization this means that a modification can be applied to the geometry only, requiring subsequent re-meshing for the simulation [2].

The flowchart shown in Figure 2 was used to create partially parametric form. Numerous design parameters which have an effect on optimization process and constant deformation function parameters were determined to transform the initial hull form for variation.

Table 1. Main Dimension and Non-dimensional Coefficients of Initial Hull Form

Length overall, L_{OA} (m)	45	L_{WL}/B_{WL}	5.806
Length Between Perpendiculars, L_{BP} (m)	44	$L_{WL}/\nabla^{(1/3)}$	7.437
Maximum Breadth, B_{MAX} (m)	7.75		
Depth, D (m)	4.15		

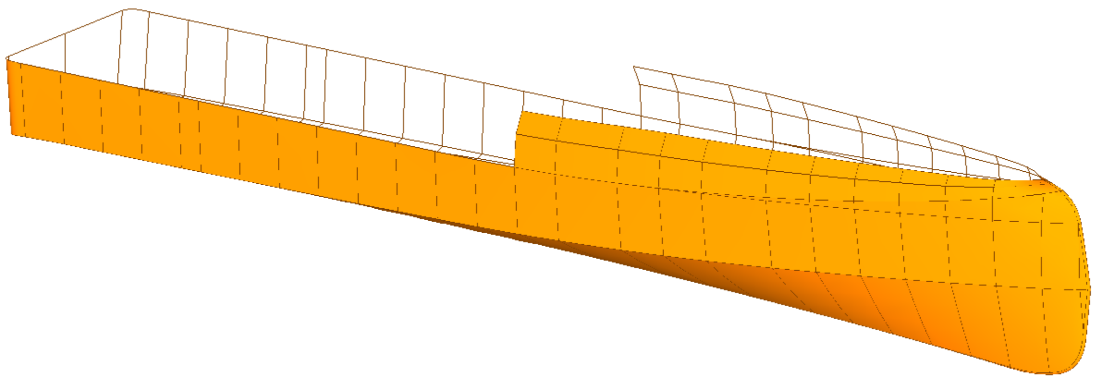


Figure 1. 3D Model of Parent Hull Form

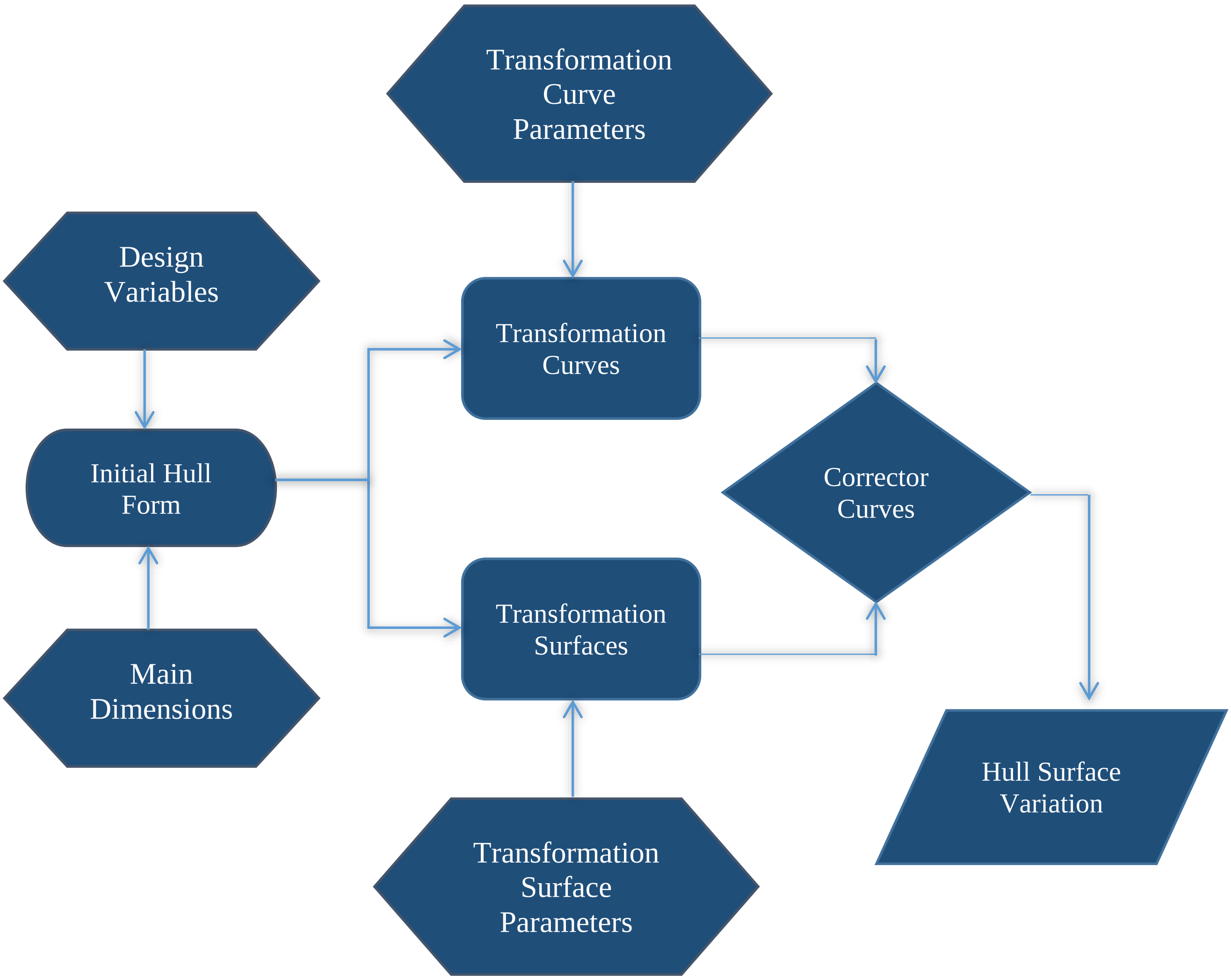


Figure 2. Flow Chart of Partially Parametric Modeling

PARTIALLY PARAMETRIC MODELING

After determining initial hull characteristics, transformation functions should be defined. These functions have a large variety of possibilities due to high dependence on engineer's decision. As mentioned above, there are numerous techniques in the state-of-the-art literature. In this paper, shift transformation and added patch deformation techniques are used to translate main hull form. In order to make variations and have new variants, curves for shift transformation and surfaces for added patch deformation are used. Deformation functions definitions are linked to parameters.

Main idea behind choosing deformation functions is specific requirements of the project case. Main hull form needed to be more efficient and more enduring. Therefore, primary objectives were reducing drag forces and increasing seakeeping capabilities, especially reduced slamming per hour values and vertical acceleration magnitudes.

Literature studies revealed the fact that a lot of factors have enormous effects on the seakeeping and ship resistance. Owing to concentrating on bow part of the ship, changing waterline entrance angle was chosen for reducing total ship resistance values. Moreover, moving ship's bow in z directions has positive effect on reducing slamming values. On the contrary, this refinement effects vertical acceleration magnitudes when it has positive effect on slamming. Third and the last deformation function is controlling fullness of the bow form so as to optimize both seakeeping and resistance performance.

SHIFT TRANSFORMATION FUNCTION

Shift transformations are realized by moving any point of the initial shape by a specified amount in the principle directions of the chosen coordinate system. Often this is done in Cartesian space. Each point, written as below,

$$\vec{P}=\begin{bmatrix} x \\ y \\ z \end{bmatrix} \tag{1}$$

receives its displacement Δx, Δy and/or Δz depending on its original position and the specified shift function. Shift transformations can be concatenated, directly summed up and/or multiplied to form complex modifications [2].

As mentioned above, in this study, a shift transformation function created and used for controlling bow shape in z (height) direction. Ship's bow form (Figure 3) completely moved z direction without using correction functions. Both shift transformations "Shift_Z" and corrector shift transformation "Shift_Correction_Z" of initial hull form created to obtain smooth tangency between static part and dynamic part of the hull surfaces. Corrector curve, shown in Figure 4, was multiplied with shift transformation curve. The reason behind this routine is to ensure zero movement where no deformation on hull surfaces is wanted.

Figure 3. Initial Hull Bow Form (Profile View)

Figure 4. "Shift_Correction_Z" (blue: non-deformed, green: deformed surface regions)

"Stem_modifier" curve is shift transformation function and has three parameters (Figure 5). "Delta_X_Modifier_Aft" parameter is controlling the starting x coordinate of this curve so as to determine where the transformation on x coordinate starts. "Delta_Z" parameter is controlling the end point of transformation function. If this value is equal to zero, "Delta_X_Modifier_Aft" values do not have any effect on bow surfaces of initial hull form. Last parameter is "Fulness_Stem" is linked to area value on XZ plane (Figure 6). This parameter gives an opportunity to change curvature of the "Stem_modifier" function independent of the other two parameters.

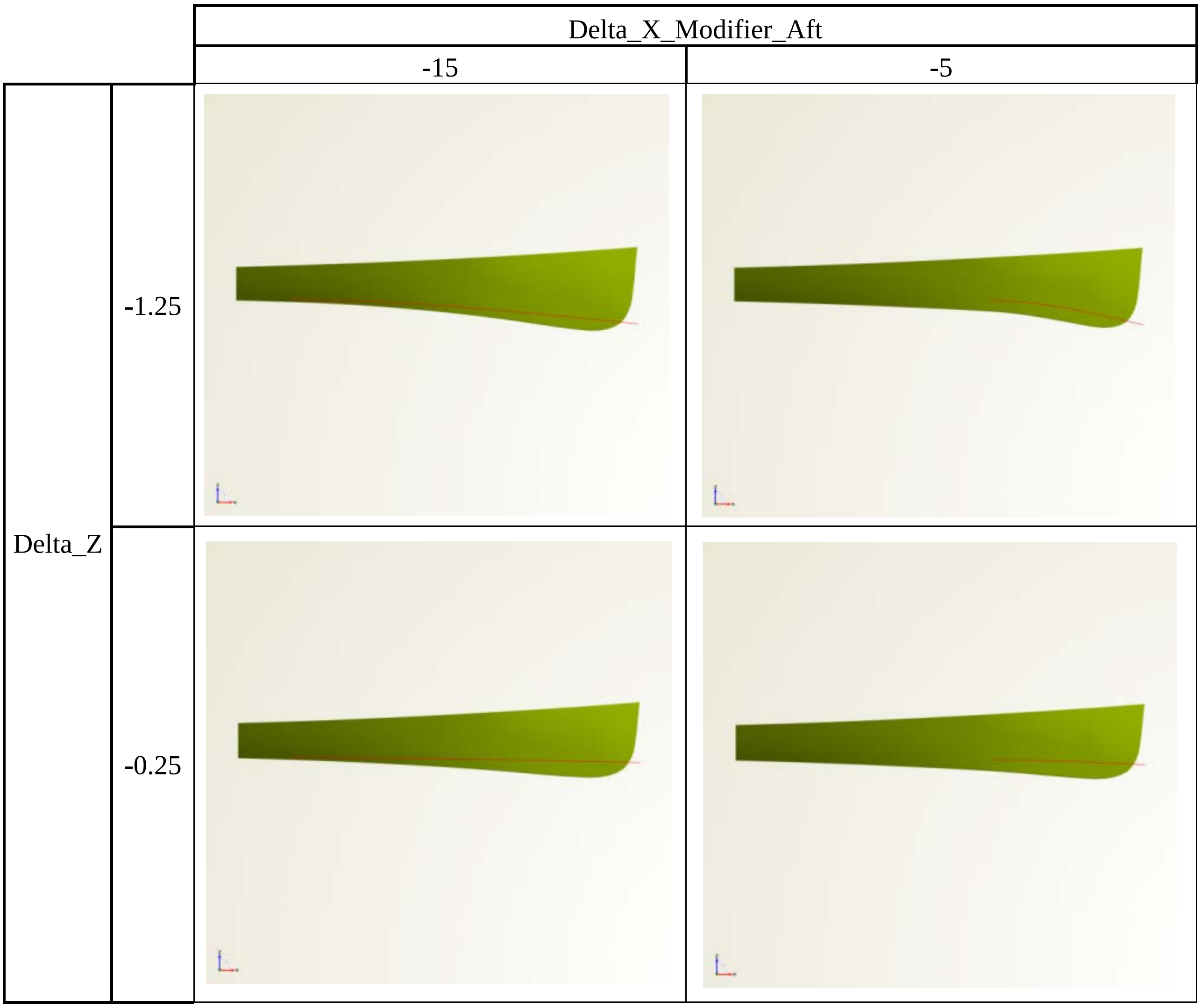


Figure 5. Effects of "Stem_modifier" (red curve) Parameters

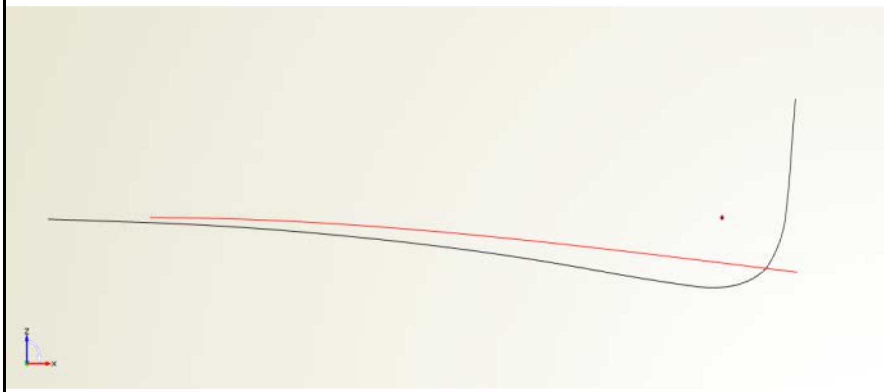
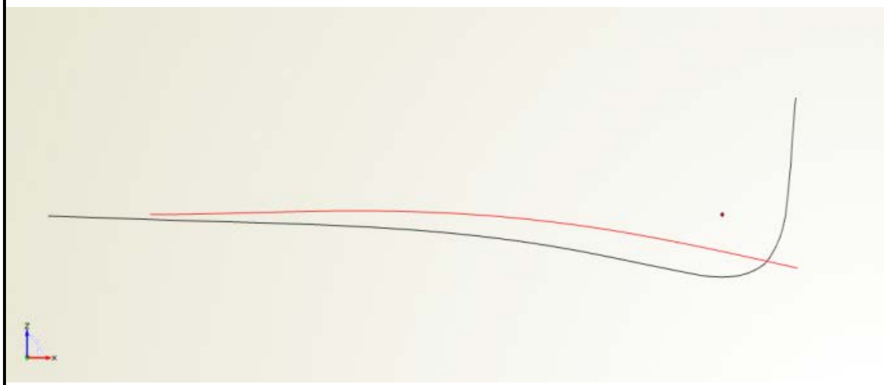
	Delta_X_Modifier_Aft = -15 Delta_Z = -1.25
Fulness_Stem = 1	
Fulness_Stem = 0.5	

Figure 6. Effects of "Fulness_Stem"

ADDED PATCH DEFORMATION

Added patch perturbation can be looked at as a generalization of a surface shift. A new surface patch, say $\vec{\boldsymbol{A}}$ (u, v), is added to the surface(s) of the initial shape, say $\vec{\boldsymbol{S}}$ (u, v). Simply enough, any new variant becomes

$$\vec{\boldsymbol{N}}\,(u,)= \begin{bmatrix} \boldsymbol{x(u,v)} \\ \boldsymbol{y(u,v)} \\ \boldsymbol{z(u,v)} \end{bmatrix} = \vec{\boldsymbol{S}}\,(u, v) + \vec{\boldsymbol{A}}\,(u, v) \qquad (2)$$

Theoretically, a superposition in parameter space according to (u, v) is more flexible than a surface shift undertaken in physical space (x, y, z). Practically, some preparatory work may be necessary to define sub-surfaces or poly-surfaces for the baseline such that the (u, v)-spaces of the surfaces align as needed. Parameters of this partially-parametric model are those used to control the added patch. A popular approach is to take a standard B-spline surface and select several of its inner vertices for change, keeping vertices at the edge(s) fixed. Often, only one or two of the vertex coordinates are modified [3].

In this paper, there are used two different added patch deformation. One of them is controlling waterline entrance angle and its corrector curve is consisted of a shift transformation curve. Added surface deforms the initial surface with its parameters. Corrector shift transformation multiplies with this surface deformation so as to determine the magnitudes of the deformation by x coordinate. Five design parameters are linked to these transformations (Figure 7).

Figure 7. Waterline Entrance Angle Transformation Parameters (Left), Transformation Surface (Grey) and Curve (Blue)

Grey surface is made of red curve which is parameterized by design variables in Figure 7. Effects due to changing their values is shown in Figure 8. Shift_Width_Knuckle serves as increased Sectional Area parameter that has negative effect on ship resistance whereas it has positive effect on seakeeping performance. Shift_Width_Top is created for smooth transition between upper knuckle line surface and the lower ones. Surface shift corrector curve determines where the maximum value of surface transformation occurs. It also gives chance to make effects zero in the beginning and the end therefore ship's stem profile line could be kept unchanged.

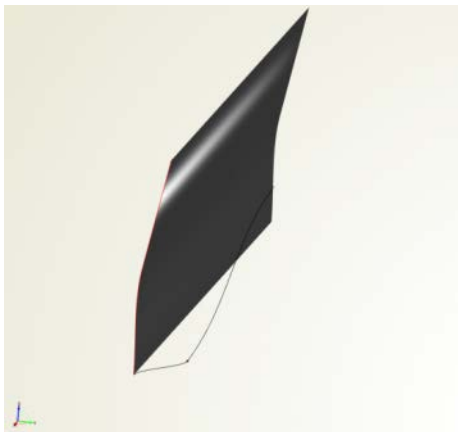
	30 meter	42 meter
Shift_Max_Xvalue		

Figure 8. Surface Shift Corrector Curve

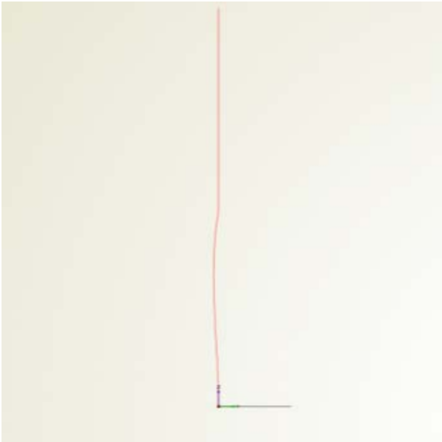
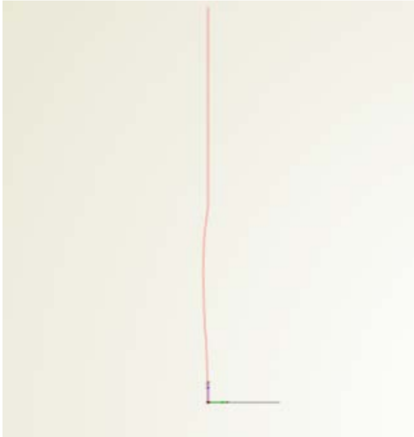
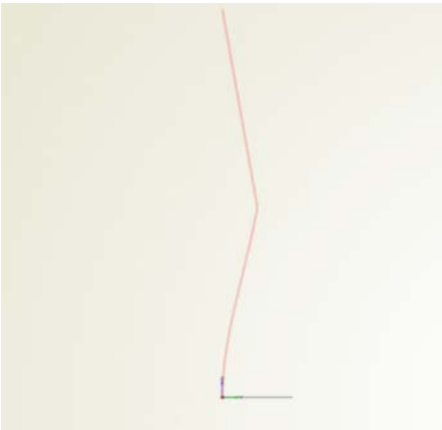
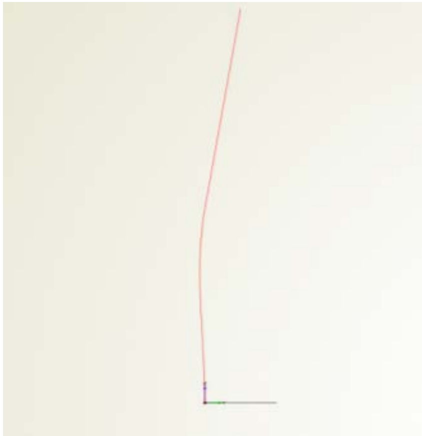
Values:	Shift_Width_Knuckle	Shift_Width_Top
0		
0.5		

Figure 9. Surface Creator Curve and Translation Parameters

Another added patch deformation transforms bow form towards y coordinate. Difference between this transformation and waterline entrance angle transformation is surface limits. B-spline surface used in “Bulbous_Shift” transformation to get its boundary fitted on the bow surface. B-spline surface has control points on its face. “Bulbous_Shift” surface has 8 rows (u vector direction) and 4 columns (v vector direction) therefore designer could change 32 control points. In this paper; u4_v1, u5_v1 and u6_v1 points has its own weighted values which is controlled by “Factor_Weight” parameter. Effects of “Factor_Weight” could be observed in Figure 10. This transformation does not need any corrector transformation because of its fitted and static points.

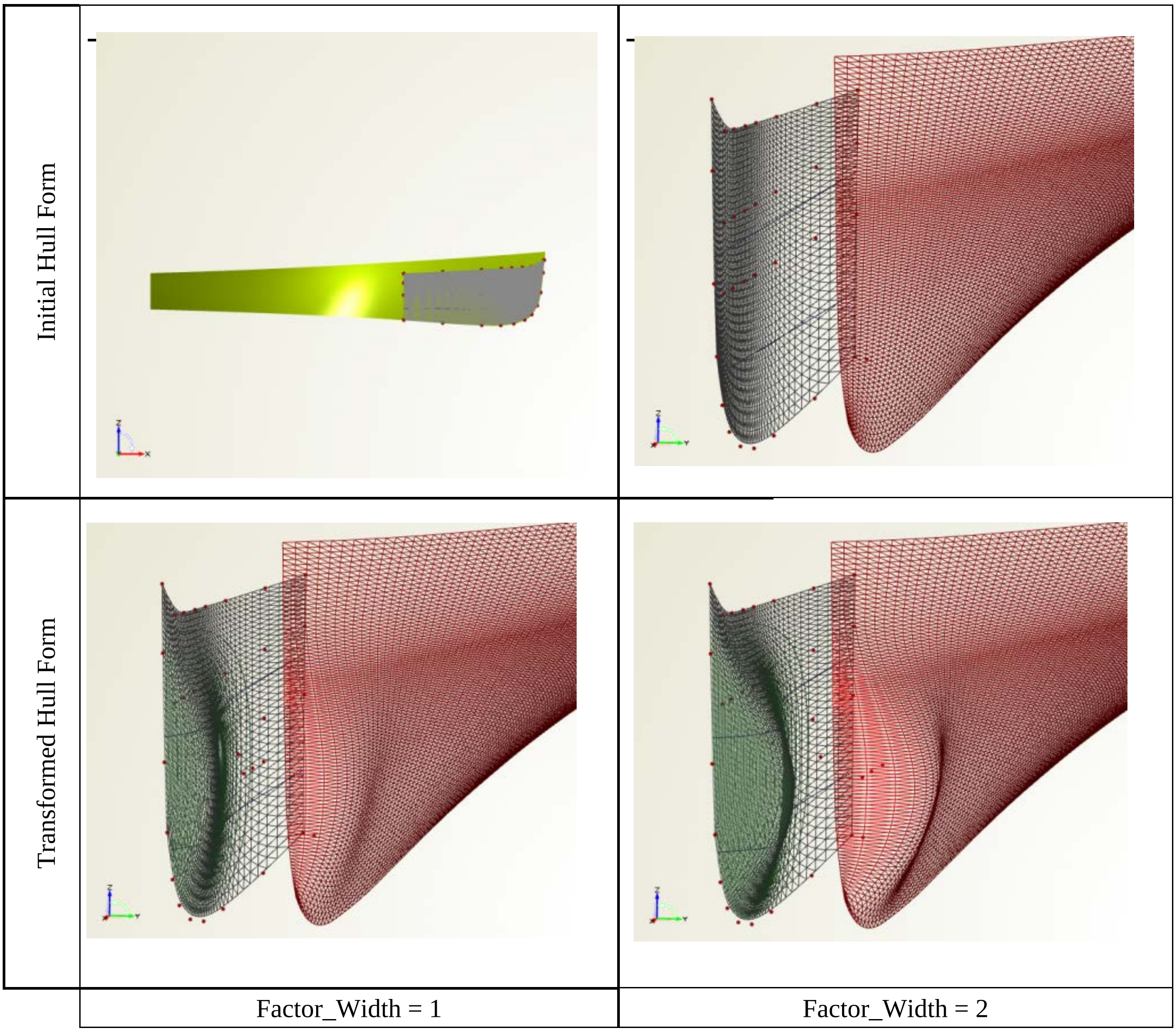


Figure 10. Bulbous Shift Transformation

CONCLUSION

In this paper, existing fast patrol boat design is chosen for partially parametric modelling implementation. All ship surfaces except for bow surface is fixed and shift transformation functions and added patch deformations formed to create numerous variants. These functions and deformations are parameterized in order to be controlled in given limitations.

Partially parametric modeling is appropriate when it comes to optimize existing surface. Transformation functions must be chosen carefully and in compliance with design requirements. After making transformation functions parameterized, optimization process is available to be done. Design parameters and their limits determined in design requirements as well as limitations.

256 new variants created with the modification of bow surface using three partially parametric functions together. In Figure 11, some examples of the variants can be found.

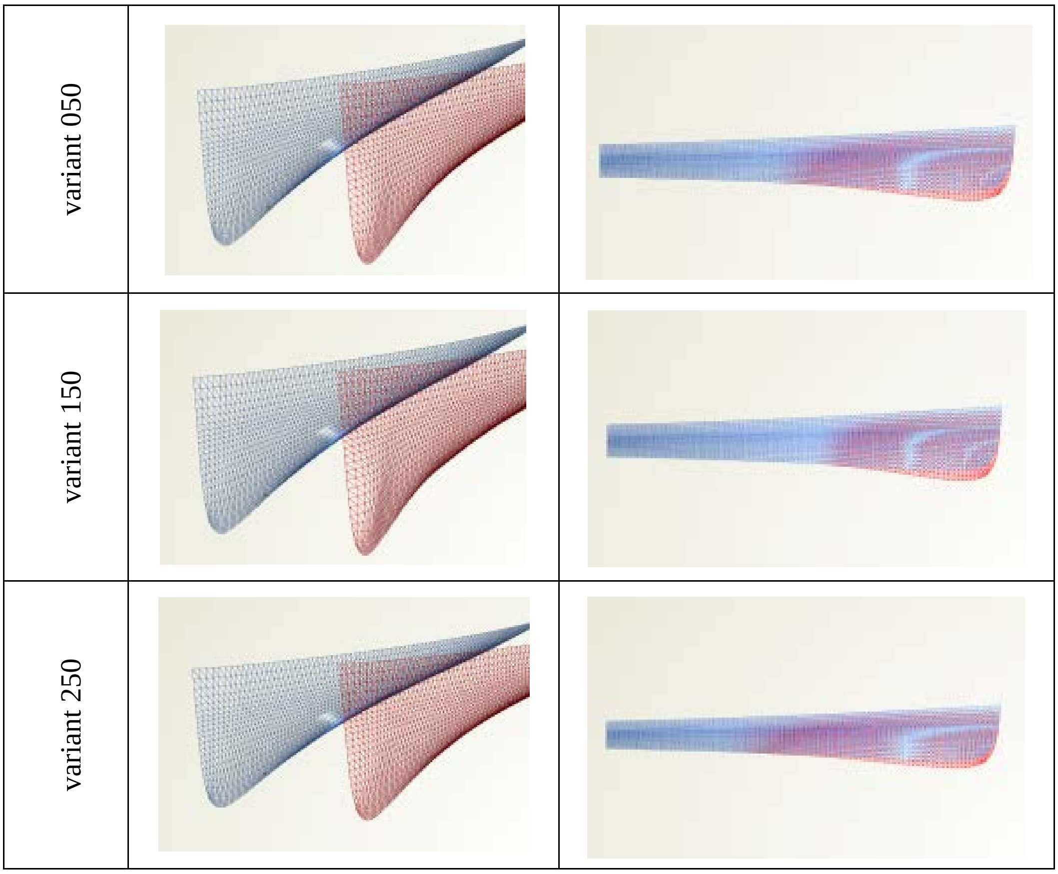


Figure 11. Variant Surface (Red) comparison with Initial Surface (Blue)

This work takes lead to connection of CFD and seakeeping softwares to CAESES and evaluate each variant that is created by changing design parameters. Statistical analysis results are gathered in a pool to see which design parameter effect the resistance and seakeeping characteristics. Finally upper and lower limits of design variables re-evaluated and optimization process could be started. Multi-objective optimization algorithms should be used in this case because there are more than one objective evaluated to get reasonable outputs.

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PRIVATIZATION OF PORTS: PARTICIPATION OF GLOBAL CONTAINER TERMINAL OPERATORS IN PORT OPERATIONS

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ABSTRACT

The global seaborne trade growth slowed 2% to 10.7 billion tonnes in 2015. The economic, environmental, social challenges and technologic developments affect the ports with regard to growing traffic volumes, increasing ship size, port hinterland infrastructure needs, maritime and port technology requirement and the cost etc. The governments expand the involvement of the private sector in port management and operations. There has been intensive increase in the interest and growth in privatization in the ports. The global container terminal operators involve in international port terminal operations and expand their operations in new markets through privatization, mergers and acquisitions in many regions all over the world. Turkish ports hold stratejic position within the Eastern Mediterranean and Black Sea Shipping Lines and at the intersection point of East-West and North-South international transport and energy corridors and has a potential to become a centre for transit cargoes in the region. Some of global container terminal operators show interest in operating Turkish ports. The purpose of this study is to explain conceptional framework for privatization and main objectives of port privatization, to examine port privatization methods, port privatization experiences in the world and Turkey, to investigate the strategies of global container terminal operators such as privatization, mergers and acquisitions, to examine the port operations of global container terminal operators in Turkey. General evaluation is conducted and the suggestions are proposed concerning the participation of global container terminal operators in port operations in Turkey.

Key words: Ports, privatization, global container terminal operators, strategies of global terminal operators, concession of ports.

INTRODUCTION

Global world trade is expected to remain unchanged at 2.8 percent in 2016 [1]. UNCTAD forecasted that the total volume of global seaborne trade has reached 9,84 billion tons in 2014. The global seaborne trade growth slowed 2% to 10.7 billion tonnes in 2015. The total number of full containers shipped internationally grew by 2,3% to 175,2 million TEU in 2015 [2,3]. Alphaliner's predicts global container port throughput increase 1.1 percent in 2015[4]. The global container market demand is estimated to increase by about 5.3 percent between 2014 and 2017 [5]. The economic, environmental, social challenges and technologic developments affect the ports with regard to growing traffic volumes, increasing ship size, adaptation of port and port hinterland infrastructure needs, maritime and port technology requirement and the cost etc. Public ports face with many problems such as infrastructure and superstructure investments requirements, inadequate efficiency and effectiveness, lack of competition, technology needs to meet the demand. Therefore, the

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governments want to expand private sector participation in port management and operations by privatization, merges and acquisitions. Many governments including South America, Eastern Europe and Southeast Asia take into consideration privatization by concession agreement or asset sales for their ports. The global container terminal operators involved in international port terminal operations have played an active role among different port locations into a global supply chain management. They expanded their operations in new markets through privatization, mergers and acquisitions in many regions all over the world.

Turkish ports hold stratejic position within the Eastern Mediterranean and Black Sea Shipping Lines and at the intersection point of East-West and North-South directional international transport and energy corridors and also has a potential to become a centre for transit cargoes in the region. Total numbers of ports are 179 along the coastline. 21 ports are operated by the government, 23 ports are operated by municipalities, 135 ports are operated by private sector [2]. Some of global container terminal operators show interest in operating Turkish ports such as PSA, APM Terminals, DP World and Global Terminal Limited (GTL).

In the paper, Section 2 includes conceptional framework for privatization Section 3 untitled "Privatization of Ports" involves main objectives of port privatization, to examine port privatization strategies, Section 4 contains port privatization experiences in the world and Turkey, Section 5 compass the strategies of global container terminal operators such as privatization, mergers and acquisitions and port operations of global container terminal operators in Turkey. In Conclusion general evaluation is carried out and the suggestions are proposed concerning the participation of global container terminal operators in port operations in Turkey.

CONCEPTIONAL FRAMEWORK FOR PRIVATIZATION

Privatization has attracted much attention over the years and many countries introduced privatization programmes. Privatization is the transfer of economic function or activities or a state owner enterprise (SOE) from public sector to private sector [6,7,8]. Privatization is related to decreasing the role of public sector and increasing the role of the private sector in industrial, commercial and other activities [9]. Privatization is the process of transferring a SOE or industry or services from government to the private sector by using the methods such as denationalization (the sale of publicly owned assets), deregulation, contracting out products and services, concession agreements or transfer of operation right. Governments privatize the owner enterprises to improve efficiency, generate revenue, disperse ownership, develop capital market etc [10].

There are three main approaches to privatization. The first approach is a change in the ownership of properties, goods and services production units of the organizations from the public to the private sector through divestiture. The second approach includes the liberalization or deregulation of public sector enterprises. The third mode involves the the transfer of goods or services from public to private sector by the methods such as franchising, leasing of public assets and concession agreement [11].

PRIVATIZATION OF PORTS

Privatization is the transfer of ownership of port assets, facilities and equipment from the public to the private sector [12]. Port privatization provides the efficient port operations, a contribution to investments in superstructure and infrastructure and commercial flexibility to increase competition by involvement of the private sector in port management and operations. The main objectives of port privatization are; to reduce the dimension of the public sector, to enhance efficiency and effectiveness of port operations, to meet investment requirements in port superstructure and infrastructure through private sector, to provide response market demand, to increase the competition, to provide diversity of port operations, to ensure technology and know-how transfer, to develop management skills, to create flexible tariff structure, to ensure maximum capacity of utilization of port facilities, to provide a financial independence, to achieve advanced management techniques and practices [13,14].

In recent years many countries have privatized their ports to increase efficiency of port operations and minimize the financial burden on governments [15]. Privatization methods are different for every country according to the privatization objects of the counry. Hence, there are various privatization methods such as leasing of port assets, concession agreement, transfer of the operation right, management contract and joint venture etc. Port Privatization strategies can be classified as follows]16].

Lease is an agreement between the lessee and the lessor which contains the right to use an port asset including land or equipment or both of them for a certain period of time and fee [12]. In leasing model, the private operator hires the cargo handling equipment or port land area which belongs to port authority. The cargo handling operations or stevedoring work is carried out by the private operators in the ports such as the Ports of Antwerp, Rotterdam, Hamburg by using their own equipment or the equipment which is leased from the port authority. If the lessee doesn't fulfill obligation of the terms of the lease, the port authority can cancel the lease unilaterally [16]. The management agreements are similar to the lease of port land and equipment and differ from concession agreements. They don't imply any major investment nor pre-financing by the lessee or contractor in which they differ from concessions [16].

Build-Operate-Transfer Model is a contract by which the grantor grants to the grantee the right of finance, build and operate a port facility or some equipment for public use during concession period, after which the equipment will be transferred as free of charge to the grantor and will become the grantor's property at the end of that period. The concession system has been a basis of port operations and main investments in many countries where concessions have been granted either to private companies, or to mixed companies, government or public authorities [16]. A joint venture includes the setting up by two or more organizations to share the ownership, risks and returns by combining public and private sector resources [14].

The privatization method depends on the main objectives of the related groups such as the privatization objectives of the government, national economy, port authority, terminal operators, port customers, labour, maritime industry, needs of port users and employees.

PORT PRIVATIZATION EXPERIENCES IN THE WORLD AND TURKEY

Port Privatization Experiences in the World

Port privatization began in Europe in the mid-1980s and spread to all over the world the period of from 1980 to 1990. In the last century, the concept of the private port has been very popular, especially in Great Britain and United States [7,17]. The countries Malaysia and Jamaica have beeen privatized their container terminals. Some countries have privatized their ports in a different way. Great Britain privatized "Associated British Ports (ABP)" which owned 19 ports in 1982 and 115 "Trust Ports" which are self-governing publicy owned ports in 1991 [14, 17]. Port of Antwep in Belgium is operated by the municipality with the landlord port authority model. Cargo handling operations in the port is performed by private operators on leased port area from the municipality for a short or long period. Stevedoring companies construct their own terminals with superstructures [14].

The ports in the Netherlands are publicy owned. The government performs dredging or the provision of port infrastructure. The private sector plays a major role in Dutch ports. In the municipal ports such as Rotterdam and Amsterdam which are landlords, private terminal operators lease land, waterfront and quay facilities to carry out their port operations. The private operators is liable to all related business and personel taxes. The private operators are involved in train services and inland container depot activities to form their logistic network [13]. The ports in the USA are owned municipality, a special district or an individual state and primarily public or quasi-public bodies. There are few private ports in USA. The ports such as Los Angeles and New Orleans sell their own securities directly into the bond market[13].

In Asia, the biggest privatization was performed in Malaysia. The share of 51% of the Kelang Container Terminal (KCT) was sold in 1986. KCT leased port equipments and quays for a period of 21 years. Many ports in Argentina, Chile, Colombia, Malaysia, Mexico, New Zealand, the Philippines, and Venezuela are privatized [18].

Privatization Perspective of Turkish Ports

In Turkey, the principles, procedures, authorised agencies and other issues regarding privatization are all set out in the Privatization Law No. 4046, dated 1994. According to the Privatization Law No. 4046, privatization is implemented through transfer of the operation right, leases or similar methods. Under the Turkish Constitution and Privatization Law No. 4046, property rights of the ports can not be sold to the private operators. As from 1997, 13 ports operated by Turkish Maritime Organisation (TDI) have been privatized. In 1997, Ports of Tekirdağ, Rize, Ordu, Sinop, Giresun and Hopa Ports; in 1998 Port of Antalya, in 2000 Ports of Marmaris and Alanya; in 2003 Ports of Kuşadası, Çeşme, Trabzon and Dikili Ports have been privatized through the transfer of the operation right method for 30 years. Operational rights of Port of Tekirdağ transfered back to TDI on 13 March 2012 [2]. As from 2007, 5 ports operated by Turkish State Railways (TCDD) have been privatized. In 2007, Port of Mersin; in 2010 Ports of Bandırma and Samsun; in 2011 Port of İskenderun have been privatized by the transfer of the operation right method for 36 years [19]. Derince port has been privatized by the transfer of operation right method for 39 years in 2014 [20].

Operatinal rights of Mersin Port were assigned to PSA-Akfen joint venture of Mersin International Port Managment Inc. [21]. Bandırma Port is operated under the name of Çelebi Bandırma Uluslararası Liman İşletmeciliği A.Ş., Samsun Port was assigned to Ceynak Lojistik ve Ticaret A.Ş. The Port is operated under the name of Samsun Uluslararası Liman İşletmeciligi A.Ş., İskenderun Port was transferred to Limak A.Ş. The Port is operated under the name of Limak İskenderun Uluslararası Liman İşletmeciligi A.Ş. [19]. Derince port was assigned to Safi Derince International Port Management [20]. The operating right of İstanbul Salıpazarı Harbor Reach has been transferred to Doğuş Holding Company Inc. for the duration of 30 years with the decision dated 04.10.2013 and numbered 2013/157 of the Privatization High Council (PHC), and the Salıpazarı Harbor Reach has been transferred to said company on 24.02.2014 [22]. İzmir port will be privatized by the method of “transfer of the operation right”. Zoning plan studies of Izmir Container and Cruise Ports are ongoing in the process of privatization [23]. Tekirdağ Port will be privatized through transfer of the operation rights method in 2016. Zoning plan studies of Tekirdağ Port are ongoing in the process of privatization[24].

GLOBAL CONTAINER TERMINAL OPERATORS

There is an increase in the freight volume being handled by the private terminal operators. Private terminal operators began to cooperate in order to be able to meet demands of big shipping lines. Global container operators and container terminal operators use various strategies by privatization, mergers and acquisitions to expand their operations many regions around the world and increase their market share [25]. The strategies of global terminal operators are horizontal or vertical integration or portfolio diversification. The terminal operators geographically spreading out by mergers, acquisitions, privatization of ports or the construction of port facilities as organic growth by horizontal integration. Global container terminal operators such as Port of Singapore Authority (PSA), Hamburger Hafen und Logistik AG. (HHLA), Eurogate, Hutchinon Port Holdings Limited (HPH), International Container Terminal Services, Inc. Terminal Investment Limited (TIL), ICTSI and SSA Marine form strategic partnerships with other terminal operators or port authorities by horizontal integration to buy or manage and operate container terminals [26]. Container operators such as APM, China Ocean Shipping (Group) Company (COSCO), Mediterranean Shipping Company (MSC), APL, Hanjin and Evergreen form alliances with various terminal operators through vertical integration to operate container terminals [26]. A shipping line can be involved in port and terminal operations, by contractual agreements between stevedore company and the shipping line, buying some shares of the terminal, joint venture between the shipping line and stevedore company to use the port or the terminal [26,27,28]. Global container terminal operators such as CMHI and DP World have been formed a partnership with financial investors to operate container terminals by portfolio diversification. Financial investors' main business is financial assets management. They want to involve in the port operations to revenue generation [26]. Therefore, financial holding companies such as DPW (Sovereign Wealth Fund), Ports America (AIG; Fund), RREEF (Deutsche Bank; Fund), Macquarie Infrastructure (Fund), Morgan Stanley Infrastructure (Fund), SSA Marine (Goldman Sachs) form partnerships with terminal operators by acquisitions, mergers and reorganization of assets to generate a return on investment [25,26].

The privatization is another method to purchase a terminal for expanding port operations. The terminal operators such as APM Terminals, DPW also expand their port terminal operations by privatization [29]. The global terminal operators such as Maersk Line, Hutchison Port Holdings (HPH), DP World, APM Terminals and COSCO form associations with rail, road and highway transportation and logistics companies and investment groups by vertical integration to constitute their own logistics network. Thus, the global container operators expand into other logistics and transportation-related businesses including rail services and highways and airway operations, inland services, distribution centres, storage, cargo services, cruise ship terminals, container equipment, ship construction and repair services [25,30-34]. The global container terminal operators DP World, Hutchinson Port Holdings Limited (HPH), APM Terminals, PSA International, Shanghai International Port Group (SIPG) and the Rotterdam Port Authority (PRA) have launched "Go Green" event which was held on the 7 September 2015 to promote environmental awareness and make a sustainable difference in the communities in which they operate [35].

The global port container is 689 Million TEU in 2015 [36]. Drewy, a maritime research firm predicts that the global container port demand between 2015-2019 will grow annually by 4,5%, such growth equates to 850 Million TEU [37]. In 2015, the global container terminal operator which has handled the most containers with 83,8 Million TEU was Hutchinon Port Holdings [38] and respectively China's Cosco Pacific (68.7 million TEU) [39], PSA (64.10 milyon TEU) [40], DP World (61.7 million TEU) [41] and APM Terminals (36 milyon TEU) [42].

Turkey is at a junction point in both the transportation and energy transport "corridors" in-between the North-South and East-West, Therefore, Turkish ports have become more attractive for global container operators. Mersin International Port (MIP) located in the Mersin Port operated by Turkish State Railways (TCDD) was privatized by transfer of the operation right method in 05.11.2007. Mersin International Port Management Inc (MIP), which was established as a partnership between PSA International and Akfen Holding, took over management of Mersin Port for a period of 36 years. The port has 1,8 million TEU capacity per year [43]. APM Terminals, which is a subsidiary of the Denmark Based Moller-Maersk Group has signed a preliminary agreement with Petkim Petrokimya Holding which is 100% owned by Petlim Port Inc. for the long-term operation of Petkim Port in a bid [44]. Petlim, which is able to accept ships with up to 11,000 TEU capacities has 1,5 Million TEU per year container handling capacity [45,46]. Asyaport is a joint venture between Global Terminal Limited (GTL), terminal investment company of MSC, and the Turkish Soyuer family located in Barbaros / Tekirdağ. Asyaport commenced operations in 8th of July 2015. Asyaport which is the first Transhipment Container Terminal (Hub Port) of Turkey has 2.5 million TEU capacity per year [47]. DP World Yarımca will be 1,3 million TEU capacity[46]. China Merchants Holdings acquired 65.8% stake in the third largest container terminal in Kumport, Turkey in cooperation with Cosco Pacific. Terminal capacity is 1.84 million TEU [49].

CONCLUSION

Privatization of ports is to increase private sector involvement in the port investments and operations. Privatization provides the efficiency and effectiveness of port operations, commercial flexibility, to meet the commercial demands necessary for survival in the port sector. Privatization of ports enlarges financial planing, allows private sector investment and port organization diversity, provides access to new technology and management skills, improves the competition between regional ports, ensures diversity of port operations and port-related activities in the port area, creates joint venture between publicy owned ports and private sector interest, provides a contribution to the regional and national economy and employment. Many countries increase in private participation in the port management and investments. Port privatization have expanded all over the world. However, scope of port privatization should be defined clearly taking into consideration the position of the ports, problems of the ports, transportation modes and future trends in the shipping sector and trade .

Global container terminal operators are increasing their role in port and terminal operations. The container terminal operators use various strategies by privatization, mergers and acquisitions to expand their operations many regions around the world and increase their market share. Port privatization is one of the means for the expansion of global players geographically spreading out. In recent times, Turkish ports which is at a junction point in both the transportation and energy transport "corridors" have become more appealing for global container terminal operators. The participation of global container terminal operators in port operations will increase effectiveness of the port operations, meet super and infrastructure requirements, increase the competition of Turkish Ports among the regional ports, provide a contribution for port's industrial function, regional and national economy. However, ongoing investments should be finalisedas soon as possible, logistics centres must be established, combined transport must be improved, flexible tariffs structure should be adopted, trade facilitation should be conducted and regulations concerning shipping and port sector should be revised to facilitate trade and investment procedures.

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ASSESSING THE ENVIRONMENT IMPACT OF PORT HINTERLAND TRANSPORT OPERATIONS

Olgay OKSAS[1], Gokhan KARA[2]

ABSTRACT

Ports play an important role in the economic development of a country. Seaports are one of the most important parts of logistics chain and mostly located in the city centers or close to these centers. Today, environmental management systems and practices are held in almost every area. The EU aims to reduce the emissions significantly which are sourced by ship and port operations as of 2050 without impeding the growth of the transport sector. The green concept idea has been raised in order to prevent marine environmental due to the pollutions sourced by port construction and operations. The emissions which are released during the berthing time, service time and leaving time of ships, emissions of handling and transport vehicles in the port, emissions due to connection roads (road, rail, etc.) which provide transportation to ports, ship and port sourced solid and liquid wastes are all the reasons of decreasing quality of life at the ports and residential areas around the ports. Today, in order to reduce the environmental impact of ports, the mandatory legislations for ports and studies on the green port applications that enhances the performance of ports indirectly come to the forefront. Energy conservation, environmental protection and ecology are the three appearances of the green concept idea which introduced in port operation and hinterland transport. In this study, ship emissions in the process of creating a green port, port operations and hinterland transport operations are evaluated and the applications to reduce these emissions are mentioned.

Keywords − *Maritime transport, port hinterland transportation, emissions, green port*

INTRODUCTION

Approximately 60-70 % of total imports and exports of a country is is carried out with maritime transport. If this country is as a kind of transshipment point in its geographical area, this percentage would be much more. Therefore, ports are the most intense places where the total cargo traffic takes place with loading/unloading, transport in port and port hinterland operations. During these operations, at the quayside ships and loading/unloading processes, at the land side all the equipments which used inside the port for the transportation, storage and shifting, are the sources of indirect emissions into the environment. Also, considering the logistics aspects of the ports, they are usually located close to the cities. Therefore, they are directly affected by the all pollutants due to the results of port operations.

Ports are the most important centers of economic activities and major reasons of pollution with the running engines of big ships, lots of trucks and train locomotives hauling cargo. These activities cause

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a serious environmental problem and affects local communities [1] This study discusses environmental impacts of port operations and hinterland transport operations.

POLLUTION AT PORTS

Sources of pollution at the port is not so different than the pollution sources of natural environment outside the port.

However ships, especially in loading and unloading operations, berthing at the port and departure maneuvers, the ballast water intake and release operations to ensure that the ship stability, damages the environment in the forms of liquid, solid and flue gas emission. In addition, another important emission resources are the equipments used for loading and unloading, transporting and storage in the port area, haulier vehicles at highways and railways in the port hinterland area.

The main sources of pollution generated by port are as follows:

Liquids; Ballast Water, Bilge Water, Bunker Fuel, Tank Washing, Oil spills.

Solids; Dunnage (Material used in stowing cargo either for separation or the prevention of damage). Garbage (MARPOL Annex V bans all overboard disposal of plastics and limits other discharges based on the form of the material and the vessel's location and distance from shore. The regulated garbage includes solid wastes (other than sewage) generated during normal operations at sea.

Mixed Waste; Typically, commercial wastes are mixtures of plastics, metals, glass, biodegradable waste [2].

Other than the above sources, vehicles, working on both landside and quayside at the ports, are seen as an important source of pollutants.

Sources of Pollution at Port Operations

Port operations may cause marine pollution with the result of damage to marine ecosystem and human health. Besides, diesel engines are the main reason of air pollution in the ports and around the ports where people work in and live around and affects their health significantly [3]. Nitrogen oxides (NOx), particulate matter (PM), sulfur oxides (SOx) and volatile organic compounds (VOCs) are the air pollutants at ports which are harmful to human health [1].

• *Shipping emissions in ports :* Shipping activity is the biggest source of emissions in ports. Shipping emissions in ports have a substantial share of total emissions in the port-city. The size of the city, the character of the city and the size of the port are the indicators that effects total emission in the city. For example, in some large port-cities, such as Hong Kong and Los Angeles/Long Beach, almost half of the total emissions is sourced by SO2 emissions [4]. Table 1 shows that shipping emissions in ports are as considerable as that 18 million tonnes of CO2 emissions, 0.4 million tonnes of NOX emissions, 0.2 million of SOX emissions and 0.03 million tonnes of PM10-emisions are measured in 2011, as well as various other emissions [4].

Table 1. Estimated Shipping Emissions in Ports [4]

Shipping emissions	Shipping emissions in ports(mln tonnes)
CO2	18.3
NOx	0.4
SOx	0.2
PM10	0.03
PM2,5	0.03
CO	0.03
CH4	0.002

• *Cargo handling equipment* : There are several types of landside vehicles to handle cargoes at ports. Some of these vehicles are electrically propelled and some of them works with diesel fuels. Quay crane, Mobile Harbour cranes (MHC), Rubber Tyred Gantry crane (RTG), Rail mounted gantry (RMG), Straddle carriers (SC), Grab unloaders, Slewing grab, Conveyors are some of the handling equipments at ports. All these vehicles working with diesel fuels releases emissions at port area and its hinterland. The parameters which are used to calculate emissions are equipment type, make and model, engine make and model, model year, horsepower, load data, annual operating hours, fuel used [5].

As shown in Fig. 1 (for container ports) that the highest emissions are respectively in marine vessels, trucks, cargo handling equipments and locomotives [3].

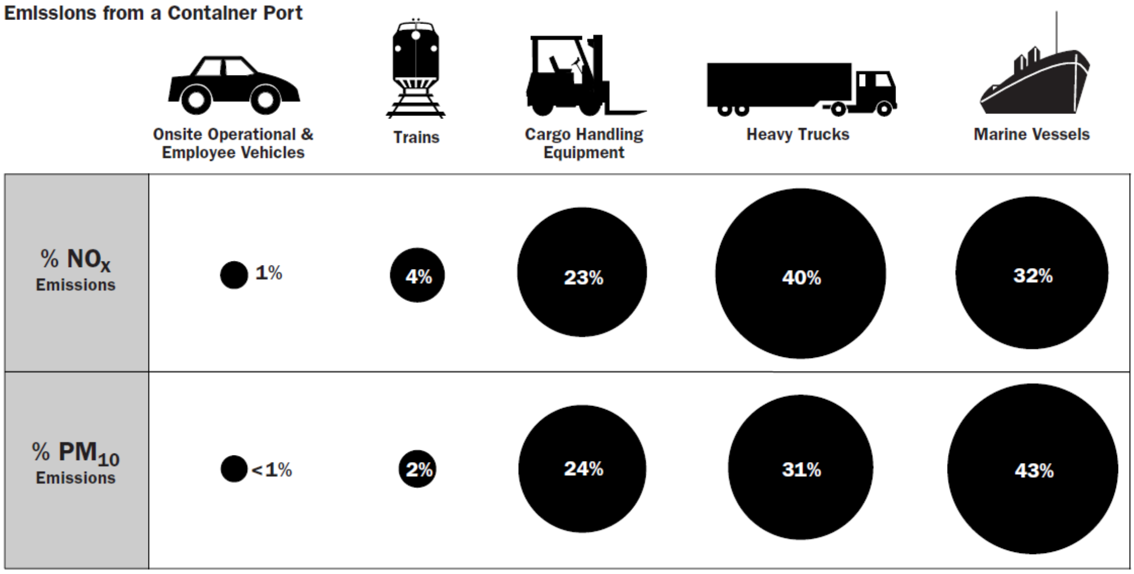

Figure 1. Average Contributions of Various Port-Related Sources to Total Nitrogen Oxides (NOx) and Particulate Matter (PM10) Emissions from a Container Port [3]

• *Port Trucks* : Truck emissions are estimated with two components of road and terminal operations. Truck operations are mostly between quayside crane activities, storage yard and terminal gates in the port area. In addition to this, these trucks sometimes wait at the gates to enter the terminal. Truck operations at port depends on terminal's total cargo capacity and emissions of the trucks depend on distance traveled, fuel type, full/empty travel, idling time while on terminal [5].

• *Ships at Berth* : Loading & Unloading Cargo (Spillages, Exhaust emissions from docks side vehicles, Noise, Shipboard Generators (Provide electricity onboard – create air and noise pollution) [2].

• *Light Pollution* : Lights at ports can effect wildlife negatively that some animal populations, particularly to birds and marine species, face high mortality due to bright lights. They can circle these structures until they die of exhaustion or fly head-on into them. Besides, lights cause animals to confuse day/night alternation and effects their biological structure directly. At the close neighborhoods of ports, especially for residential areas, bright nighttime lights and the flashing lights of straddle carriers and forklifts can affect people living around and cause stress and annoyance [3].

Pollution at Port Hinterland Operations

• *Railway link* : Especially in large industrial ports, railways are used commonly to transport cargoes from/to hinterland areas. Locomotives working with diesel fuel cause a linear air pollution in the port and around the port area. This proportion is quite high in total emissions at ports. It also affects residential areas around the ports.

• *Heavy Trucks Transporting Cargo to and from Ports* : Most of the large trucks which are serving transport to/from ports are older than long haul trucks and all uses diesel fuel. Heavy trucks also cause congestions at the terminal gates while terminal traffic is busy. They idle for long periods and cause more pollution when waiting. On a normal day, thousands of trucks might gate in to a port depending on port's capacity and size [3].

• *Noise Pollution* : Ports work nonstop in a day with many vehicles for handling and ships berthed. These vehicles make ports a loud place where this noise might affect people's health negatively. According to World Health Organization's report noise pollution has been linked to hearing impairment, high blood pressure, sleep deprivation, reduced performance, and even aggressive behavior. Additionally, noise from ship engines may disturb marine species and birds around the ports. Due to all these negative effects some ports took steps to overcome noise pollution such as Valencia port applied a new law in 2003 which calls for a reduction in noise pollution and regulate that city port's equipment and machinery.

APPLICATIONS FOR REDUCING PORT-SOURCE POLLUTION

T When ships are berthed they use their diesel auxiliary engines in order to generate necessary electrical power for climate control, lighting, cargo refrigeration, on-board cargo handling equipment, etc. for a ship in the port. Emissions that created by these auxiliary engines make up a major portion of total port emissions. For example, the rate of these emissions are 32 percent of all marine vessel NOx emissions at the Port of Houston and nearly 20 percent at the Port of Los Angeles.

Cold ironing is an application which allows ships using shore power while at berth, thus allowing them to turn off their auxiliary engines. This application is most effective for ports where vessels have long waiting times and needs high auxiliary power. It's estimated that using cold ironing allows reducing emissions significantly for a port in comparison to auxiliary diesel engines.

Another application to reduce emissions would be decelerating ship speed. Before entering to a port, ships first arrive port's "reduced speed zone" where should be decelerated. Reduced speed zone area might be extended by regional port authorities or specified reduced speed might be lower for less emission [6].

As per Discussion Paper 2013-19 of International Transport Forum Emissions from Hinterland Transport can be reduced in five ways. These are:

1. Rationalising the pattern of container movement
2. Shifting container traffic to lower carbon transport modes
3. Improving the loading of vehicles, wagons and barges carrying containers
4. Increasing the energy efficiency of the transport operations
5. Powering these operations with cleaner, lower-carbon fuels [7].

CONCLUSIONS

A large proportion of international trade is carried by maritime transport. Therefore, ports are the most intense transport structures where cargo traffic takes place. Advanced equipments, used in the ports, allows a quick and easy way to perform freight traffic and the number and capacity of these vehicles are increasing rapidly. All vehicles except of electrically powered, release significant emission to the atmosphere and around the port. Water and air pollution from ports increased rapidly in recent years, in response to this new international regulations and rules have been made. However, most of these regulations are related to ship-source pollution. A significant part of the pollution created in ports (approximately %35-40) is formed by ships and the rest of is formed by port hinterland operations. Respect to this, emissions created by loading/unloading equipments, handling and storage vehicles and vehicles connected to port either road and rail, became crucial and applications have been developed to reduce these emissions. These applications are, ballast water treatment system (BWTS), using low emission fuels in diesel vehicles in the port area, applications aimed at reducing exhaust gas emissions by ships and arranging of fuel used in locomotives in railway connections.

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CARGO LOADING-UNLOADING SEQUENCE OPTİMIZATION AT BULK CARRIER VESSELS

Kadir IŞIK[1]

ABSTRACT

Loading more cargo than cargo capacity of the ship and planning cargo loading-unloading sequence wrong induce over-stressing which causes to break-down and damage on ship's structure at bulk carrier vessels. This situations generally constitute when the stevedores request the least crane shifting for rapid operation. For this reason chief mates encounters a hard problem which is planning load-unload sequencing which also concerns planning ballast water operations. In this study, total cargo loading by cranes between break times divided the holds with linear optimization method to prevent stopping and minimize crane shifting in respect of ship safety.

Keywords – Cargo Loading-Unloading Sequence Plan, Linear Programming, Bulk Carrier Vessels

INTRODUCTION

Structural failure is an important factor which causes 73 loss and 40 serious damage on bulk cargo vessels [1]. There could be many factors which induces ship loss in bulk carrier vessels due to overstressing of hull. The factors which causes overstressing of a bulk carrier are age of the ship, mistaken loading of the cargo holds and damage on the side structure during the cargo operations. In this case, loss of mistaken cargo planning can be prevented with preparing proper sequence plan. Essential elements of preparing a cargo sequence plan are recognizing cargo very well, being good connection with shore authorities and be acquainted with own ship stability data[2]. Furthermore, lots of unplanned difficulties may happen which causes deviation from cargo sequence plan are crane failure, cargo delays and cargo shortage during cargo operation. So that happening any unexpected incidents, a good chief officer who is responsible for preparing cargo sequence plan in ship should update his cargo sequence plan. But, updating of cargo sequence is time consuming task why putting any part of cargo by trial in ship load master software and difficult duty that's why chief officer has to be care about of ship stability, port division and hold capacities. Also fatigue and workload on chief officer may reason making mistakes. Prevention these mistakes is possible with creating a linear programming which includes any holds and ballast tanks maximum and minimum loading-discharging capacity in each step belonging with other holds and ballast tanks.

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METHODOLOGY

Alterations on cargo sequence plan may be happened due to unexpected progress and generally these requests are about finishing any holds earlier than planned. For this reason, finishing cargo operations on any hold is practical with linear programming which defined as the problem maximizing or minimizing a linear function subject to linear constraints [1]. Using linear programming for one crane cargo operations seem useless but it will be useful to find balance cargo in other holds while operations continues with two or more cranes.

Linear Programming

Linear programming is used on a road type of optimization problems in which both the optimization criteria and the constraints are linear functions. It turns out an large number of problems can be expressed in this way [4].Linear programming can be described as the problem which maximize or minimize to subjects with linear function subject to linear constraints. The constraints may be parity or disparity [3].

Spreadsheet Modelling and Excel Solver

Mathematic model is easy to solve with the graphical method if it has just two variables. But in real life very few problems consist of just two variables. And cargo sequence optimization problem also involve more variables that’s why we need to use more combined techniques and troublesome calculations for solving [5]. For this reason, building cargo sequence plan as a mathematical model is possible with a spreadsheet model which is Microsoft excel solver. Microsoft excel solver is used as built-in optimization tool to find optimal solution in this study.

The first step for organizing of the spreadsheet is representing of mathematic model. Using separate excel cells to represent decision variables and creating a formula in a cell to show the objective function and create a formula in a cell for each constraint. Once the model is applied in a spreadsheet, next step is to use the Solver to find the cargo sequence plan problem solution. In the Solver, locations of objective function, decision variables, nature of the objective function and constraints should be identified [5].

When applying excel solver on cargo sequence plan problem our objective function, variables and constraints are in Table1. Furthermore, based on hourly crane loading capacity any part of cargo distribution can be done automatically for shifting by solver. Moreover, when deviation is being necessary on initial cargo sequence plan, chief mate will restrict the cargo quantity for holds which operations can’t be continued until operations on other holds finished. In this situation, the distribution of cargo is made by solver more surely and more easily than chief mate.

Table 1.Cargo Sequence Planning Problem Constituent

Objective function

Total Cargo Quantity on Ship (Maximizing function for loading and minimizing function for discharging)

Variables of cargo sequence plan problems

$h1 + h2 + h3 + h4 + h5 <=$ Total cargo capacity (for loading operation)

$h1 + h2 + h3 + h4 + h5 =>$ Remain Cargo on board or nil (for discharging operation)

Constraints

h1 =< Intended cargo quantity (for loading operations)

h2 =< Intended cargo quantity (for loading operations)

h3 =< Intended cargo quantity (for loading operations)

h4 =< Intended cargo quantity (for loading operations)

h5 =< Intended cargo quantity (for loading operations)

h1 => Remain cargo quantity or nil (for discharging operations)

h2 => Remain cargo quantity or nil (for discharging operations)

h3 => Remain cargo quantity or nil (for discharging operations)

h4 => Remain cargo quantity or nil (for discharging operations)

h5 => Remain cargo quantity or nil (for discharging operations)

-0,5 =< Trim <= 2,0 (During loading- unloading operations)

Sagging M=< Still Water Bending Moment =< Hogging M

Sf max =< SF hold 1= < Sf min

Sf max =< SF hold 2 =< Sf min

Sf max =< SF hold 3 =< Sf min

Sf max =< SF hold 4 =< Sf min

Sf max =< SF hold 5 =< Sf min

Longitudinal Stresses ın Still Water

Homogeneous log of rectangular section buoyant freely immobile in still water as shown figure 2. Total force of buoyancy (B) balanced total weight (W) of the log of any section..

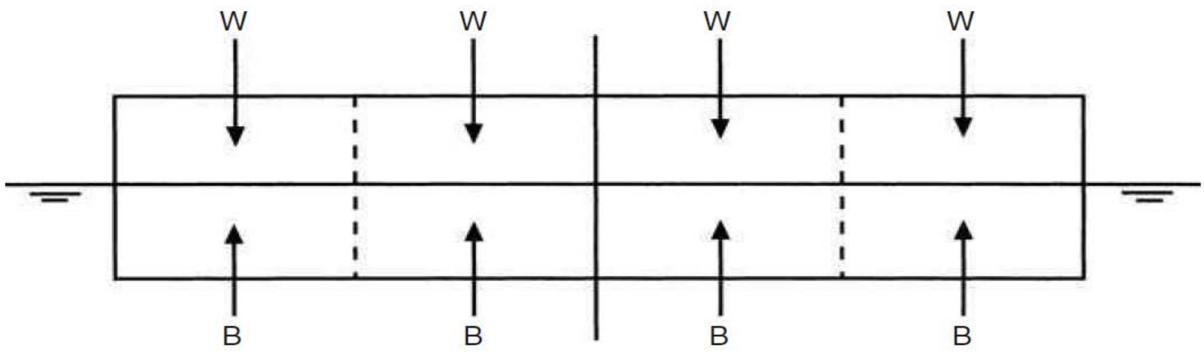

Figure 2. Homogeneous log of rectangular section weight and buoyant force [7]

In this case, there is no bending moment effect to log which would reason longitudinal stresses. When considering the case of not underway and afloat ship in still water, without trim, at the less draft as shown figure 3 [7].

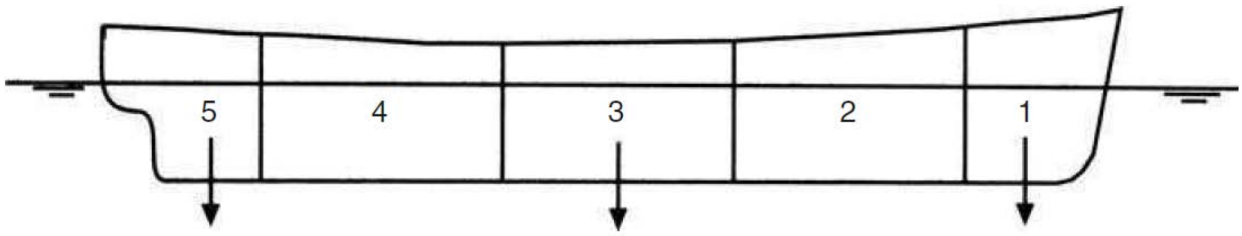

Figure 3. Ship Floating At Rest in Still Water [7]

Despite total weight of the ship balanced by the total force of buoyancy, the weight is equally distributed all along the ship's length. Consideration of cutting the ship to a lot of transverse sections as shown Figure 4. Each section of vessel is watertight and can place vertically until it displaces water which is equal with its weight. In figure 4 the parts of vessel will sink more when the weight of the any part's end exceeds the buoyancy until balance is arrived at its own weight of water. [7].

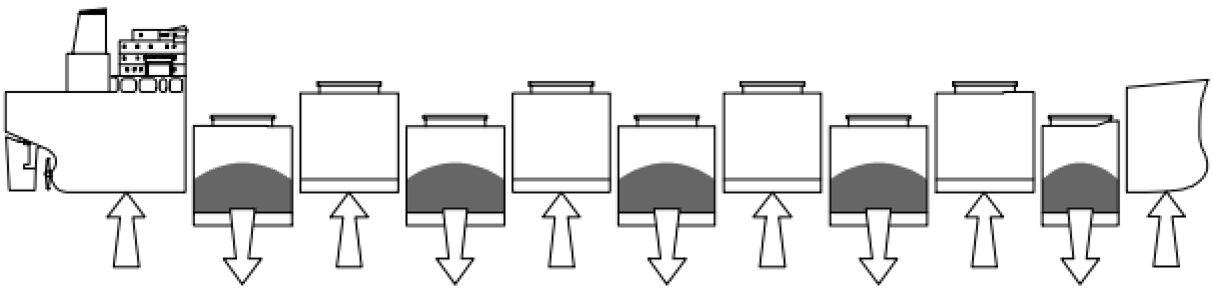

Figure 4. Shearing Action of the Hull Girder in Still Water [2]

Loading and Unloading Operations at Bulk Carrier Vessels and Studied Ship

For bulk carrier vessels loading and unloading cargo is time-consuming and dangerous task. The process is generally planned by the chief mate under the supervision of master. Due to international regulations before commencement of operations the captain and terminal master must agree on a detailed cargo plan [6]. Deck officers and stevedores are charged about controlling progress of operations as planned. Unfortunately, loading mistakes are caused a ship to capsize or break in half at the pier. For this reason each step of cargo sequence plan should be pursuit carefully [7].

İn this study, chosen bulk carrier ship is 45375 deadweight ton and 5 hold bulk carrier and ship particular is given below. Ship's holds are planned to load ch1: 7711 t, ch2:8275 t ch3:8276 t, ch4: 8275 t, ch5: 8228 t and total quantity is 40766 ton bulk cargo. Ship is planned to load with four gantry crane which has 600 ton capacity per hour by shore. Each shift is six hours long and crane shifts are expected to happen in break time by stevedore. Cargo is supposed to load all holds homogeneously and middle of the holds are accepted gravity center of the holds. Especially the cargo and quantity is chosen from stability manual of the ship because of checking conclusions by reliable source. Ship particular is given below [7].

Table2. Ship Pariculars

Length overall ....approx. 190.00 m

Length BP (Centre of rudder stock to forward perpendicular). ....183.05 m

Breadth moulded ....32.26 m

Depth to upper deck moulded..17.50 m

Design draught moulded...11.10 m

Scantling draught moulded ....12.54 m

Displacement to design draught ....56,419 ton

Weight...11,044.1 ton

LCG from AP ....84.076 m

Weight...11,044.1 ton

LCG from AP ....84.076 m

TCG from CL (positive to PS) ....0.00 m

VCG from BL ....11.853 m

Deadweight

Deadweight to design draught (even keel and density of seawater of 1.025 t/m³) ......45,375 ton

Due to ship info and port working info as above our cargo sequence plan occurred by our cargo sequence plan problem mathematic model as below.

For each shift we have to distribute 12000 tons cargo to at least four or five holds. Moreover, we have to decide which holds commence to load. For this reason we started to load ch1, ch2, ch3 and ch4 but our model distribute cargo as figure5. But as seen model gave ch2 less cargo than expected that's why ship's trim arrived half metre trim to fore. Therefore ch4 is kept 1500 tons and then shifts ch5 1500 tons. And then checking at models this distribution, it is seen that all constraints are provided which is at figure 6. With this method for other shifts cargo distribution was made and the cargo sequence plan which built up is seen figure 7.

	A	B	C	D	E	F	G	H	I	J
1	ch1	ch2	ch3	ch4	ch5					
2	-60,3063	-31,7263	-2,92628	25,8737	55,0337					
3										
4	2165,57	3000	3000	3000	0	=	22206,6	<=	23041	
5	<=	<=	<=	<=	<=					
6	3000	3000	3000	3000	0	=	12000	=	12000	
7	L-Mom tr	L-Mom tr	L-Mom tr	L-Mom tr	L-Mom tm					
8	343459	390060	303660	217260	0	>=				
9	7711	8275	8276	8276	8228	=	40766	Max Cargo		
10	158,6	130,02	101,22	72,42	43,26					
11										
12	LCG	98,2937	LCB	96,56	LCG	88,92	Trim	-0,5	Light Ship	11041
13	L-Mom	2182766	SF	60,3169	LBP	183,05	MCT	770	Light Ship	928327
14	Mw	1091383	SF H1	19,2088		518,637			60,3169	
15	Mb	1072133	SF H2	50,1138		1353,07				
16	SWBM	19250	SF H3	50,1138		1353,07				
17	Buoyant Forc	121,314	SF H4	50,1138		1353,07				
18			SF H5	-60,9974		-1646,93				
19		Sfmax	Sfmin							
20	h1	-10000	10000							
21	h2	-8759	8579							
22	h3	-9310	9310							
23	h4	-8994	8906							

Figure 5. First Distribution Plan for First Step of Cargo Plan

	A	B	C	D	E	F	G	H	I	J
1	ch1	ch2	ch3	ch4	ch5					
2	-60,3596	-31,7796	-2,97963	25,8204	54,9804					
3										
4	2870,59	3000	3000	1500	1500	=	22911,6	<=	23041	
5	<=	<=	<=	<=	<=					
6	3000	3000	3000	1500	1500	=	12000	=	12000	
7	L-Mom tr	L-Mom tr	L-Mom tr	L-Mom tr	L-Mom tm					
8	455276	390060	303660	108630	64890	>=				
9	7711	8275	8276	8276	8228	=	40766	Max Cargo		
10	158,6	130,02	101,22	72,42	43,26					
11										
12	LCG	98,2404	LCB	96,56	LCG	88,92	Trim	-0,5	Light Ship	11041
13	L-Mom	2250844	SF	60,3169	LBP	183,05	MCT	770	Light Ship	928327
14	Mw	1125422	SF H1	41,4694		1119,67			60,3169	
15	Mb	1106172	SF H2	46,2622		1249,08				
16	SWBM	19250	SF H3	46,2622		1249,08				
17	Buoyant Forc	125,166	SF H4	-9,29336		-250,921				
18			SF H5	-9,29336		-250,921				
19		Sfmax	Sfmin							
20	h1	-10000	10000							
21	h2	-8759	8579							
22	h3	-9310	9310							
23	h4	-8994	8906							

Figure 6. Final Cargo Distribution of Holds for First Step of Cargo Sequence Plan

LOADING PLAN

Vessel: DIAMOND 03	Last cargo: N/A		Dock water density: 1,025	Date: 1.9.2016
Loading port: AMSTERDAM	Cargoes: Coal 40765	Assumed SF of cargo(es): 47 CF/MT	Max draft available MTR	Max air draft 47
Arrived from port: BORDEAUX	Load. rate: 300 MT/PER HOUR	No of conveyor: 1 2	Min draft available	Max DEPARTURE draft in berth: 12,0 m

	5	4	3	2	1
Tonnes / Grade	Coal 8228 MTS	Coal 8276 MTS	Coal 8276 MTS	Coal 8275 MTS	Coal 7711 MTS
Totals:					

Pour no	CARGO Hold no	Tonnes	Ballast operations	Time Req'd (Hrs)	Comments	Calculated values Trim	Maximum SF	SWBM	Calculated values Air Draft	Draft mid	Trim	Observed values Draughts F	M	A
1	1	3000												
	2	3000												
	3	3000												
	4	1500												
	5	1500			Commence After CH2	-0,5	1249	19250,0						
2	1	1500												
	2	1500												
	3	3000												
	4	3000												
	5	3000				0,30	2459,00	######						
3	1	1500			Continue with 3 Gang,Resume after ch2									
	2	1500												
	4	3000												
	5	3000				-0,16	2632,00	6254,0						
5	1	1711			First Completed hold									
	2	2276			Second Completed Hold									
	3	2276			Third Completed Hold									
	4	777			After Completion CH1									
	5	726			Comletion of loading	-0,20	2262,00	8855,0						
TOTAL:		40766	Signed on behalf of stevedores:		Signed Chief Mate:			*Bending moments&shearing forces are to be expressed as a % of max permitted in SEA values for intermediate stages&of max permitted at sea values for the final stage.						

Figure 7. Final Cargo Sequence Plan

CONCLUSIONS

The aim of this study is to help ship officer about to make up initial cargo sequence plan also interval cargo sequence plan when meeting unexpected situations. In this study, it is found that creating initial cargo sequence plan is not useful because the first step of cargo sequence must be determined by chief mate. But after first step, the model is helpful to find remain cargo quantity distribution for next steps. On the other hand, if deviation on cargo sequence plan needed after commencement, model is going to be useful to find cargo distribution easy and safely. Additionally, for cargo discharge operations ballast water tank weights considered to add in cargo sequence plan mathematic model for safety of ship in the future studies.

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EFFECTS OF TECHNOLOGICAL DEVICES UTILIZED AT CONTAINER PORTS ON OPERATIONAL PROCESSES

Cem Saatçioğlu[1], Mehmet Sıtkı Saygılı[2]

ABSTRACT

As container transportation develops, a competition occurs in the market and therefore ports invest on new technologies for full-time and cost-oriented operations. In this way, use of contemporary software and modern equipment become widespread in container ports. The aim of the present study is to evaluate the positive effects of technological devices utilized at ports on operational processes in terms of planning capacity, time-based competition and cost reduction in order to increase productivity.

Keywords – Container, operation, port, technology

INTRODUCTION

One can define a container as any kind of portable device in which various materials can be stored, transported, handled, treated, disposed or recycled. [1]. "The container is at the core of a highly automated system for moving goods from anywhere, to anywhere, with a minimum of cost and complication on the way" [2] In order to plan and carry out port operations like handling and storage by a container, computer software, cranes and other various technological equipments are utilized.

As containers which can be integrated with different vehicles become widespread in maritime transportation, intermodal transportation gain importance and ports have turned out to be logistics centers in which technological devices are used intensely and which provide door to door services. New generation ports with intense technology aim to carry out service-oriented, proactive, full-time and secure operations

ECONOMIC EFFECTS OF TECHNOLOGY USE

First investment costs of new technology might be high for companies. However, economic benefit of the investment during its lifetime might surpass its total cost and therefore technological investment is preferable.

New technologies initiate mechanization period with capital and information intensive rather than labor intensive period. [3] As economical result of new technologies being used for production, good

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and service production increases. Also, costs are reduced while speed and productivity increase [4]. In this way, production opportunities of new goods and services are facilitated.

All ports that seek to be distinguished in global competition evaluate their economic conditions and invest on technology in order to provide quality services and meet customer needs by using minimum resources.

FACTORS AFFECTING PRODUCTIVITY AT CONTAINER PORTS

Productivity is amount of products or services per unit used for production like labor, capital or land [5]. According to this definition, the following is the basic calculation of productivity (Table 1):

Table 1. Basic Calculation of Productivity

P= O / I
P= Productivity
O= Outputs
I= Inputs

According to American Productivity Center (APC), productivity is calculated just on the basis of actual quantities and prices of inputs and outputs for a time period [6] and the calculation is as follows (Table 2):

Table 2. APC Calculation of Productivity

P= Pc / Pb
P= Productivity
Pc= Current Period
Pb= Base Period

Productivity of a container port indicates the relationship between containers that comes to and departs from the port. Basic aim is to obtain high amounts of handling [7]. Factors affecting performance of container operations are productivity of the ship, productivity of quay, productivity of terminal area, productivity of equipments (e.g. crane, reach stucker etc.) and productivity of labor [8]. Although in companies, the basic factor that plans and applies work is human, every kind of technology contributes to the productivity. For this reason, number of actions and amount of load handled per hour by each equipment which is used in ship and field operations at the port is important.

Basic work processes at a container port are divided as quayside, yardside and landside operations (Figure 1).

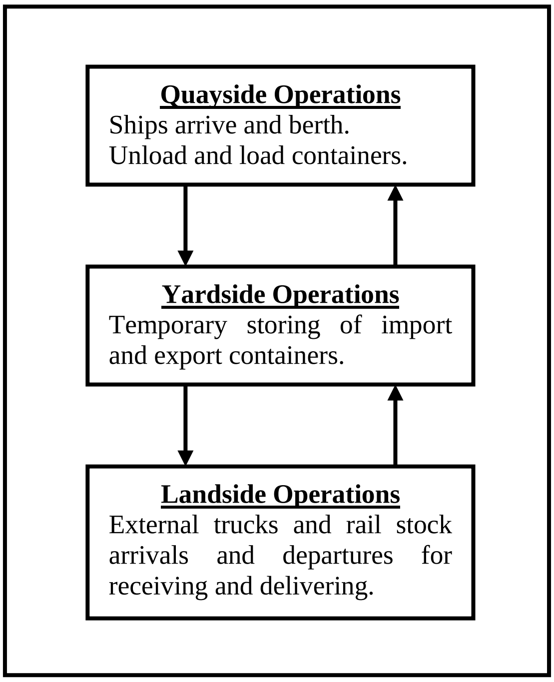

Figure 1. Unloading and Loading Processes in a Container Terminal [9]

Quayside operations involves preparation of the ship for transportation, namely loading and unloading containers from quay to ship and vice versa; whereas yardside operations include storage of containers at yard depending on their transportation status, i.e., import, export or transit. Landside operations consist of hinterland transportation.

TECHNOLOGICAL DEVICES UTILIZED AT CONTAINER PORTS

In general, devices used at container ports are listed as loading-unloading software (bay plan), stockyard software, mobile harbour crane, ship to shore gantry, transtainer, container reach stucker, staddle carrier and automated guided vehicles (Figure 2).

Figure 2. Some Examples of Technological Devices Utilized at Container Ports

Software

Software at container ports is used for intrasite planning and ship load planning. An important aspect of intrasite planning is yard crane management and it has two segments: Yard crane dispatching and yard crane deployment. The main aim of yard crane dispatching is deciding the route of the yard cranes within a block; whereas the yard crane deployment is concerned with the number of yard cranes to be deployed in blocks and with the way the yard cranes are shifted among the blocks [10].

In ships carrying container, detailed cargo plan showing position and address of containers in the hold is called bay plan. It is a system established for personnel to monitor the load during navigation in modern ships [11]. Also, rapid and reliable ship operations can be carried out by preparation and reporting of bay plans through using necessary software at the port.

Mobile Harbor Crane

Mobile harbor cranes are used widely in ports all around the world because of the short delivery lead-time, possibility of simple transfer from one quay to another and favorable financial arrangements. Moreover, the flexibility of the mobile harbour crane contributes to the productivity in all areas of application in the harbor [12].

Ship to Shore Container Crane

They are cranes used on a stable rail. Reduction of trans-shipment time leads to an increase in productivity. Using anti-sway systems is a potential way to improve productivity because it diminishes load oscillations efficiently. As oscillations decrease, the speed of trans-shipment increases and as a consequence the ship to shore productivity improves [13].

Transtainer

In order to pick up or to put down a container on the storage area of the yard, transtainers are utilized [14]. Transtainer cranes have two types, ones with rubber wheels and ones moving on rails. They increase stowage capacity at large capacity container ports.

Container Reach Stucker

Container reach stucker is used for container handling between quay and yard. Their ability to handle all types of containers contribute to increase productivity.

Staddle Carrier

Staddle carriers are used in order to carry and stow containers. Their speed and flexibility contributes to the optimization of terminal productivity at container yards.

Automated Guided Vehicle

Automated guided vehicles (AGV) are among the equipments which are used for unloading and loading ship operations. During these operations, AGV mediates between cranes and storage yard [15]. AGV is beneficial for improving productivity, reducing operation costs and increasing safety.

CONCLUSION

Effective use information and communication technologies increase productivity of companies and facilitate sustainable competition power. Technological devices used at container ports eliminate time loss, decrease transportation and supply chain costs and provide effective communication. For this reason, ports utilizing technological devices are preferred by carriers like maritime lines, and shippers like agencies and freight forwarders for efficient time management and cost minimization. As a result, operating income of a port that is run in full capacity and preferred by customers increases.

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ADVANTAGES OF PANAMA CANAL TRANSIT FOR VESSELS

Gökay Yılmaz[1], Gökhan Kara[2]

ABSTRACT

All civilizations around the world have been established on sea coasts or in areas close to coastal regions and have commuted among continents via the seas. Recently, the effectiveness of the seas has risen strikingly, especially in terms of economic aspects, and World trade has become increasingly more dependent on seas. All the countries leading the World economy are the ones that have both had coastal areas and benefited from it effectively for centuries. As per researchs %80 of world trade is ensured via seaway. Some voyages is completed between two oceans, some voyages between only a sea or an ocean. But some voyages duration is less than a week, some voyages duration is more than a month. Because some vessels have to pass two oceans. In the World, to facilitate and to shorten the time there are some artificial canal which were built by engineer. These canals provided to shorcut for voyages. One and the most important of them is Panama Canal. It connects the Pacific and Atlantic Ocean. In this topic advantages of Panama Canal transit for vessels will be explained.

Keywords − Trade, Ocean, Voyage, Panama Canal, Vessel

INTRODUCTION

71% of the Earth's surface, in other words the land of approximately 2.5 it is coated with a seas. All states provide the most nurturing and contact important element is the sea. As per researchs %80 of world trade is ensured via seaway[1]. A large part of the world trade center that is founded on the coast, while approximately 75 % of the world population Illegal is known in regions close to the coast with lands. Seas, large -capacity transportation storage facilities, offered by numerous food and natural alternative energy sources in addition to the common humanity and essential areas of life and the economic struggles ground constitute. For trades there are some voyages between buyers and sellers. Some voyages is completed between two oceans, some voyages between only a sea or an ocean. But some voyages' duration is less than a week, some voyages' duration is more than a month. Because, some vessels have to pass two oceans. In the World, to facilitate and to shorten the time there are a some artificial canal which were built by engineer. These canals provided to shorcut for voyages. One and the most important of them is Panama Canal. This canal connects the Atlantic and Pacific ocean [2]. And it shorts the voyage approximately a month as per voyage order. Panama canal has a few advantages both owners, sellers and buyers. Therefore, Panama Canal is a engineering wonders. In Figure 1. one of docks is shown.

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Figure 1. Panama Canal General Overviews

HISTORY OF PANAMA CANAL

The earliest mention of a canal across the Isthmus of Panama dates back to 1534, when Charles V, Holy Roman Emperor and King of Spain, ordered a survey for a route through the Americas that would ease the voyage for ships traveling between Spain and Peru. Such a route would have given the Spanish a military advantage over the Portuguese [3]. In 1788, Thomas Jefferson suggested that the Spanish should create it since it would be a less treacherous route than going around the southern tip of South America, which tropical ocean currents would naturally widen thereafter [4]. During an expedition from 1788 to 1793, Alessandro Malaspina outlined plans for its construction [5]. The first attempt to construct a canal through what was then Colombia's province of Panama began on 1 January 1881. The project was inspired by the diplomat Ferdinand de Lesseps, who was able to raise considerable finance in France as a result of the huge profits generated by his successful construction of the Suez Canal . De Lesseps wanted a sea-level canal as at Suez, but only visited the site a few times, during the dry season which lasts only four months of the year [6]. His men were totally unprepared for the rainy season, during which the Chagres River, where the canal started, became a raging torrent, rising up to 35 feet (10m). The dense jungle was alive with venomous snakes, insects and spiders, but the worst aspect was the yellow fever and malaria which killed thousands of workers: by 1884 the death rate was over 200 per month [7]. Public health measures were ineffective because the role of the mosquito as a disease vector was then unknown. Conditions were downplayed in France to avoid recruitment problems, but the high mortality rate made it difficult to maintain an experienced workforce. The French effort went bankrupt in 1889 after reportedly spending 287,000,000 Usd and losing an estimated 22,000 lives to disease and accidents, wiping out the savings of 800,000 investors [8]. Work was suspended on May 15 and in the ensuing scandal, known as the Panama affair, various of those deemed responsible were prosecuted, including Gustave Eiffel. After the failed attempt by the French government undertook the construction of the United States officially on May 4th In 1904 and completed in 1914, the canal has opened a canal. Other dock in Panama Canal is shown in Figure 2. as below.

Figure 2. A Dock in Panama Canal

LAYOUT OF PANAMA CANAL

While globally the Atlantic Ocean is east of the isthmus and the Pacific is west, the general direction of the canal passage from the Atlantic to the Pacific is from northwest to southeast. This is because of a local anomaly in the shape of the isthmus at the point the canal occupies. The Bridge of the Americas at the Pacific side is about a third of a degree east of the Colón end on the Atlantic side [9]. Still, in formal nautical communications, the simplified directions "Southbound" and "Northbound" are used. The canal consists of artificial lakes, several improved and artificial channels, and three sets of locks. An additional artificial lake, Alajuela Lake, acts as a reservoir for the canal. The layout of the canal as seen by a ship passing from the Atlantic to the Pacific is as follows [10]:

- From the formal marking line of the Atlantic Entrance, one enters Limón Bay, a large natural harbour. The entrance runs 8.7 km (5.4 miles).
- A 2.0 miles (3.2 km) channel forms the approach to the locks from the Atlantic side.
- The Gatun Locks, a three-stage flight of locks 1.9 km (1.2 miles) long, lifts ships to the Gatun Lake level, some 26.5 m (87 ft) above sea level.
- Gatun Lake, an artificial lake formed by the building of the Gatun Dam, carries vessels 24.2 km (15 miles) across the isthmus.
- From the lake, the Chagres River, a natural waterway enhanced by the damming of Gatun Lake, runs about 8.5 km (5.3 miles).
- The Culebra Cut slices 12.6 km (7.8 miles) through the mountain ridge, crosses thecontinental divide and passes under the Centennial Bridge.
- The single-stage Pedro Miguel Lock, which is 1.4 km (0.87 miles) long, is the first part of the descent with a lift of 9.5 m (31 ft).
- The artificial Miraflores Lake, 1.7 km (1.1 miles) long, and 16.5 m (54 ft) above sea level.
- The two-stage Miraflores Locks, is 1.7 km (1.1 miles) long, with a total descent of 16.5 m (54 ft) at mid-tide.
- From the Miraflores Locks one reaches Balboa harbour, again with multimodal exchange provision. Nearby is Panama City.

- From this harbour an entrance/exit channel leads to the Pacific Ocean (Gulf of Panama), 13.2 km (8.2 miles) from the Miraflores Locks, passing under the Bridge of the Americas.

Thus, the total length of the canal is 77.1 km (48 miles).

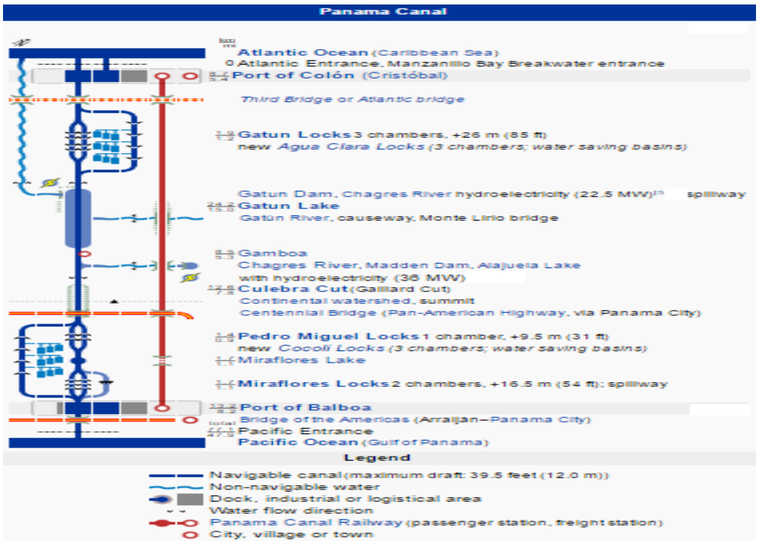

Figure 3. Panama Canal Locks and Lake [2].

Panama Canal has some restrictions for transit vessels. To transit the canal, vessels have to have these feauters which are as below:

- Length: 294.1 mtr
- Breadth: 32.3 mtr
- Draft: 12 mtr in (TFW)

After completion of new canal;

- Length: 366 mtr
- Breadth: 49 mtr
- Draft: 15.2 mtr (TFW). [11]

Some part of Gatun Lock is shown in Figure 4. which is as below:

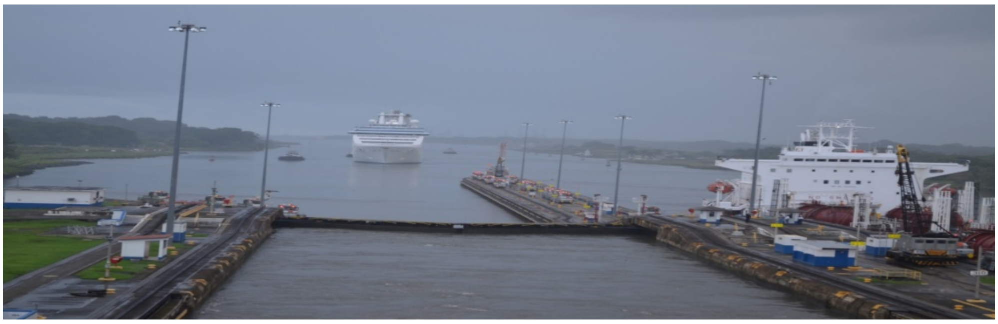

Figure 4. Gatun Lock in Panama Canal

NAVIGATION IN PANAMA CANAL

Channel from the Pacific Region (Balboa) Pedra Miguel and Miraflores pool, the Atlantic Region (Cristobal) Gate is connected to the channel with the locks. In Panama Canal all vessels must navigate with Pilots. Generally total 4 pilots for each vessel are provided. Besides, before entering to locks tug assistance is provided to enter the locks in safety condition. And except helsman all mooring and unmooring operations provide via Panama Canal Crew. Officers manage only windlass and their crew. In emergency situation they can warn Panama Canal Crew or contact with Bridge to take command. In the canal there are locks and lake. That’s way, pilots, master and helsman should navigate with safety and coordinated during the canal passing. In table 1 which is as below, some positions in Canal are presented:

Table 1. Points in Canal

Point	Position	Point	Position
Gatun Locks	9.27215°N 079.92266°W	Paraiso Reach	9.02573°N 079.62492°W
Trinidad Turn	9.20996°N 079.92408°W	Pedro Miguel Locks	9.01698°N 079.61281°W
Bohio Turn	9.17831°N 079.86667°W	Miraflores Lake	9.00741°N 079.60254°W
Orchid Turn	9.18406°N 079.84513°W	Miraflores Locks	8.99679°N 079.59182°W
Frijoles Turn	9.15904°N 079.81362°W	Balboa Reach	8.97281°N 079.57771°W
Barbacoa Turn	9.12053°N 079.80395°W	Pacific Entrance	8.88846°N 079.52145°W
Mamei Turn	9.11161°N 079.76856°W	Empire Reach	9.06104°N 079.66309°W
Gamboa Reach	9.11774°N 079.72257°W	Culebra Reach	9.04745°N 079.65017°W
Bas Obispo Reach	9.09621°N 079.68446°W	Cucaracha Reach	9.03371°N 079.63736°W
Las Cascadas Reach	9.07675°N 079.67492°W		

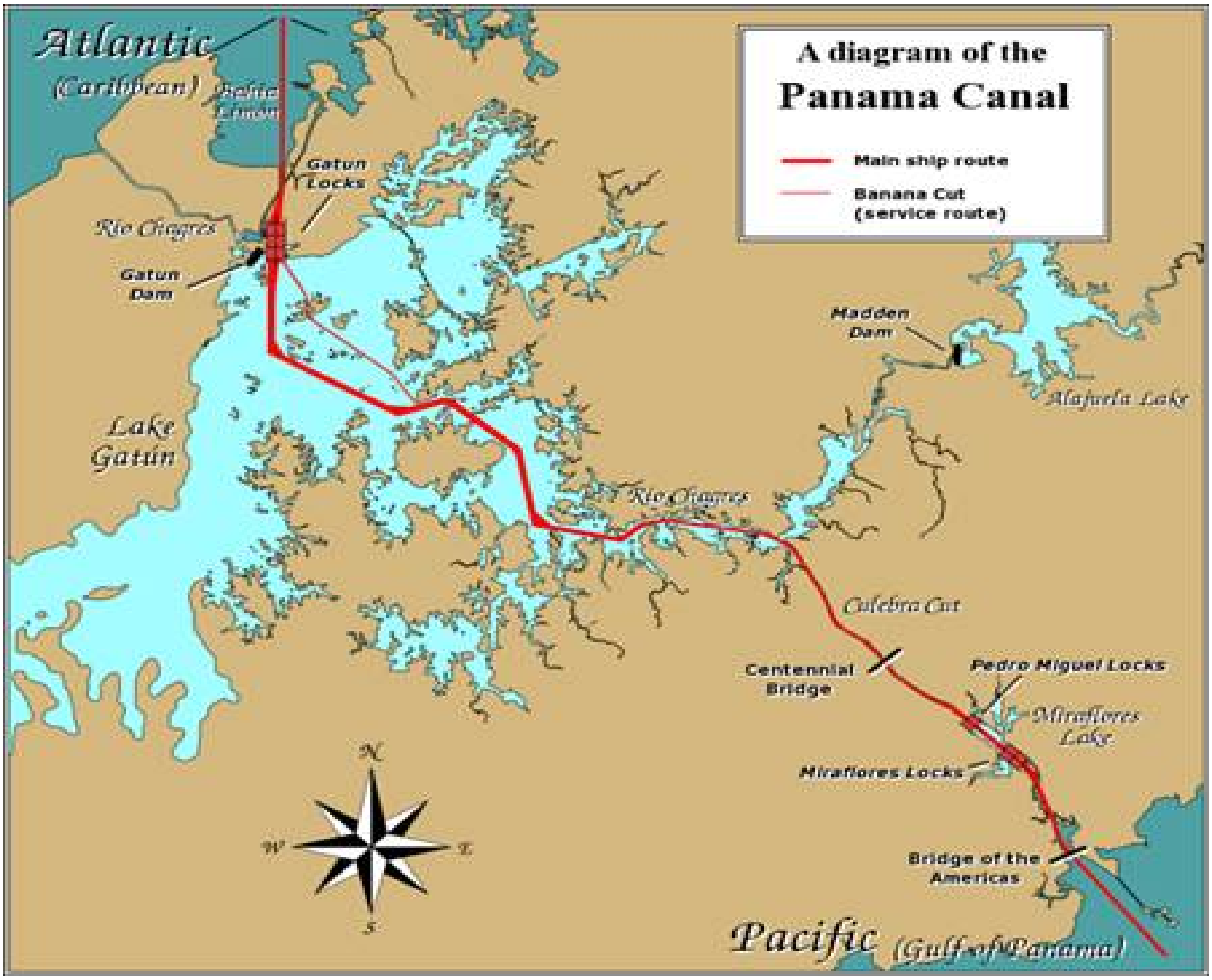

Figure 5. Panama Canal (http://www.nortonlilly.com.pa/canal.php)

ADVANTAGES OF PANAMA CANAL

Advantages of the Panama Canal to ship owners, charterers, buyers and sellers are as below:

- Time period is shortened.
- Using this channel, the extra voyages can be provided.
- Condition and wear of the vessel is saved.
- Vessels would be protected from heavy sea conditions in the south area.
- Saving fuel and oil.
- Running Cost reduces.
- Cargo owner pay less money.

Shortly, Panama Canal has more advantages for each sides.
These advantages are explained via an example:
Our company's 50,000 dwt, 183 meters lenght, 32.2 meters' breadth has a MR Product Tanker vessel. The charterer wants to load 270,000 Barrels ULSD from San Francisco, Ca in USA to Freeport in Bahamas. The vessel has 11.2 meters draft when she loaded it. Speed order is 12.5 knt. Charterer will pay only fuel and canal fee. We calculate this voyages with Panama Canal and without Panama Canal. If the vessel navigate through the Panama Canal voyage distance apprx. 4,700 miles, as the time it will take 16 days. (Without waiting time at the Panama Canal.)

Figure 6. Voyage between San Francisco and Freeport (With Panama Canal) (Bp Shipping Marine Distance Tables)

If vessel does not use Panama Canal, she passes from the South America. It is apprx. 13,000 miles and 43 days as duration. If the vessel passes the Strait of Magellan, duration will be reduced to 42 days.

Figure 7. Voyage between San Francisco and Freeport (Without Panama Canal) (Bp Shipping Marine Distance Tables)

There are 27 days difference between two same voyage with difference route. In addition, vessel can complete this voyage in 16 days in order to 43 days. It means that owner or charterer can have one ore more voyages in 43 day with using Panama Canal. Besides, vessel will be protected from heavy weather conditions in south pacific ocean. When prices of these two voyages were compared; This vessel burns apprx. 35 tons of fuel per day. She uses 5 days Lsmgo, 38 day Hsfo when she navigates from South America.

Currently a ton of Hsfo is 246.5 Usd and a ton of Lsmgo is Usd 430.00 Usd. [12]
246, 5 x 38(day) x 35 (daily fuel) = 327,845.00 Usd (For Hsfo)
430, 00 x 5(day) x 35(daily fuel) = 75,250.00 Usd (For Lsmgo)
Total = 403,095.00 Usd

If we pass the Panama Canal, vessel will burn 5 day Lsmgo, 11 day Hsfo.
246, 5 x 11(day) x 35(daily fuel) = 94,902.50 Usd (For Hsfo)
430, 00 x 5(day) x 35(daily fuel) = 75,250.00 Usd (For Lsmgo)
Total = 170,152.50 Usd

When the Panama Canal Passing fee is added: 136,500.00 Usd for own vessel. [13]

If the vessel uses the Panama Canal, owner will pay total apprx. 336,652.50 Usd. So, owner will make profit 66,442.50 Usd and 27 days. But it should not be forgotten that it is calculated under the good weather condition. Besides, owner will make profit from Running Coast. The average running cost of these ships is around 7,000.00 Usd . If she passes Cape Horn, 301,000 Usd will be total Running Coast . But if she uses the canal, only 112,000.00 Usd will be total Running Coast. This is also more profitable for shipowners . Because, she will use less bunker, less luboil and she navigates shortcut and under good condition. Finally, Panama Canal has advantages for Panama's people and Panama's economy. Because for each vessel apprx. fourty crew are working. In the other hand, agents, pilots, tugs will be used for safety transit canal. Miraflores Lock's general overview is shown in Figure 8. which is as below:

Figure 8. Miraflores Lock in Panama Canal

CONCLUSION

Panama Canal is a engineering wondes. It presents more advantages for each side. Owners and charterers want always make profit. People in Panama want always find a good job. So, Panama Canal is true way for both of them. In a year approximately 14,000 vessels are using Panama Canal [14]. After opening second canal for big size vessels, more vessel are going to pass Panama Canal. It improves to trade between more countries. Finally, Panama Canal which was built hundred years ago is one of most important canals.

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PORT OPERATIONS AND SEA TRANSPORT PROCESSES FOR THE TOWER BLOCKS OF THE IZMIT BAY BRIDGE

Kemal Tepekıran[1] , Gökhan Kara[2] , E. Gül Emecen Kara[3]

ABSTRACT

The İzmit Bay Bridge is the construction project that planned to link south and north provinces of the Marmara Region for the short and fast land transportation. The hardest part on logistics processes of the project is safe and economic shipment of the voluminous and heavy tower blocks, and delivery on time. The study indicates that port operations and sea transport processes are evaluated. Port storage management; technical assessment of the equipment's for the storage; unavailable storage area because of the storage equipment; handling methods; the suitable ship or barge characteristics; the lashing of the tower blocks on the ship are evaluated.

Keywords - handling, heavy, sea transport, sea transport, storage, voluminous

INTRODUCTION

The İzmit Bay Bridge is the suspension bridge which links Dilovası and Altınova on the east of the Marmara Sea. The mid-span is 1550m and total length is 2682m. It is the fourth-longest suspension bridge in the world by the length of its central span. After the completion of the bridge, the distance between İstanbul and İzmir shorten about 140 km.

Expectation of the economic effects of the bridge on the Marmara Region is around 27 billion TL. The region economy is expected to grow by %7 because of the İzmit Bay Bridge. Many business line is planned to get positive effects such as improvements of tourism in the Aegean Region.

The bridge produced from the pieces of 113 OBG blocks and 44 tower blocks and 164 tower panels and the total steel structure weight is approx. 55000t. Production and logistics processes of the project has many difficulties because of safe and economic shipment of voluminous and heavy tower blocks. The heavier and voluminous block is 9,5m x 13m x 8,5m x 336,3t.

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STORAGE METHOD

The tower blocks delivered to the port as a horizontal position. Before the sea shipment the blocks has to be assembly (vertical) position. In accordance with the necessary operations, the tower block directions can be vertical or horizontal position during the storage.

Operational Equipment on the Storage Area

Land transportation

12 axle lines Self Propelled Modular Trailer (SPMT) is used during the land transport operations. Maneuver advantages of the SPMT is shown on the Figure 1. However, there are still unavailable storage area because of dimensions or movements of SPMT

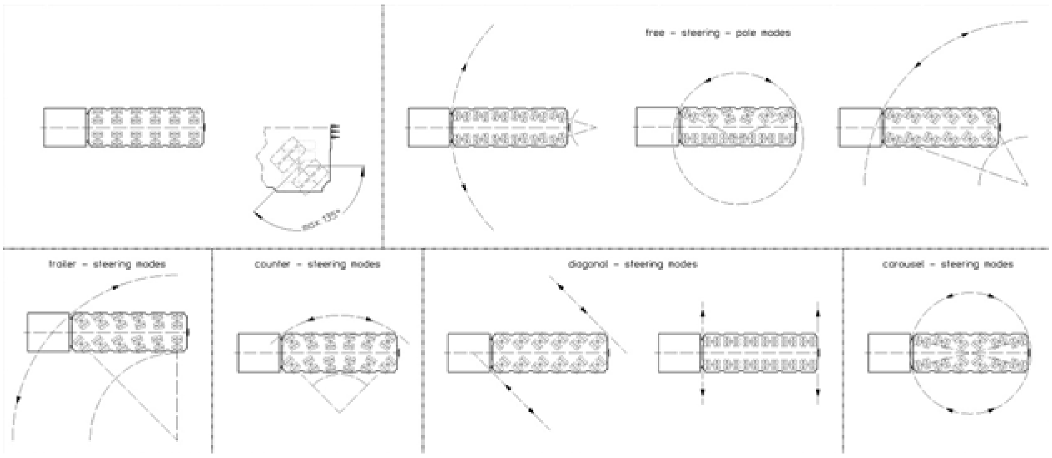

Figure 1. Movement Abilities of the SPMT

Erection equipment

Erection equipment (cranes) is only considered as operational area coverage. Lifting capacities and other technical details about the cranes is not studied on this paper.

The erection operation is handled by main crane and single tailing crane. The main crane is DEMAG CC 2800 SSL configuration, and the tailing crane is Liebherr LG 1750 SL configuration. DEMAG CC 2800's operational foot print incl. load spread is aprox. 500 sqm, and LG 1750 is approx. 300 sqm.

Storage Management

The cranes footprint is 800sqm in total, and the cargo on the trailer is 150 sqm. Necessary unavailable storage area incl. Maneuver area, road, accessory storage of the cranes is 1000 sqm. Total necessary only erection area is 2000 sqm.

Storage area for the vertical tower block is max. 100 sqm each, and the horizontal blocks are max. 110 sqm each. Before each shipment min. 8 vertical tower blocks has to be ready and stored, other blocks can be horizontal position in worst case. Calculated net storage area is 1500 sqm. Necessary area for safe movements of storage equipment and accessories is 3000 sqm. 4500 sqm for the storage, 2000 sqm for the erection operation.

Table 1. Storage availability table

Tower Blok Status	1st shipment	2nd shipment	3rd shipment	4th shipment	5th shipment	6th shipment
Storage (Qty)	14	13	8	6	8	8
Shipped (Qty)	8	8	8	4	8	8

Storage Operation Sequence

The Self Propelled Modular Trailer (SPMT) is used for the movements on storage area.

Basic operation steps are shown as below;

- The trailer shall be maneuvered into final lay down position between concrete blocks.
- The trailer shall be lowered until the bottom of tower block is nearly
- touch the top of the concrete blocks.
- Lowering of SPMT shall be effected to transfer all loads of tower block to the concrete blocks.
- The 4 concrete blocks shall be inspected out to ensure there integrity.
- Removal -The SPMT shall be slowly removed from under the tower block.
- Loaded The cargo is stayed on the concrete blocks from min. 4 points.

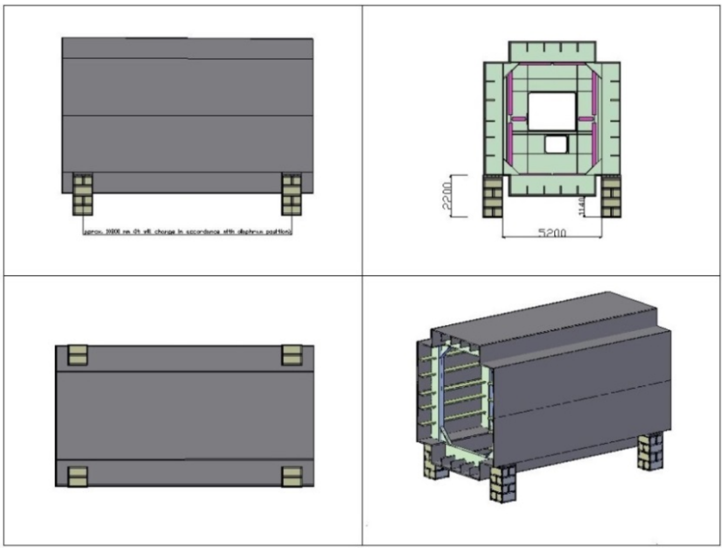

Figure 2. Horizontal Storage Position of the Tower Blocks

SEA TRANSPORTATION

The barge will follow the route shown in the sketch below (Figure 5.7) to reach the shipyard, the total cycle per shipment shall be around 7 days.

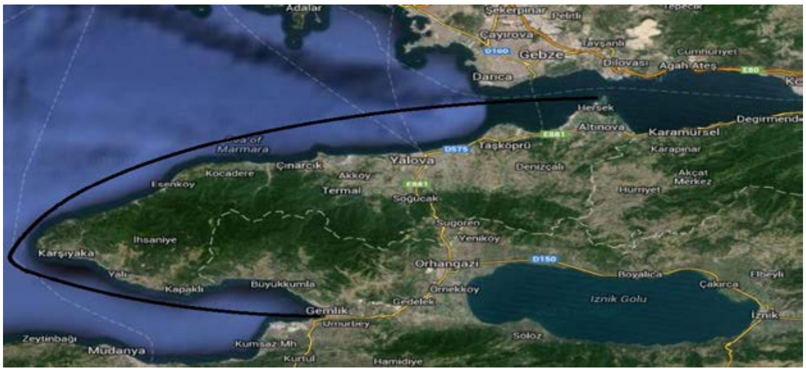

Figure 3. Route Description of the Barge– Gemlik to Construction Site

The sea states in accordance with the Marmara Sea is mathematically represented by a JONSWAP wave spectrum and shown in table 2. The transportation will be performed under the sea state 5. If the weather condition above the sea state 5, the operation will be stopped until the weather condition is under acceptable values.

Table 2. Marmara Sea Wave Characteristics

Sea State	Marmara Sea	
	Maximum Wave Height (m)	Modal Wave Period (s)
3	0,88	5,41
4	1,88	7,28
5	3,25	9,1

The possible sanctuary ports on the route are Kapaklı, Fıstıklı, Karşıyaka, Esenköy, Çınarcık and Yalova. The master has a responsibility to anchor one of these sanctuary port in accordance with a sudden change of the weather condition (harder than sea state 5) and wind directions during sea transportation.

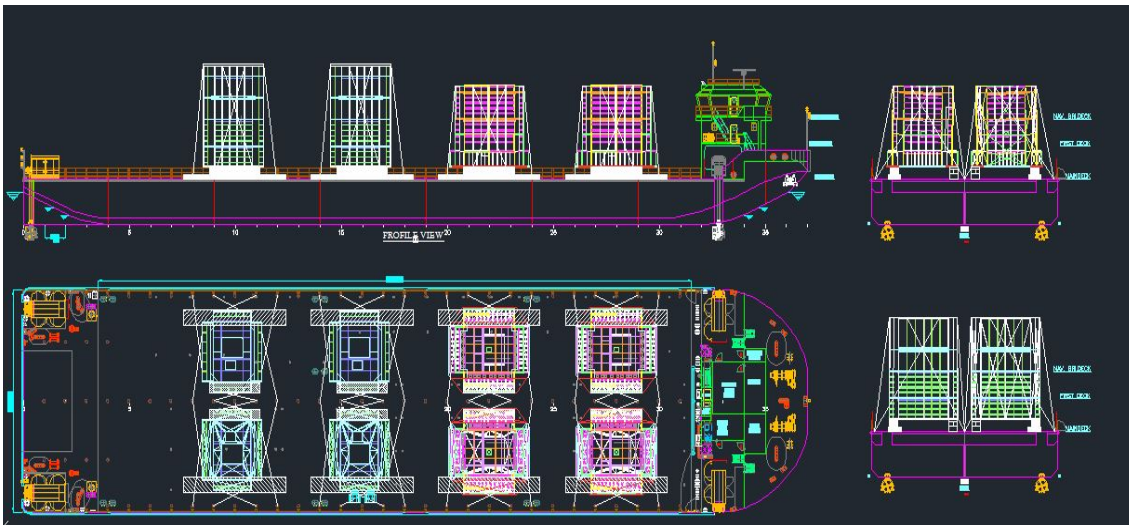

Figure 4. The Basic Shipment Drawings for the Tower Blocks

Barge Characteristics

General particulars of the Self Propelled Barge are as follows;

General particulars Length over all (LOA)	: 92.90 m
Length between perpendiculars (LBP)	: 90.67 m
Length at waterline (LWL)	: 90.67 m
Moulded Breadth (BM)	: 22.00 m
Moulded Depth (DM)	: 4.50 m
Draught (design)	: 1.60 m
Draught (freeboard)	: 3.228 m
Displacement (freeboard)	: Abt. 5853.5 t
Block coefficient (Tf)	: 0.912
Prismatic coefficient (Tf)	: 0.919
Midship area coefficient (Tf)	: 0.992
Water plane area coefficient (Tf)	: 0.999

Roll On/Off Operation

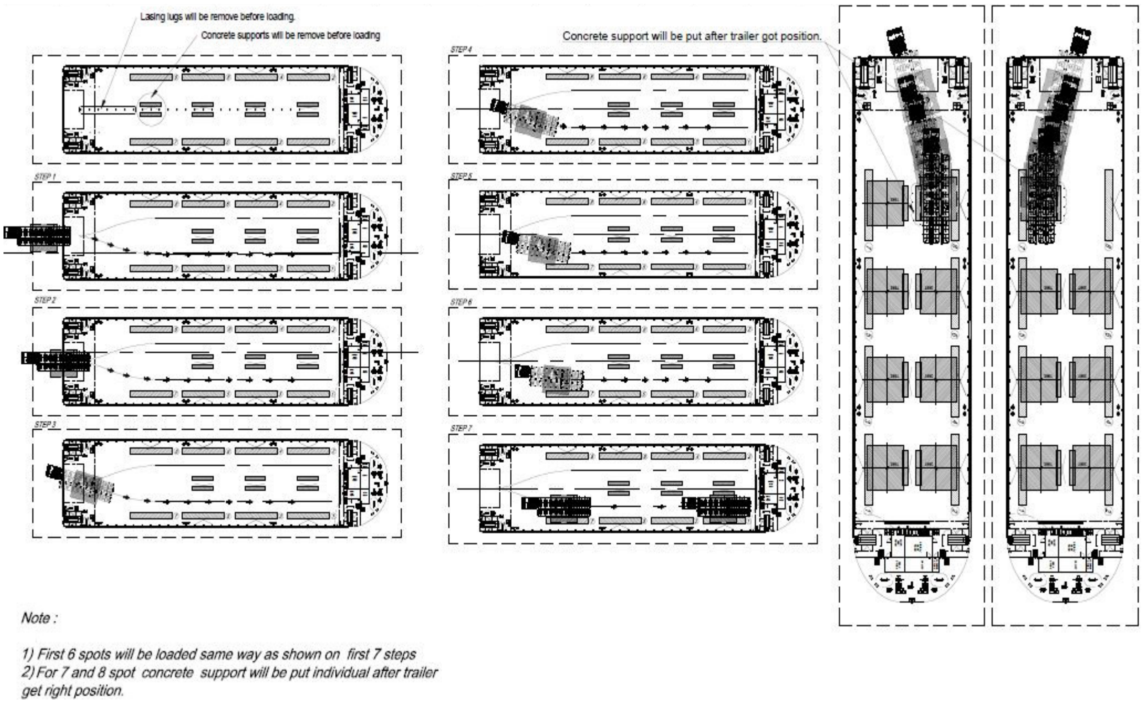

Figure 5. Loading Sequence of Roll On Operation

The ship has an automatic system for trimming, healing, and ballasting. The data input limits for the safety will be identified in accordance with the climate changes by the Barge Master, and controlled by the staff that is authorized by Master.

LASHING

The general lashing arrangement is shown in the following drawing for the tower block. Each tower block shall be lashed from 8 top point to the lashing lug on the ship. All the lashing units are planned to be at least 250kN capacity. The system for each connection include (from top to bottom) omega shackle, lashing wire, clemencies and turnbuckle.

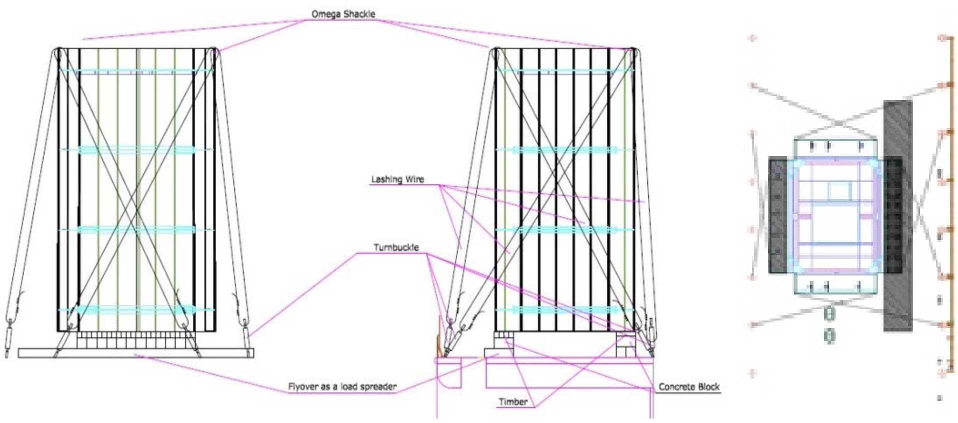

Figure 6. General Lashing Arrangement for the Tower Block

Load Spread on The Barge

The ship has two different deck capacities which are 15 t/sqm and 25 t/sqm on some parts. The tower blocks will stand on stillage's during the shipments. The outer stillage's will include concrete block, timbers and load spread beam and the inner one will include only concrete blocks and the timbers.

Table 3. Estimated Pressure On The Deck Of The Ship

Shipment No	Block No	Qty	Load Spread by concrete block (t/sqm)	Load Spread by Stillage's (t/sqm)
1	1	4	18,9	11,1
	2	4	16,6	8,5
2	3	4	15,8	8,1
	4	4	14,3	7,3
3	5	4	12,5	6,4
	6	4	15,4	7,9
4	7	4	11,6	6
	8	4	12,1	5,6
5	9	4	17,6	9
6	10	4	11,2	5,7
	11	4	11,2	5,7

Lashıng Calculatıon for Tower Blocks

Table 4. Loading Conditions

	Loading Condition
Draught (FP)	2,824 m
Draught (midships)	2,828 m
Drraught (AP)	2,831 m
Trim (Stern)	(-) 0,007 m
Displacement	4999,47 t
LCB (from AP)	44,043 m
LCG (from AP)	44,043 m
TCG	0.000 m
VCG	6.008 m
GM (fluid)	10.142 m
Speed	6.3 knots

Vertical and lateral accelerations are computed at the following locations;

Table 5. The center of gravity coordinates of the cargos

ITEM	WEIGHT(t)	XM(m)	YM(m)	ZM(m)
W_1	300.0	70.00	5.35	9.07
W_2	300.0	70.00	-5.35	9.07
W_3	300.0	57.50	5.35	9.07
W_4	300.0	57.50	-5.35	9.07
W_5	350.0	43.75	5.35	9.07
W_6	350.0	43.75	-5.35	9.07
W_7	350.0	28.75	5.35	9.07
W_8	350.0	28.75	-5.35	9.07
ADD_WEIGHT	100.0	43.80	0.00	7.45

Table 6. Max. Acceleration on sea state 3

	Location	**Heading**	**Maximum vertical/Lateral Acceleration (m/s2)**
Loading Condition	W_1	Bow Seas	0,253
	W_1	Beam Seas	0,425

Table 7. Max. acceleration on sea state 4

	Location	**Heading**	**Maximum vertical/Lateral Acceleration (m/s2)**
Loading Condition	W_1	Bow Seas	1,144
	W_1	Beam Seas	1,159

Table 8. Max. Acceleration on sea state 5

	Location	**Heading**	**Maximum vertical/Lateral Acceleration (m/s2)**
Loading Condition	W_1	Bow Seas	1,968
	W_1	Beam Seas	1,590

Assumption of External Forces

The data for the example of the lashing calculation is chosen the heaviest, the highest center of gravity position and more voluminous cargo among the list. The chosen cargo considered on the place which is affected by max. acceleration
In the sea state 5 the wind speed assumption is 11 m/sec (max 10,5m/sec on the sea state 5). The max. wind speed is 17,3m/sec on the cargo.

$$Fx = m \cdot ax + Fw \qquad (1)$$

$$Fy = m \cdot ay + Fw \qquad (2)$$

Fx ; total vertical external force calculated 722 kN

Fy ; total lateral external force calculated 589,6 kN

Fw ; max wind force calculated 33,1 kN

ax ; max vertical acceleration

ay ; max lateral acceleration

m ; mass of max. block weight

Transverse Sliding

Table 9. Friction coefficient in accordance with materials in contact

Materials in contact	Friction coefficient (μ)
Timber- timber, wet or dry	0,4
Steel- timberr or steel-rubber	0,3
Steel- steel, dry	0,1
Steel-steel, wet	0

$$Fy \leq \mu . m . g + CS1.f1 + CS2.f2 + \ldots + CSn.fn \qquad (3)$$

n; the number of lashing being calculated

Fy; transverse force from load assumption (kN)

μ; friction coefficient

m; mass of the cargo unit (t)

g*;* gravity acceleration of earth = 9,81 m/s2

CS; calculated strength of transverse securing devices (kN)

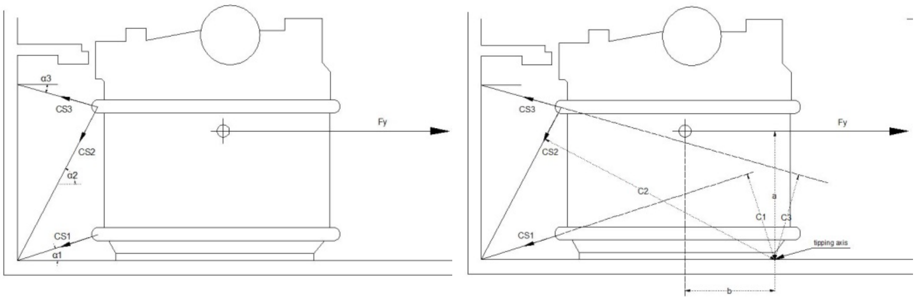

Figure 7. Definitions of abbreviations for longitudinal and transverse sliding calculation and for transverse tipping calculation

Table 10. Correction of

μ \ α	-30	-20	-10	0	10	20	30	40	50	60	70	80	90
0,3	0,72	0,84	0,93	1	1,04	1,04	1,02	0,96	0,87	0,76	0,62	0,47	0,3
0,1	0,82	0,91	0,97	1	1	0,97	0,92	0,83	0,72	0,59	0,44	0,27	0,1
0	0,87	0,94	0,98	1	0,98	0,94	0,87	0,77	0,64	0,5	0,34	0,17	0

589,6 ≤ 0,3 x 350 x 9,81 + 250 x 0,3 x 2 + 250 x 0,62 x 2

589,6 ≤ 1490 safe

Transverse Tipping

$$Fy.a \leq b.m.g + CS1.c1 + CS2.c2 + \ldots + CSn.cn \quad (4)$$

Fy, m, g, CS, n are as explained under 4.3.1.1.2

a is lever-arm of tipping (m) (see figure 9)

b is lever-arm of tipping (m) (see figure9)

c is lever-arm of tipping (m) (see figure9)

589,6 x 7,1 ≤ 3,65 x 350 x 9,81 + 8,7 x 250 x 2 + 7,7 x 250 x 2

4186,2 ≤ 20732,275 safe

Longitudinal Sliding

$$Fx \leq \mu.(m.g - Fz) + CS1.f1 + CS2.f2 + \ldots + CSn.fn \quad (5)$$

Fx is longitudinal force from load assumption (kN)

μ, m, g, f, n are as explained under 4.3.1.1.2

Fz is vertical force from load assumption (kN)

CS is calculated strength of longitudinal securing devices (kN)

722 ≤ 0,3 x 350 x 9,81 + 250 x 0,3 x 2 + 250 x 0,47 x 2

722 ≤ 1415 safe

CONCLUSION

44 pieces of the tower blocks of the İzmit Bay Bridge stored and transported safely from manufacturer to the port, and rolled on/off to the ship. Before all the shipment, weather forecasts for 3 days had been followed not to risk cargoes. The sea transports completed on the summer 2014 without any delay.

Figure 8. the Last Shipment of the Tower Block

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THE EFFECTS OF GLOBALIZATION ON MARITIME TRANSPORTATION IN VIEW OF DIFFERENT PERSPECTIVES

Serap İncaz[1], Ali Umut Ünal[2], Güler Alkan[3]

ABSTRACT

Globalization is the most important fact in the World. Globalization is a new concept but it is a concept that affects continuously all sectors anyway. Globalization is primarily an economic concept. With 90% maritime trade as an important role in the world's total trade. The development of maritime trade also depends on the development of maritime transportation. In this case, globalization affects inevitably the world trade and the maritime trade. Maritime transportation has a long term experience of both national and international relationship during the maritime history. In this study is aimed to explain the relationship between globalization with globalization criteria, total trade, maritime trade, labour market, the maritime security, pollution, maritime education and all transportation modes. This study has two parts; the first one is globalization and the second part is factors which affects the maritime transportation. This study tries to find an answer to the question about globalization and its effects on the maritime transportation.

Keywords – *globalization, KOF Index, maritime education, maritime transportation, pollution, security*

GLOBALIZATION AND ITS DETERMINANTS

Definition of Globalization

A lot of countries have been able to take advantages of several forming changes better than others. After World War II, Europe and Japan were important benefactive roles of globalization as they make effort to reconstitute their economies. Globalization has greatly accelerated since the mid-1980s by several affects [1]**.** These are the most important technological developments. Technological developments have especially decreased the cost of transportation and it is often to help to locate different phases of production in different countries [2]**.**

Nowadays, there are different meaning written by everybody and the word of globalization means different meaning for different people. Many organizations and institutions are affected by globalization. In addition, manufacturing, services, international operations in the country, international Institutes, non-governmental organizations are also affected by globalization that this effect occurs in economic level of countries [3]. Globalization is increased by the markets of different

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countries to be more integrated and economic transactions that national cross-border. [4]. The term "globalization" has been widely used to describe the increasing internationalisation of financial markets and of markets for goods and services. Globalization refers above all to a dynamic and multidimensional process of economic integration whereby national resources become more and more internationally mobile while national economies become increasingly interdependent [5]. According to economists globalization means that integration through international trade of markets in goods and services, as reflected in a variety of possible measures. These include direct measures of barriers, e.g., tariffs and transport costs; quantity-related measures of the result, i.e., trade volumes; and price-related measures of the result, i.e., the law of one price and other evidence of arbitrage [6]. Within this framework, shipping and port operations are main elements of the globalization process [7].
Globalization and internationalization also sometimes used interchangeably, there are still differences in meaning. While the term "internationalization" refers to international movements among countries, globalization means to set out cross border movement [8].
Globalization; are faced with many issues, such as globalization of economic production and military risks, communication, technology, trade, finance.

Globalization Criteria

Globalization has three dimensions these are listed below [9]:
*Social dimension- means that ideas, opinion, ideals, images, and people.
* Political dimension- characterized by a government policies and strategies.
* Economical dimension-occurred goods movement, flow of capital and services

These three dimensions occur disparities. To major these disparities have been constituted some index. One of the most important Index is the KOF Globalization Index which is produced by the KOF Swiss Economic Institute, measures the economic, social, and political dimensions of globalization with same criteria [10].

2015 KOF index which was based on the year of 2012 is as follows: [11].

The value of the 2015 general globalization KOF index is below:
1. Ireland 91.30
2. Netherlands 91.24
3. Belgium 91.00
4. Austria 90.24
44. Türkiye 69.02

In KOF general index, Ireland took first place with 91.30 points while Turkey took 44. place with 69.02 points among 207 countries

The value of the 2015 economic globalization KOF index is below:
1. Singapore 95.69
2. Ireland 92.59
3. Luxembourg 91.12
4. Netherlands 90.33
105. Türkiye 55.63

In KOF economic globalization index Singapore took first place with 95.69 points while Turkey took 105.place with 55.63 points among 207 countries

The value of the 2015 social globalization KOF index is below:
1. Austria 91.54
2. Singapore 90.83
3. Switzerland 90.80
4. Netherlands 90.53
57. Turkey 65.23

In KOF social globalization index Austria took first place with 91.54 points while Turkey took 57.place with 65.23 points among 207 countries.

The value of the 2015 political globalization KOF index is below:
1.Italy 97.52
2. France 97.51
3. Austria 96.76
4. Belgium 96.51
14. Türkiye 92.97

In KOF political economic index Italy took first place with 97.52 points while Turkey took 57.place with 65.23 points among 207 countries.

Globalization and Trade

The Silk Road was the center of attention in the globalized world. Silk Road is one of the first international trade routes. Silk Road is based on trade from Asia to the Middle East and Europe. Silk Road is not only traders but also ideas, it has been way too religions, sages, army, and cultures. Since the transport capacity was limited, over long distance and often unsafe, luxury goods were the only commodities that could be traded [12].

Globalization has removed trade barriers between countries and Multinational Corporation. As a result, it has gained world trade different dimensions. Globalization has created the threat as it provides benefits in commercial life.

General Agreement on Tariffs and Trade (GATT) was made possible by the liberalization of world trade. After GATT, World Trade Organization has played an important role in the spread of globalization. In the postwar years, the pace of globalization was quickened by the multilateral trade negotiations of the General Agreement on Tariffs and Trade (GATT) [13].

The main objectives of the GATT agreement were liberalization of world trade, the abolition of restrictions between the countries, reduction of customs duty and the easing of protectionist measures. These objectives were accelerated globalization. This mobility between countries global goods movement is a critical element in the global freight transportation system that includes ocean and coastal routes, inland waterways, railways, roads, and air freight [14].

Globalization and Technology

Technology has played a critical role in spreading globalization all of the world. During the past quarter century, the aviation system has moved to satellite-based communications, navigation, and surveillance systems [15]. Global Navigation Satellite System (GNSS) consists of the following systems. These can be summarized as follows. GPS (USA), Glonass (Russia), Galileo (Europe), Global Positioning Satellite Systems (GNSS); American (GPS) and Russia (Glonass), Europe (Galileo), China (Beidou) and India (IRNSS). GPS is the only GNSS globally that have reached the goal, as it is known, GPS is consist of space, controls and the user section. Global Positioning System (GPS) technology has provided major advances in positioning accuracy for maritime shipping, railroads, and highway vehicles as well [15]. The use of Information and Communication Technology (ICT) speeds up the exchange of information and allows for more efficient customs operations including risk management techniques. It also provides management with advanced information for planning; gives shippers greater choice and improves the quality of service The use of ICT has also contributed to the development of multiple transportation all over the world.[16]. Finally, the rapid development in technology made all transportation modes quickly and safely and also expand the transportation area. All these contribute to globalization.

GLOBALIZATION AND MARITIME TRANSPORTATION

Maritime transportation related with all transport modes

International maritime shipping is the lifeblood of world trade. The common information is that nowadays 90 % of world trade is carried out by the shipping industry (the information that was impossible to confirm or disprove), which enables cheap transport of raw materials and commodities as well as the distribution of manufactured goods all around the world. In spite of the technical innovations that have evolved all means of transport in the last couple of centuries, ships still remain the most cost-effective way for moving large quantities of goods around [17]. In many steps of combined transport is thus a need for a strong maritime transportation system. For many commodities and trade routes, there is no direct substitute for waterborne commerce. On other routes, such as some coastwise or shortsea shipping or within inland river systems, marine transportation may provide a substitute for roads and rail, depending upon cost, time, and infrastructure constraints. Other important marine transportation activities helps to development to globalization. These can be summarized as follows; passenger transportation (ferries and cruise ships), military ships, fishing and resource extraction, and navigational service (vessel-assist tugs, harbor maintenance vessels, etc.) [14].

Globalization and Maritime Trade

The intrinsic connection between maritime transportation, international trade, and globalization trends will continue as long as economic wealth continues to derive from consumption of goods and services [14]. Maritime transportation is growing because it is required to move traded goods and components, and trade in maritime services is itself also taking place on an ever more global scale [18]. Maritime transportation or shipping is the backbone of world trade and globalization [19]. Shipping continues to be the dominant mode of transport, accounting for almost two thirds of world trade (metric tons).World seaborne trade has grown almost continuously since World War II, increasing more than two-fold since 1970 (UNCTAD 2001) from [18]. Twenty-four hours a day all year round, ships carry cargoes to all corners of the globe. World trade and maritime transport are fundamental to sustaining economic growth and spreading prosperity throughout the world, thereby fulfilling a critical social as well as an economic function. Furthermore, maritime transport will be indispensable in a sustainable future global economy as it is the most environmentally sound mode of mass transport, both in terms of energy efficiency and the prevention of pollution [14].
Globalization, technology and the environment were impacting in many fundamental ways on maritime industries, and were in turn being shaped by feedback channels from the industries themselves (Figure 1).

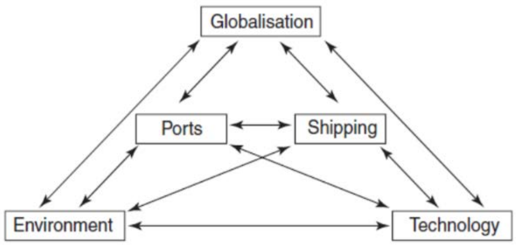

Figure 1: Globalization, technology and the environment were impacting in many fundamental ways on maritime industries

Source: David Pinder and Brian Slack, 2004, "Contemporary contexts for shipping and ports" Shipping and Ports in the Twenty-first Century, Ocean management and policy series Edited by H.D. Smith, ISBN 0-203-57119-3, First published 2004 by Routledge, p.2.

The ocean shipping industry has been dramatically transformed in the past 25 years. Ships have generally become faster and larger, and intermodal container shipping has replaced breakbulk cargo on many routes [20]. International organizations are another area in which globalization movement is active. International organizations are another area in which globalization movement is active. International organizations are a direct factor in the spread of this movement. A number of international institutions established in the wake of World War II—including the World Bank, International Monetary Fund (IMF), and General Agreement on Tariffs and Trade (GATT), succeeded in 1995 by the World Trade Organization (WTO)—have played an important role in promoting free trade in place of protectionism [2]. International maritime organizations should play a bigger role in the process of globalization which is increasing effect on maritime transportation. Developed countries and international maritime organizations especially IMO have been playing a very important role in the process of globalization on maritime transportation. The International Maritime Organization (IMO), established under the auspices of the United Nations to promote safety standards in shipping and cleaner seas, has a number of provisions aimed toward these objectives. First of all, globalization of maritime transportation has in fact expanded rather than reduced the differences among maritime countries [18].

Globalization and maritime education.

Shipping is a global industry and will always respond to radical changes in education as well as political, economic, technological, changes. So, a global organization such as the International Association of Maritime Universities (IAMU), should guide Maritime Education and Training (MET), which can impact the MET system worldwide [8]. Standards of Training Certification and Watchkeeping system is one of the maritime areas where most of globalization. STCW is an international agreement about the training of seafarers which is an indispensable worldwide.

Globalization and labor market

As a result of the technological changes and the open world labor market, substantial declines have taken place in the seafaring populations of all the Traditional Maritime Countries. There is now a major world shortage of officers since the Traditional Maritime Countries have not been recruiting and training sufficient numbers for these posts over the past decades [21].

Globalization identified labor markets overseas that encouraged transport of semi-raw materials and intermediate products where manufacturing costs were lower [14]. Globalization is creating impact in terms of working conditions, along with this effect. International Labor Organization (ILO) is an essential organization in terms of general operating conditions in the international arena in maritime transportation MLC can be given as an example which is emerged as a result of ILO and IMO working together for a long years. In terms of globalization; MLC is the most important international contract related all working condition rules which governments, owners, shipping companies and seafarers must comply.

Shipping provides job opportunities to people around the world. More than 1.5 million people are employed as seafarers and the vast majority of them are from developing countries. And, if the world economy continues to grow, more highly trained and qualified seafarers will be needed. To meet the demands of growth, more than 50,000 new seafarers are needed every year. Related activities such as shipbuilding, ship repair and ship recycling provide more jobs to people in developing countries and will contribute towards achieving the Millennium Development Goals. [22].

Globalization and maritime security

The influence of globalization has led to the idea that "security" increasingly is global in nature and that "insecurity," in turn, is increasingly a phenomenon shared both by communities and humankind in general that takes little account of national borders. Human security and new ideas on how to order human affairs on a global scale are at the forefront of these concerns of "global security." The security implications of a globalizing world, then, including both traditional and non- traditional security challenges, are still best approached from somewhat conventional, state- centric, strategic perspectives [23]. The oceans are increasingly threatened by illegal exploitation of living marine resources and increased competition over nonliving marine resources. Although the global economy continues to increase the value of the oceans' role as highways for commerce and providers of resources, technology and the forces of globalization have lessened their role as barriers. Thus, this continuous domain serves as a vast, ready, and largely unsecured medium for an array of threats by nations, terrorists, and criminals [24].

The raised threat needs a global response, and after the terror attacks in the United States the International Maritime Organisation (IMO) adopted a new Chapter XI-2 in its Convention on Safety of Life at Sea (SOLAS) and the International Ship and Port Facility Security (ISPS) Code [25];.

Global maritime security over the last five years, including [26];

* the Container Security Initiative (CSI)

* the International Ship and Port Facility Security (ISPS) Code

* the Proliferation Security Initiative (PSI)

* the Customs-Trade Partnership Against Terrorism (C-TPAT)

The most notable new maritime security measures passed by the IMO include the International Ship and Port Facility Security (ISPS) Code, added as an annex on maritime security to the SOLAS Convention; significant new Protocols to the SUA Convention and its Protocol; and provisions for the satellite-based long-range identification and tracking (LRIT) of SOLAS-regulated ships. From the time that the ISPS Code entered into force (1 July 2004), therefore, maritime safety and security became increasingly interconnected for globalization [23]**.** All of these agreements is to contribute to increasing globalization.

Pollution at Sea and Globalization

Pollution at sea and globalization the foremost example of this is the impact on the creatures all at sea which cause by microorganisms carried ship's hull. Besides this impact pollution at sea also come up from harbour activities and ships. The most important and basic convention about pollution is MARPOL during the internationalization process this convention and its annexes constitute the basis about widespread of globalization. Sea accidents are another component that causes sea pollution associated with this after every accident a new convention put into practice especially in maritime law. For example; SOLAS which accepted after TITANIC disaster come up as an important convention about survive at sea and safety at sea in maritime transportation and also it plays an important role in preventing accidents and pollution.

Intermodal Transportation, Containerization and Globalization

With the expansion of globalization, intermodal transportation has become even more important. Intermodal transportation began in the United States and Europe with the use of containers that could be transferred between ships and railcars, thereby minimizing cargo loading and unloading time, linking water and land routes, and speeding the delivery of raw materials and intermediate and finished goods [27]. Intermodal transport systems include a variety of different transport modes like short sea shipping, inland waterways, rail and even air transport. Road transport is used only in pre or end haulage. Due to the globalization and the increase in international trade, more and more cargo is transported by sea. Shipping cannot exist without other modes [28]. Intermodal transportation is the essence of container transport. Containerisation is an important component of maritime transport in recent years. Container transportation has enabled the interconnection of the four transportation modes.

CONCLUSION

Globalization is concerned in all areas. Belong to KOF globalization index; it realize in economics, social life, and politics and also in general situation and each one has different effect on globalization. In 2015 Turkey took 44.place in general globalization index while it was in 105.place in economical index. Nowadays %90 of world trade take place by sea so globalization with maritime is more important when together. In all areas of maritime industry globalization comes with internationalization. International rules carried out at convention level and it must be applied in every port, every shipping business, every ship and to all seafarers of the countries which are side of these rules and this makes directly contribution to globalization.

In maritime transport globalization begins with international organization and goes on with education. Spread of sea pollution is also a global concept and prevention is evaluate in global precaution. When we take a look to whole door to door transportation understanding; in all load transportation maritime transportation covers a significant portion but maritime transportation cannot perform this system alone. It needs the other transportation systems. In this context; in a country maritime-highway transportation and maritime-railway transportation begin with highway or railway and goes on with maritime and this process ends in a port or in another transportation mode of the country which the goods send. So maritime transportation exposed to the effect of globalization as well as the scope of foreign trade, agents and freight forwarder.

The most supporting maritime transporting system to door to door transporting is container transportation.

Because of not to be limited to certain areas and effecting all countries sea pollution is the subject of globalization.

Maritime security is also part of globalization especially after 11 September attack.
These and similar factors require coordinated agreements and actions by the UN agencies IMO, ILO, UNCTAD, the International Transport Workers Federation, the International Shipping Federation, and other institutions of shipping [27].

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A STUDY ON FINANCIAL RISK MANAGEMENT IN TURKISH MARITIME SECTOR

Birsen KOLDEMİR[1] , Gökçe Çiçek CEYHUN[2] , Gamze KAYIMER[3]

ABSTRACT

Modern maritime transport is affected by various economic dynamics. Therefore requires successful economic management. The maritime industry is a capital intensive sectors, such as might be experienced great losses or big gains. The most important risk of the sector is the freight risk. Identification of risk is required for a successful business management and comprehensive planning.World trade is affected by the maritime sector and the financial turmoil affected quickly from the economic crisis. Especially after the 2008 global economic crisis and the crisis of 2012 freight, as well as all over the world, leading to the collapse of the Turkish maritime fleet has resulted in losses not compensated in this sector.In this study, maritime transport is of great importance between transport modes were investigated in the economic risk. Enhanced efforts to improve the financial risk management are aimed at Turkey.

Keywords – Risk Management, Maritime Transport, Turkish Maritime Sector

INTRODUCTION

Generally the concept of risk is the probable occurrence of unexpected situations, injury, trauma, loss or undesirable event in the future. Risk from financial point of view is probable variance from expected yield to actual yield. Possessing financial assets brings certain risks to be taken.According to Stopford the shipping industry has very high volatility. Because of the instability between supply and demand of sea transport, shipping business itself includes financial deprivation. Moreover the freight rates which are constituted by shipping supply and demand causes high volatility in the shipping industry [1]. On the other hand, Ghiorghe and Ana Maria states that the risk in the shipping industry is derived from fluctuations of freight rates in the market [2].In order to reveal the impact of the fluctuations on the freight market and risk related management techniques in the shipping business, it is required to specify the details of economic mechanism. Despite of the fact that the shipping business is enclosed with financial risks this study has focused on prominent economic risks which have great impact on freight rates.Financial risk is the reduction of the company's debt-payment adequacy. The risk here is revealed by financing the activities of the company with the its own resources or foreign resources. Financial risk is the risk of falling below the level of income to pay tax and profit shares..[45]

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LITERATURE REVIEW

Definition of Risk and Risk Types

Risk can be defined as the potential changes in the expected profit of the investor. That means, the possibility of falling of actual profit below the expected profit or raising up of the actual profit the expected profit. This possibility creates the risk of investment made in terms of investors. A risk associated with financial asset is accepted just in case its expected profit can compensate the risk.

For taking risk investors must also look at alternatives. Those alternatives with minimum risk may generate little profit. Those alternatives with high risk may generate the greatest possible return but may carry more risk than the producer will wish to bear. The preferred and optimal choice must balance potential for profit and the risk of loss. It all comes down to management, and there are no easy answers [3].

Risk can be defined as the danger of from outside and suddenly or unexpected accident [4]. Existing of risk brings the uncertainty and if there is no uncertainty, we cannot mention from risk. Moreover, risk means exposure to trouble [5].

In order to understand the term of risk, we have to reveal the types of risks. The number of possible sources and combinations of sources of risk is almost beyond classification. The primary classification typologies revolve around the origin of the risk and around the nature of the effect. The most obvious initial classification of risk is to differentiate it in terms of the *risk level* within the organization on which it impacts. The obvious classification in this respect is as listed below [6]:

- Strategic risk: Strategic risk relates to risk at the corporate level, and it affects the development and implementation of an organization’s strategy. An example is the risk resulting from an incorrect assessment of future market trends when developing the initial strategy.
- Change or project risk: Change risk can operate at numerous levels within the organization. Changes can be imposed by variations elsewhere either within or outside the organization. Alternatively, changes can be planned and engineered by the organization as a way to achieve objectives.
- Operational risk; Operational risk relates to the production process. This includes the process itself, the asset base, the people within any project teams, and the legal controls within which the organization operates.
- Unforeseeable risk: Unforeseeable risk is the type of risk that cannot be accurately forecast before it occurs. Some risks may be reasonably anticipated, such as a change in interest rates over a five-year period. In developing a strategic plan for an organization, it will be assumed that there will be some variation in interest rates and that this variation will be contained within reasonable limits.
- Financial Risk and Knowledge Risk: Financial risk includes market, credit, capital structure and reporting risks. Knowledge risk includes the information that is stored using IT, hardware and software, information management, knowledge management and planning.
- External and Internal Risks: External risks take numerous forms. Some examples of external risk factors are interest rate risk, volatility risk, convexity risk (a market risk that is closely related to interest rate risk), time-dependent risk , competitor risk, customer demand risk, exposure risk, shareholder risk, political risk, legislative risk. Internal risks originate from within the organization and over which, at least in theory, the organization should have some degree of control. Some examples of internal risks are operational process risk, legal risk, liquidity risk, supply chain risk, competence risk, complexity risk, it and technology risk, people risk, residual risk.
- Speculative and Static Risks: Speculative risk is concerned primarily with the risk to all the stakeholders within the company, whereas speculative financial risk is restricted to equity holders. Speculative risks can change over time and can shift between likely positive and negative values. Static risk considers losses only. It looks at potential losses and seeks to implement safeguards and protection in order to minimize the extent of the loss.

Risk Management

Historically the shipping business has been influenced from great variety of economic developments. The latest financial events and economic turmoil of the last decade shifted shipping organizations' attentions to the risks seriously. In order to control the risk factors, the companies have spent more money for personnel and technology to avoid risks. However most of these investments have become peculiarly related with strategic risk management applications.

According to ISO 31000:2009, "risk management process is systematic application of management policies, procedures and practices to the activities of communicating, consulting, establishing the context, and identifying, analyzing, evaluating, treating, monitoring and reviewing" [7]. Moreover, systematic application of management procedures, processes policies, and to the tasks of establishing the context, analyzing, communicating, monitoring, identifying, assessing, and treating risks are the components of the risk management [8].

As a process of identifying, assessing and managing risks, risk management is focused on the most significant risks for the attention of executive management and the directors. This concept relies on the six principles of strategic risk management [9]:

- It is a process of defining, evaluating and managing risk anywhere in the strategy together with final aim of protecting and constituting the value for shareholder and stakeholder.
- It is a major part and basis of enterprise risk management.
- The boards of directors and management affect it.
- It requires strategic view of risks and evaluation of how scenarios, external and internal events may influence the firm's ability in order to achieve its goals.
- It requires a company to determine tolerable risk levels or risk desire for giving strategic decisions.
- It is an ongoing process that must be placed in strategy setting and strategic management."

Due to shipping cycles stay at the center of *shipping risk*, we should guess about content of the risk term. From the technical aspect, shipping risk can be described as the 'measurable liability for any financial loss arising from unforeseen imbalances between the supply and demand for sea transport'.

Stated in other words, we are dealing with who undertakes the financial matters if the supply of ships does not exactly match the demand and results with losses. For instance if too few ships are constructed and oil companies couldn't supply their refineries, manufactured exports are stranded in the ports, and steel mills run out of iron ore, who pays? Or if too many ships are constructed and many earn nothing on their multimillion-dollar capital placement, who pays [1]

Actually ship owners (the investors who own the equity in the ships offered for hire) are the major risk takers and the cargo owners (the shippers between them perform the balancing act of adjusting supply to demand). When we evaluate shipping risk distribution, they stay on the opposite sides of shipping industry. Furthermore one or the other loses their investments because of the imbalance between supply and demand. The movements of the freight rates and time have shown in Figure 1. The line *T* – in a perfect market this should reflect the long-shows the breakeven cost of transport. If supply and demand were always precisely in balance freight rates would follow this line. Actually supply and demand are rarely exactly in balance in practice, so freight rates fluctuate around *T*, as shown by the short-term cycle *F*. If cargo owners get wrong information about this and have too many cargoes, rates shoot above the trend cost, transferring cash to ship owners who respond by ordering more ships [1].

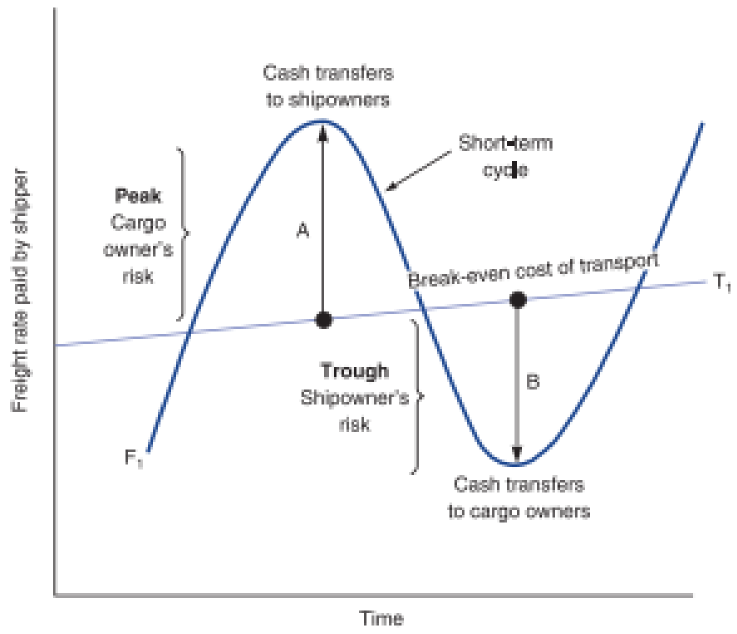

Figure 1: Key Risk Features of the Shipping Cycle

Source: Compiled by Martin Stopford from various sources

On the contrary, if the ship owners get the wrong information about this and there are too many ships, rates swing below trend. They subsidize the cargo owners and they stop investment (point B). Therefore the cycles use fiscal constraint to straighten the situation and take freight rates back to the trend. At the and if business is to continue, the freight cash flow should average out at the break-even cost of transport, so across the whole market shipping risk is primarily about the *timing* of receipts [1].

GLOBAL FINANCIAL CRISIS AND THE IMPLICATIONS

2008-2009 Global Financial Crisis

Global economic environment was surrounded by sustained economic growth, low inflation levels, and low interest rates in the pre-crisis period. Actually the growth model that revealed from the 2000s was bringing high risks with it. The economic growth in the USA was supported by intense consumer demand, induced by easy credit and well-supported by oncoming house prices and by high investment rates. When the difficulties of USA mortgage market were expanded to the all financial sectors, the turmoil spread all around the world [10]

As many countries, Turkey was hit very hard by the global financial crisis of 2008-2009 in many ways. Turkish economy entered the crisis with a large current-account deficit and the current-account balance turned to positive within one year and a-half. Three years after the previous crises, Turkey again has run large current- account deficits. The widening of the current account deficit has been more spectacular in 2012 crisis [11].

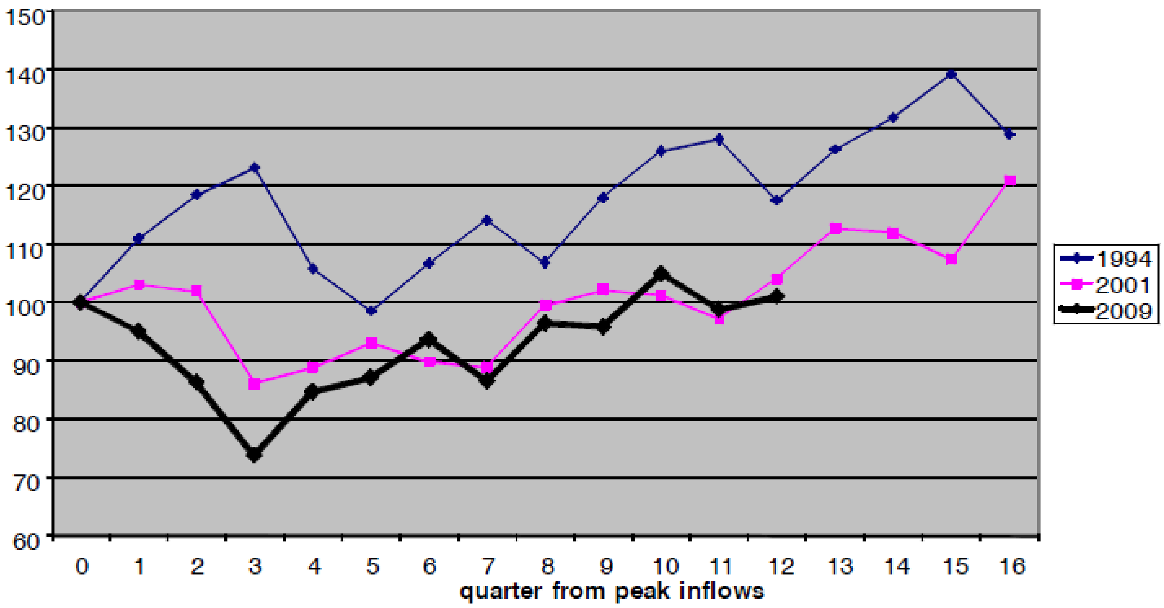

Figure 2 Industrial Production (peak inflows quarter=100)
Source: Rodrik, 2012

As indicated in the Figure 2, industrial production has followed the path of the 2001 crisis fairly closely in bouncing back, even though the initial downturn was more severe.

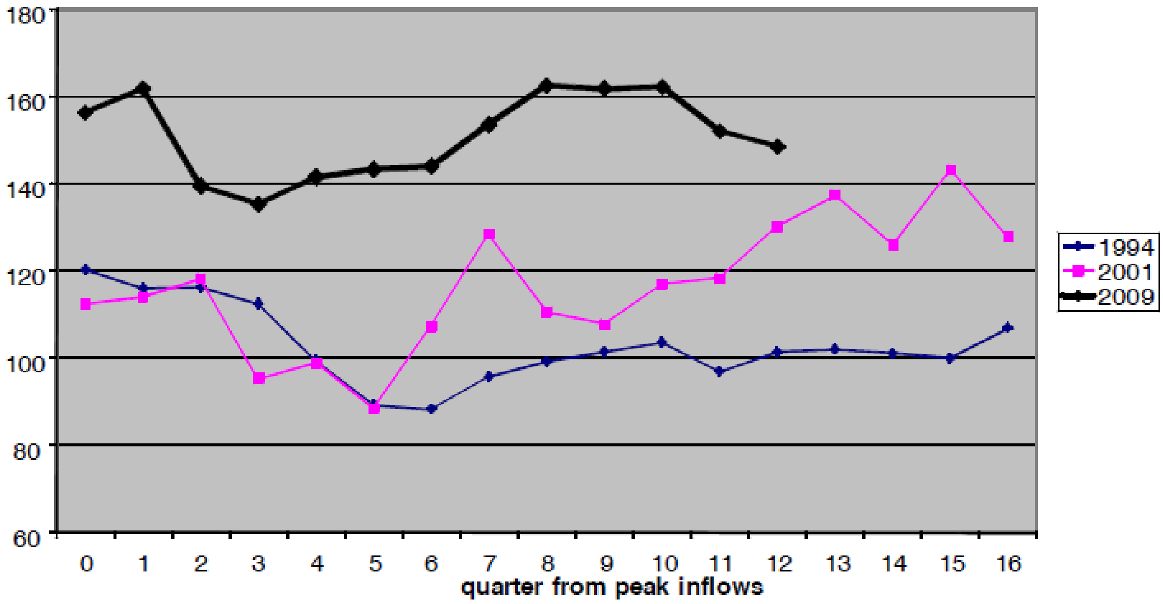

Figure 3. Real Effective Exchange Rates
Source: Rodrik, 2012

According to Figure 3 Turkey entered the 2012 crisis with a strong lira. However, the rapid currency appreciation was really become a problem [11].

As it well known one of the sectors that affected by the economic crisis is the maritime sectors. Due to diminishing actions in sea transport, the freight traffic of seaports was decreased. However seaport were influenced intensively and they suspended their investments, lower their costs and tariffs in order to survive [12].

2012 Freight Crisis

When compared with the previous crises, 2012 freight crisis had a strong impact on the Turkish shipping industry. Most of Turkish shipyards and ship-owners went bankrupt because of the dramatic decline of time harter rates and freight rates. Many shipyards lost their prestige together with capitals and qualified employers [13].

In order to understand the statistical effects of 2012 crisis on Turkish maritime sector, we have to analyze Baltic Dry Index (BDI). As Figure 4 shows the BDI was dramatically declined especially on February 2011.

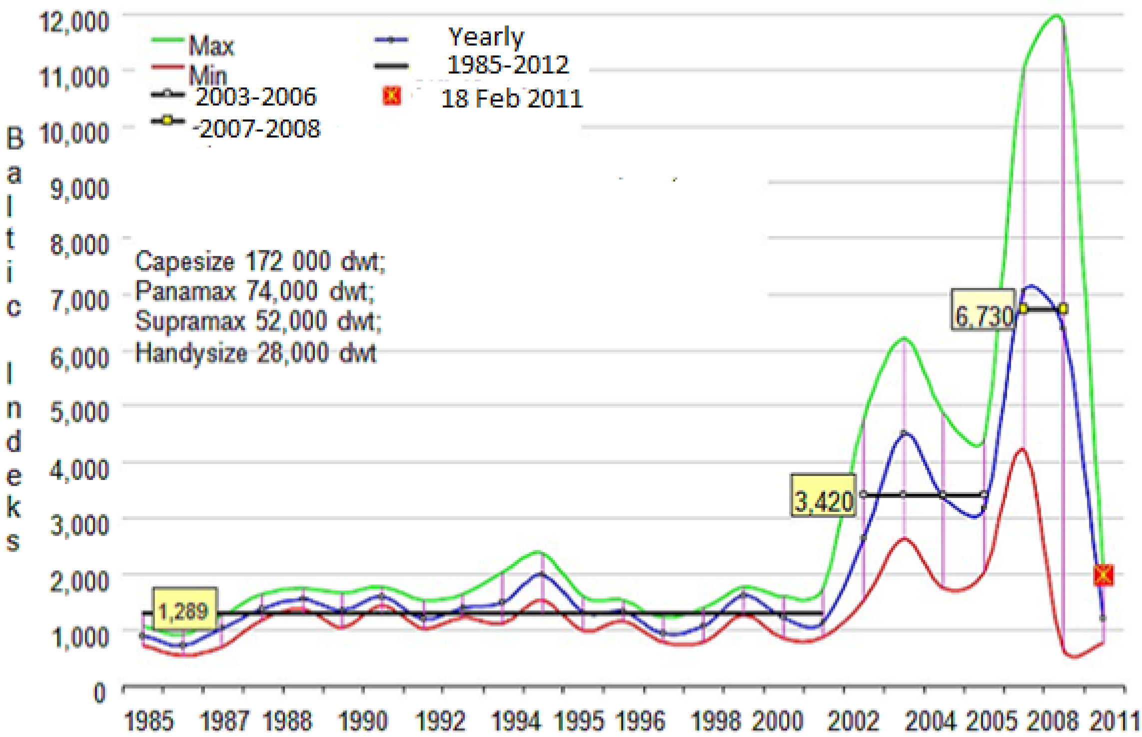

Figure 4: Changes in Baltic Dry Index
Source: ISL (Institute of Shipping Economics and Logistics), 2012. [14].

Despite the economic recession during 2012, the maritime sector has gone to crisis because of excess supply of the ships all around the world. While Freight rate was 70.000 usd for bulk ships in 2007, it was fell down to 10.000 usd in the last quarter of 2012. Therefore Turkish maritime sector has influenced from this regression and the freight rates was sharply fell down from 2008 to 2012 [13].

On the other hand, Turkish shipyards was badly affected from the crisis so that incoming ship orders to Turkish shipyards were dramatically fell down 20 pieces in 2012. Most of the ship orders were postponed or cancelled in Turkish shipyards because of the negative effects of the crisis. By virtue of these cancellations and postponements, the workers of the shipyards numbers have declined from 40.000 to 10.000 [13].

FINANCIAL RISK MANAGEMENT APPLICATIONS IN TURKISH MARITIME SECTOR

Port investments are commonly short-term in Turkey. If the companies have a perfectly working and confidential risk management units, they can predict the troubles of harbor, take precautions and they can apply decision making procedures. Thus, Enterprise Risk Management includes completely this type of risks that may be impediment for company operations. Today, a risk manager can create significant added-value by offering the risk reports. In order to achieve this there must be a powerful board of management behind of the risk management unit.

Most companies have a risk manager title in Turkey, but they are usually interested in insurance issues. Insurance can be defined as the first step of risk management. In this context, we can see that risk management is being carried out as in basic levels in Turkey. Decisions such as port investment are made by commonly industry leaders who have more sectoral information. However, the problem of harbor investment may not be a matter of financial investment. In summary all of risks return to financial risk when it comes true. We can approach proactive for many financial risks, but we can show more reaction for external, and macroeconomic risks. This macroeconomic risk may return to financial risk if it is not have been managed in the correct way.

When we look at the risk models, we can see that the operational risk modeling is being carried out as most basic levels particularly in Turkey. In general, it can be realized by analyzing historical data, file processing and similar steps as insurance. For instance, if we consider the failure of important service, we have to identify acceptable levels of customers for cargos delay and frequent of the delay. As a result of these applications, we have to take precautions by calculating the encountered maximum risk. These operations can actualized with excel programmes and workshops. Principally, Turkish firms do not use the improved risk management models, even if it can be used, they cannot be overreach of corporate practices.

Credit risk modeling is one of the most important models used in risk management. This modeling can be used as very sophisticated systems in order to determine the selected suppliers, subcontractor, and the customer's credits and make investments. However, Turkish systems and models that are related maritime sector does not function in perfect way and unfortunately they are lack of morality approach. Models that seen in theory are being carried out by international companies that produce to large size.

There is no standard risk model implementation in Turkey. Companies managing their risks within the frame of corporate risk management stated in ISO 31000 and ISO 30110 or COSO 2013. Firms often determine the risk managements scope and analyze according to possibilities after identify the risks in the direction of Corporate Risk Management methodology. Afterwards kinds of risk attitudes are defined. Lastly, companies designate the actions and preventive activities which will be carried out.

Turkish waters have the intense of maritime traffic and passenger transportation in terms of straits and gulfs. Turkey must care about risk management studies because of the traffic density. Turkish P&I Club that created with come together six companies is a good example of these studies. Turkısh P&I Club has established for obligatory of liability insurances for over the 300 grt vessels. The developing efforts of this club which is situated for providing assurance for Turkish flagged vessels is stil in progress [15].

Other good example of this studies is Izmit Gulf Risk Assessment Workshop committed on the date of 11-12 March 2014. There is high traffic density and passenger transportation performed simultaneously in the Izmit Gulf where the 34 port operating facilities, liner passenger transport and ferry lines, shipyards and boat yards, passenger quays, fishing ports and marinas, sailing and water sports clubs. The aim of the Workshop that has 47 participation from 36 companies was to incerase security and efficiency of the port. In this workshop, PAWSA (Ports & Waterways Safety Assessment) Model (the risk management methods which proposed for member governments to use) applied that was accepted from IMO (International Maritime Organization) and IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities). PAWSA that until today which mainly implemented in America, has been successfully applied also outside of America. PAWSA model applied the first time in Turkey after Denmark in Europe.

CONCLUSION

Maritime transportation sector is relatively risky in comparison with other types of transportation. Maritime sector risks are effected by political changes, changes of oil prices, interest rates, exchange rates, meteorological conditions and market fluctuation. An existence of market fluctuation makes difficult the improved forecasts and creates dangerous conditions for investors.

Moreover, risk management is related with identifying, assessing, selecting and adapting strategies in order to reduce risks. To perform the correct application of risk management, the different levels of risks and different precautions must be defined. As it's well known every risk does not have the same effect on the firms' future plans. While some of the risks are needed to be taken crucial providences, others may be seen negligible. That's why the risk definitions and precautions are the starting point of the risk management practices.

Lastly, minimizing risk factors and avoid from dangers of risks are needed in every sphere of life as well as in maritime working environment. As a result, organizations should apply professional risk management models in order to tolerate risk factors of maritime sector.

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MARKETING SEGMENTATION AND POSITIONING OF TURKISH MARITIME SECTORS

Güzide Öncü EROĞLU PEKTAŞ[1]

ABSTRACT

Maritime and shipping that originates from the beginning of the 20th century. In Europe and the USA, these exemptions have only recently been abolished. Trade facilitation has developed from a narrow idea about the possibility to move goods between countries through ports to a much more extensive concept, encompassing the general trade environment in countries and between countries.(Song and Panayıdes, 2012, pp.12)In this study, analysis of the market situation of the Turkish Maritime sector is made and formed maritime industry according to statistical data which is in the last two years. The criterias of the defined marine partitioning and Turkish Maritime sector are segmented. It causes to better view of the sector. There are 5 factors involved in marketing partitioning criteria literature are preferred. These are, the service provided in maritime sector, which ships are involved, how many ship they have, how many tones capacity they have and do they provide port service. Market positioning in the maritime sector in the second part of this partitioning results were interpreted create a map based on specific criteria perception again. There are posititioning criterias: Average fleet age, number of ship's business, brand awareness and capacity. This study made by both the Turkish maritime sector of the market segmentation with data made last year, also positioning of the brand is determined locations relative to each other. It is among the first seven companies in the sector positioning . (Arkas, Palmali, Ulusoy, Yasa, İnce, Beşiktaş ve Genel Denizcilik). The scanning of the datas were done by Turkish Statistic Institutiion, the media sources that analysing the sectors, web sites and kinds of contemporary media adress. It happened useful and also developable for both academic and also sector. This study which is a subtype of the qualitative research technique can be supported in the future and can lead to different studies based on different marketing partitioning and positioning criteria.

Keywords – Maritime Sector, Marketing Segmentation, Marketing Location

MARKETING SEGMENTATION

In the section of the market segmentation process the different types of market segmentation and the variables of each type will first be explained. They include *the demographic segmentation*, which is considered the most common one that deals with basic demographic factors such as age, income, gender etc. and divides the target customers into segments based on these variables. *The geographic segmentation* divides the target customers into segments based on geographical areas such as nations, regions, cities etc. The psychographic segmentation divides the customers into segments according to their values and lifestyle. Finally *the behavioural segmentation* divides the target customers into segments based on their attitude toward a product. On the basis of the description of the types it will be concluded which of the types are best suited when identifying the target customers of respectively the landline telephone and the mobile telephone in this case being the demographic and the

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behavioural segmentation.(2) Positioning, the reason a target segmentation is interested in buying the product, is the foundation of product, marketing and business strategy. (3) Market segmentation and positioning are considered together and implemented. The segment identification decision involves identifying segmnets which have the probability of a favorable market response. (4)

Critical to this strategic approach is selecting some segments to target and others to ignore. As David Aaker writes, "Positioning usually implies a segmentation commitment—an overt decision to ignore large parts of the market and concentrate only on certain segments." One reason this segmentation commitment is necessary is that the needs of different segments are often conflicting and their satisfaction mutually exclusive. For example, older consumers may prefer a quiet cruise, restaurant, hotel, or resort environment and might be put off by a loud, rock-based show that would appeal to younger consumers. Likewise, amenities and entertainment for families with children might not mesh with those of singles or seniors. Even if those features and amenities are not mutually exclusive, the cost of building a single product with all the features desired by different segments would drive costs to unreasonable levels. (5)

So, which variables should you use to segment the market, and how many segments should you identify? No single answer to these questions applies across the board. Instead, the answer depends on your business, your market, and your customers. Different markets are best segmented using different types of variables and different numbers of segments. Most likely, the preexisting, generic market segmentations sold by marketing research firms will not be ideal for your situation. For this reason, you should conduct or commission segmentation studies of your own specific market—starting with literally hundreds of different variables, analyzing them, and gradually winnowing the list to see which ones produce segments or groupings of consumers that are most useful. (5)

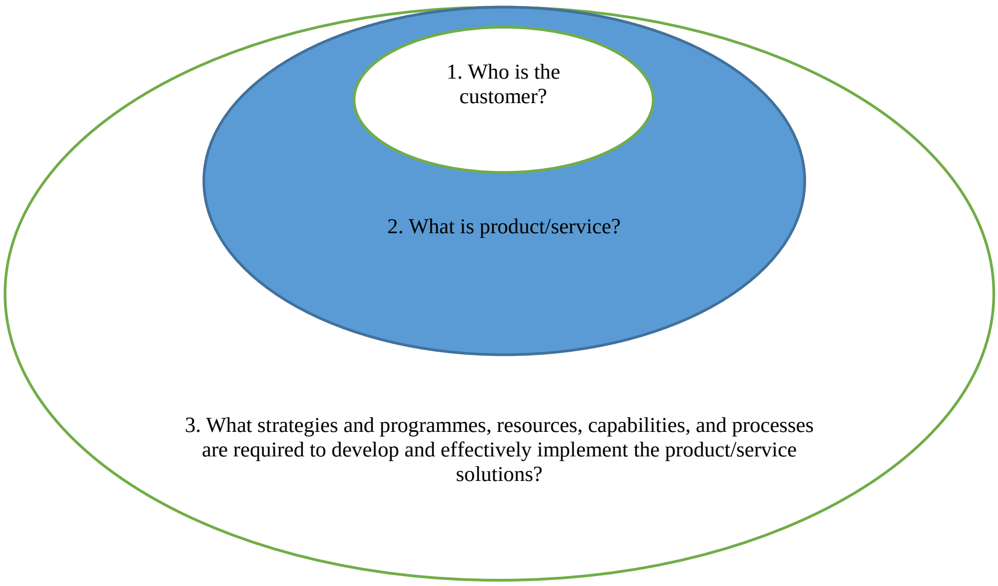

Figure 1 Focus on market-driven strategy (5)

Figure 1. illustrates the centrality of segmentation and the progression of essential questions to address. At the core is the identification of the existing and potential customer base, an understanding of underlying heterogeneity. After is the response to segmentation and finally positioning provides the foundation for the rest of the marketing strategy and other processes of the firm and resource

allocation resolve. A segmentation audit can help a firm make an initial determination as to whether it uses an effective segmentation strategy. In scoring this particular audit it is important to note that effective segmentation requires a positive answer to each question. (1)

1 Who are my market segments? This depiction approach forces management to try and first identity the observable characteristics of individuals to be in the target market segments. A firm unable to effectively answer this question is likely to have considerable trouble not only locating existing segments, but also predicting the evolution of new market participation.

2 What do my segments think and feel? An attitudinal evaluation of segments focuses on pyschographics and underlying segment preferences. An understanding of perceptions, preferences and attitudes towards the firm and its competitors are necessary conditions for being able to tailor marketing messages and talk in the appropriate ‘language’.

3 How do my segments behave? This question forces the firm to think about usage, demand and consumption patterns, and the reaction to changes in the marketing mix (product, price, promotion and distribution).

4 Where are my segments going? Here, the company must attempt to map out the trajectory of segment growth. All factors follow a life cycle and this question forces the firm to address dynamics, and thereby understand long-term viability of segments.

5 What are my pecular customers worth? This last question stipulates that the firm must attempt to place a financial value on market segments and the inefficiacy to answer this question is likely to hamper company efforts to effectively allocate marketing resources and maximize marketing return on investment (ROI). (1)

WORLD MARITIME SECTOR

Sea transport; especially industrial raw materials forming a very large amount from one location at a time of cargo in another place transport to provide the opportunity, to be reliable, no limit timeout, a minimal level of goods casualties, least-polluting, passenger-km and is the least energy consumed ton per km almost complete absence of other losses, according to the airway 14, according to highway 7, 3.5 times by rail to be cheaper, since these features, see transport is the most preferred mode of transport in the world. (7)

The elimination of border ceased, the basic elements of international competition intense maritime transport are ships and ports are. Cargo in ports by the end of the beginning of the handle transport, domestic transportation of ships, international and transit transportation which contribute to the economy of the country is great. (7)

In Table 1, Worldwide Merchant Marine fleet in the world rankings in 2011 and 2012. As can be seen from it, since 2013 the ranking has increased from 15 to 13 order. This is Turkey's last 3 years in the maritime industry in a way that the rise in the world rankings with the two digits 13 indicate that settled in the queue.

Table 1. World Marine Fleet

Dünya Sıralaması (DWT)						Ulusal Bayrak				Yabancı Bayrak				Kontrol Edilen Toplam Filo				2015-2014 DWT DEĞİŞİMİ (%)	YABANCI BAYRAK DWT ORANI (%)
2015	2014	2013	2012	2011	Ülkeler	Adet	1000 DWT	1000 TEU	Ort. Yaş (Yıl)	Adet	1000 DWT	1000 TEU	Ort. Yaş (Yıl)	Adet	1000 DWT	1000 TEU	Ort. Yaş (Yıl)		
1	1	1	1	1	YUNANİSTAN	807	74.938	152	13,6	3.445	233.190	1.604	11,0	4.252	308.128	1.755	11.5	9,2	75.5
2	2	2	2	2	JAPONYA	709	19.244	13	12,5	3.426	222.936	1.327	7,2	4.135	242.180	1.340	8,1	2,9	92.1
3	3	3	3	4	ÇİN	2.489	72.019	595	10,8	2.231	117.774	930	11,8	4.720	189.793	1.524	11,3	2,9	62,1
4	4	4	4	3	ALMANYA	256	12.461	923	13,9	3.389	111.113	4.860	9,4	3.645	123.574	5.784	9,8	-2,7	89,9
5	5	5	5	5	KORE	719	15.164	91	17,9	904	70.003	617	9,9	1.623	85.167	708	13,5	2,1	82,2
6	6	6	8	6	NORVEÇ	498	15.064	71	15,0	1.050	44.853	313	13,9	1.548	59.917	384	14,2	4,4	74,9
7	8	8	6	7	A.B.D	201	4.602	70	23,3	869	51.075	204	13,3	1.070	55.677	274	15,2	16,9	91,7
8	7	7	12	11	SİNGAPUR	735	30.181	772	8,2	588	24.959	258	15,1	1.323	55.140	1.031	11,3	7,2	45,3
9	9	9	10	10	TAYVAN	105	4.606	125	16,2	741	40.708	824	10,8	846	45.314	949	11,5	-4,7	89,8
10	11	11	14	14	ITALYA	505	15.335	58	13,8	522	26.523	1.064	10,9	1.027	41.858	1.123	12,4	1,9	63,4
11	10	10	11	9	DANİMARKA	330	15.129	869	13,0	558	21.863	774	10,0	888	36.992	1.643	11,1	-10,1	59,1
12	12	13	7	8	HONG KONG (SAR)	453	26.665	422	7,2	301	8.455	50	17,9	754	35.121	472	11,5	4,4	24,1
13	13	13	15	15	TÜRKİYE	645	8.788	96	18,0	753	18.719	108	18,5	1.398	27.507	204	18,3	-9,6	69,8
14	15	15	18	18	KANADA	112	1.028	7	30,7	327	23.598	514	9,8	439	24.626	521	15,1	9,1	95,8
15	14	14	16	17	HİNDİSTAN	474	13.906	23	11,6	152	9.346	7	12,9	626	23.253	30	11,9	0,7	40,2
16	17	16	17	16	RUSYA	1.075	5.476	71	27,1	508	17.276	46	18,4	1.583	22.753	117	24,3	6,5	75,9
17	16	22	9	13	İNGİLTERE	223	6.302	130	11,1	358	15.684	233	12,3	581	21.986	363	11,9	0,8	71,3
18	20	20	19	21	BELÇİKA	61	7.005	1	10,2	131	11.132	44	8,3	192	18.137	45	8,9	33,2	61,4
19	18	18	24	19	İRAN	135	3.920	98	15,6	70	14.093	13	11,3	205	18.013	112	14,1	-1,0	78,2
20	21	23	22	23	ENDONEZYA	1.351	11.275	158	24,8	145	3.625	12	14,8	1.496	14.900	171	23,8	12,1	24,3
21	19	19	20	20	S.ARABİSTAN	60	1.958	8	18,3	81	11.339	1	13,6	141	13.297	8	15,6	-6,7	85,3
22	24	24	23	26	BREZİLYA	66	2.116	14	22,8	44	11.149	-	10,2	110	13.265	14	17,8	10,7	84,0
23	22	21	21	22	MALEZYA	221	6.423	17	16,4	85	5.952	3	14,6	306	12.376	20	15,9	-4,8	48,1
24	23	25	27	25	B.A.E	42	302	0	12,8	401	11.790	65	20,0	443	12.093	65	19,3	-5,3	97,5
25	26	27	26	28	HOLLANDA	626	5.412	211	9,6	266	5.120	56	12,7	892	10.532	267	10,6	17,8	48,6
26	25	26	25	27	FRANSA	112	2.864	189	13,2	169	7.521	392	9,6	281	10.385	581	11,0	4,0	72,4
27	30	28	29	-	KUVEYT	35	5.299	22	8,0	46	3.442	209	8,2	81	8.741	230	8,1	27,3	39,4
28	27	-	13	12	BERMUDA	-	-	-	-	33	7.512	0	14,5	33	7.512	0	14,5	-9,0	100,0
29	29	29	30	29	VİETNAM	738	5.835	31	10,3	78	1.183	7	20,0	816	7.018	37	11,3	1,6	16,9
30	28	-	-	-	UMMAN	28	3.856	-	11,4	9	3.158	-	7,7	37	7.014	-	9.3	1,8	45,0
TOPLAM 30 ÜLKE						13.811	397.173	5.238	15,1	21.680	1.155.091	14.534	11,3	35.491	1.552.264	19.772	12,8	3,7	74,4
DİĞER						2.330	36.917	238	23,2	2.658	58.733	557	19,9	4.988	95.651	795	21,5	-0,8	61,4
ALT TOPLAM						16.141	434.090	5.476	16,3	24.338	1.213.824	15.091	12,3	40.479	1.647.915	20.567	13,8	3,5	73,7
BİLİNMEYEN						...	...	...	...	...	...	...	...	523	4.561	27	20,4	51,7	...

<u>www.denizticaretodası.com</u> 2014 Deniz Ticaret İstatistikleri (7)

TURKISH MARITIME SECTOR

Turkey is surrounded by sea on three sides, it is a distinguished country with the unique geography of transportation. This geographical advantage, is also effective to ensure that every region in the country of 8 thousand 300 km of coastline, with maritime transportation. The foundation of the Turkish maritime sector; fleet constituting maritime transport, ports and shipbuilding elements are based on the presence of these elements together, since work have the ingredients the business sector, serving in a variety of over 30 coastal areas.

Turkey's largest 30 Maritime Company:

The ranking table is seen in Table 1 that based on the total capacity. First place is situated in General Maritime. But the next table that the asset value according to the market ranking in Table 2 shows that China is now the first place in the sector Ciner Marine. This young fleet so as to have a low average of 2.2 years and a total capacity of vessels that can be told sector raise the success of effective and efficient use.

Another finding of the Black Sea with the oldest fleet in the table Holding has created differences with the floating power plant achieved a first in the industry to ship the old fleet despite the fact that having the Powership.

Palmali shipping vessel having the highest number in the table and reached the second place of the table data in 2016. When the results are investigated that the company it is crucial to review the number of ships that can be done.

According to 2015 data from the General Marine, total capacity is set to have the highest capacity to ship grain to 88 in 2016, while data in the first place ranking is topped.

Table 2. Turkey's largest 30 Maritime Company

Turkey's Largest 30 Maritime Company			
Maritime Company	**Total Capacity**	Number of Ship	**Age of Ships**
Genel Denizcilik	2489	28	5,1
Ya Sa Shipping	2472	26	6,6
Densa Denizcilik	1622	21	2,8
Palmali Shipping	1404	84	12,3
Beşiktaş Shipping	1111	16	5,6
Kıran Holding	1012	17	7,1
Ciner Ship Management	919	16	2,4
İnce AB	778	13	6,5
Arkas Holding	603	52	13,2
Güngen Denizcilik	545	4	5,5
Kaptanoğlu Holding	514	12	7,3
Akmar Shipping	398	7	9,5
Karadeniz Holding	395	7	30,8
Mardeniz Denizcilik	391	7	4,3
Densan Deniz Nakliyat	311	7	5,6
Ditaş Deniz İşletmeciliği	276	9	5,8
Kalkavan K	276	17	8
Er Denizcilik	262	5	2,8
Çebi Denizcilik	257	6	5,3
Beks Denizcilik	254	4	2,9
Nemtaş Nemrut Liman	253	5	12,4
Ulusoy Denizyolları	251	8	9,9
Bayraktar Gemi	231	13	13,6
Finner Ship Management	227	4	3,2
Çolakoğlu Metalurji	225	3	13,7
Albros Shipping	219	43	17,2
İzmir Demir Çelik Sanayi	210	4	10,9
Atlantik Denizcilik	207	11	10,3
GSD Holding	205	4	1,1
Manta Denizcilik	189	6	16

Retrieved from www.patronturk.com.tr at 01.10.2016 (8)

Table 2. Asset Values and the Number of Ships in 2016 According to Market Segmentation

Ciner Company	**Palmali Shipping**	**Ya Sa Shipping**	**Arkas Company**	**Densa – Marinsa Shipping**	**Genel Denizcilik**	**Beşiktaş Shipping**	**Kıran Company**
1 billion dolar $	780 million dolar $	640 million dolar $	600 million dolar $	580 million dolar $	420 million dolar $	420 million dolar $	350 million dolar $
26 ship	88 ship	22 ship	50 ship	22 ship	31 ship	17 Ship	19 ship

Retrieved from www.denizhaber.com.tr at 03.10.2016 (9)

Table 2. FigureTurkey Maritime Sector of Market Segmentation 2015

Genel Denizcilik	**Ya Sa Shipping**	**Arkas Holding**	**Beşiktaş Shipping**	**Ulusoy Denizyolları**
Shipowner	Shipowner	Forwarder and Shipowner	Shipowner	Forwarder and Shipowner
Container and Cargo	Dry bulk and tanker	Container and Cargo	Dry bulk and tanker	Roro and dry bulk
Number of 28 ship	Number of 30 ship	Number of 52 ship	Number of 19 ship	Number of 8 ship
Total 2,4 million DWT	Total 2,471 million DWT	Total 74,792 TEU	Total 1,1 million DWT	Total 251 thousand DWT
It provides port service	No provides port service	It provides port service	No provides port service	It provides port service

Formed by researcher.

In terms of the size of the total capacity as seen in the table, the firms that are armature, Genel Denizcilik, Ya Sa Shipping and Beşiktaş Shipping place in. Also, Ulusoy Shipping and Arkas Holding are places as Forwarder and also armature. Beşiktaş and Ya Sa Shipping firms does not serve as port, on the other hands, the other firms serve as ports.

Companies in the transportation products as seen as different from them while cargo and container shipping company Ulusoy has differentiated transport with RORO ship separately. Given the number of vessels at a rate of 40% is between 20 and 29 years old so it is seen that with the ship class. This is to show us the comment that stands out for me to have a new fleet of young sailors firms in Turkey.

FINDINGS AND CONCLUSIONS

Market segmentation of the Turkish maritime industry and company position in the market are dealt with together. Sunday penetration of Turkish companies in the maritime sector, the total capacity, dealt with criteria such as number and age of the ship and tried to obtain data about it. The resulting data are the conclusion of the Turkish maritime sector in recent data on 2015 data, while the overall market leader in maritime shipping China also seems to be a market leader. In this study, the industry is in the nature of a preliminary study to a subsequent quantitative research studies have been done in an overview.

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THE ECONOMIC AND COST ANALYSIS OF RO-RO SHIPS USED LNG AS PROPULSION FUEL

Sercan Erol[1], Selim Baştürk[2]

ABSTRACT

Cause of environmental and economic concerns, shipping companies was forced to use more environmentalist fuels including less rate of sulfur oxides (SOx), nitrogen oxides (NOx) and particulate matter (PM). International Maritime Organization (IMO) has announced the Regulation- 14. This regulation is about to define suitable levels of SOx, NOx and PM onboard. According to the Regulation -14, sulfur limit of outside an Emission Control Area (ECA) zone will have to be maximum 0.50% m/m from 1 January 2020. Therefore, there are some ways in order to decrease level of SOx, NOx and PM, such as selective catalytic reduction (SCR) using bunker oil. But, this SCR system has an extra cost for ships. So, detailed cost evaluation is necessary to chose LNG as fuel or with SCR system. This paper presents concepts and economic analysis of 11636 deadweight (DWT) roll on roll off (Ro-Ro) ship fueled by liquefied natural gas (LNG), sailing between Adriatic Sea and Aegean Sea. A model Ro-Ro ship data, fueled by bunker oil, was used to determine whether using LNG onboard is more attractive or not. Economic analysis parameters of this paper include market research and the general information: initial shipbuilding cost, freight revenue, operation expenditure, and fuel cost.

Keywords − *LNG, Ro-Ro ship, Fuel oil, Fuel cost, Ship emission.*

INTRODUCTION

Shipping is the one of the most economical way of transportation goods and resources [1]. Nearly 90% of world trade is carried by the international shipping industry. On the other hand, there is not an alternative way to import and export of goods on the scale necessary for current world. The United Nations Conference on Trade and Development (UNCTAD) announces that the operation of merchant ships contributes nearly US$380 billion in freight rates within the global economy, equivalent to about 5% of total world trade [2].

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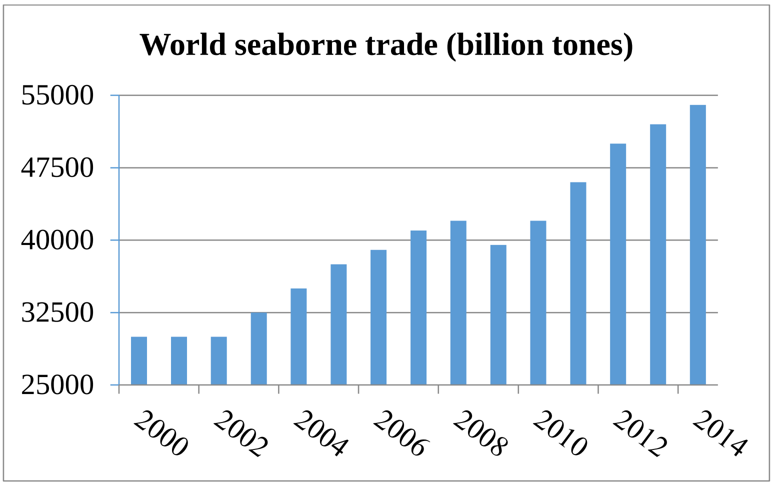

Figure 1. World seaborne trade between the years of 2000 and 2014 [2]

It is shown Figure 1, world seaborne trade goes on growing larger year by year cause of shipping low transportation costs than other transportation ways. However, consumers also profits by low prices of goods.

Although shipping transportation have many advantages both shippers, carriers and consumers, voyage costs are still an important item considering by shipping companies. Fuel oil cost means ship's total fuel and lubricating oil consumption cost both at sea while sailing and port period. The previous works proves that fuel cost is the main item of voyage cost contributing between 47% and 53% of total cost [3]. The global merchant fleet presently consumes approximately 330 million tons of fuel annually, 80-85% of which is residual fuel with high sulfur content, and the remaining of that amount are distillate fuels for the purpose of complying with IMO regulations [4]. Nearly 70% of emissions from ship operations are spread within 400 km from land [5]. Nowadays, global shipping transportation faces two important problems about fuel oil, economic and environmental concerns. As we express about environmental aspect, IMO regulations should be mentioned. Since international legislations by IMO for the purpose of decreasing sulfur level in marine fuels, shipping companies began to search ways to adopt IMO rules e.g. using LNG as fuel, installing modified fuel oil systems and slow steaming.

IMO sulfur and greenhouse gases (GHG) emissions regulations

In 2009, IMO revealed new sulfur regulation due to environmental concerns. According to IMO sulfur oxides (SOx) – Regulation 14;

SOx and particulate matter (PM) emission applications contain all fuelled combustion engines e.g. main engines, diesel generators and oil fired boilers onboard (as defined in regulation 2.9). These applications depend on where the ship sails in emission control area (ECA) or outside the ECA area. Fuel oil sulfur limits, shown on below Table 1, (expressed in terms of % m/m – that is by weight) shows step changes over the years [6];

Table 1. IMO sulfur emission limits

Outside an ECA established to limit SOx and particulate matter emissions	Inside an ECA established to limit SOx particulate matter emissions
4.50% m/m prior to 1 January 2012	1.50% m/m prior to 1 July 2010
3.50% m/m on and after 1 January 2012	1.00% m/m on and after 1 July 2010
0.50% m/m on and after 1 January 2020*	0.10% m/m on and after 1 January 2015
* Depending on the outcome of a review, to be concluded by 2018, as to the availability of the required fuel oil, this date could be deferred to 1 January 2025.	

The ECAs established are:

1. Baltic Sea area – as defined in Annex I of MARPOL (SO_x only);
2. North Sea area – as defined in Annex V of MARPOL (SO_x only);
3. North American area (entered into effect 1 August 2012) – as defined in Appendix VII of Annex VI of MARPOL (SO_x, nitrogen oxide (NO_x) and PM); and
4. United States Caribbean Sea area (entered into effect 1 January 2014) – as defined in Appendix VII of Annex VI of MARPOL (SO_x, NO_x and PM).

In 2008, IMO has also revealed nitrogen oxides (NOx) Technical Code' for the purpose of mitigating NOx levels of ships. These NOx limits are calculated at different tiers depending on ship building year and main engine revolution. According to IMO NOx regulation table,as seen in Figure 2 different tiers were accepted. Tier I, Tier II and Tier III have different NOx limits and different adaptation years.

Tier	Date	NOx Limit, g/kWh		
		n<130	130≤n<2000	n≥2000
Tier I	2000	17.0	45*n-0.2	9.8
Tier II	2011	14.4	44*n-0.23	7.7
Tier III*	2016*	3.4	9*n-0,2	1.96
*In NOx Emission Control Areas (Tier II standards apply outside ECAs)				

Figure 2. IMO NOx limits [6]

Not only SOx and NOx gases arising from ships are danger for environment, but also CO_2 is dangerous for environment. According to Figure 3; if global shipping companies continue to use present fuel oil, emitting CO_2 to atmosphere will be around 2750 m/t in the year of 2050.

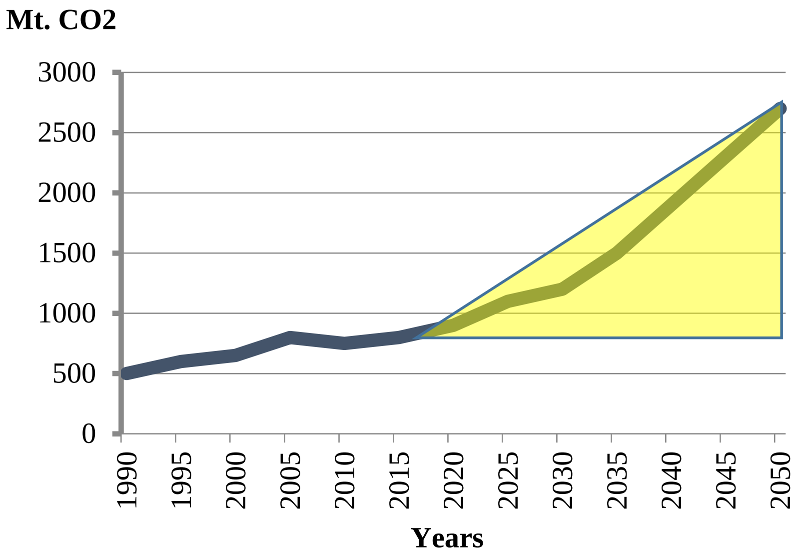

Figure 3. CO_2 emissions from global shipping [17]

Liquid Petroleum Gases (LNG) as ship propulsion fuel

Most of the ships use HFOs as propulsion fuel on ships cause of its high efficiency. However, HFOs are the main figure of environmental danger exposing greenhouse emissions. Recent studies show that fuel consumption in the ECAs is presumed at nearly 30-50 million tons of fuel per year. On the other hand, if more areas are added in the ECAs in the future that amount of fuel will raise significantly [7].

Besides, international legislations enforce shipping companies to use low sulfured fuels onboard. That’s why LNG has become serious alternative fuel onboard. Although HFOs have low cost characteristic, cause of its chemical composition they include high levels of asphalt, carbon residues and metallic compounds. Therefore, burning of HFOs in marine diesel engines induces remarkable amounts of air pollutants such as NOx, SOx, CO and CO_2 [8]. As a highly alternative fuel, LNG has many advantages about protecting both human health and environment. Nevertheless, LNG has lower carbon content than HFOs and provides more efficient burning inside marine diesel engines. It eliminates completely SOx and PM emissions and reduces NOx emission of up to 85%. In addition, reducing CO2emissions by at least 20% is possible by using LNG onboard as ship propulsion fuel [7]. On the other side, LNG use onboard has disadvantages too. Firstly, investment cost of LNG system is high. The other risk is about safety. LNG is stored at very high pressure. Unconfined spills of LNG expand and boil at a very high rate therefore if any gas leakage occurs; explosion risk is always possible [9].Cargo handling is another struggle. Depending on any chemical reaction between cargo and LNG, risky cargos loaded far away from LNG system. Besides that lack of LNG infrastructures in main ports of South Europe and limited gas fuel engine manufacturers are other mainly difficulties to meet face [10].

According to Figure 4 below, it can be said that world has enough LNG reserves as much as HFOs. This conclusion makes sense if the whole global shipping companies to begin using LNG instead of HFOs.

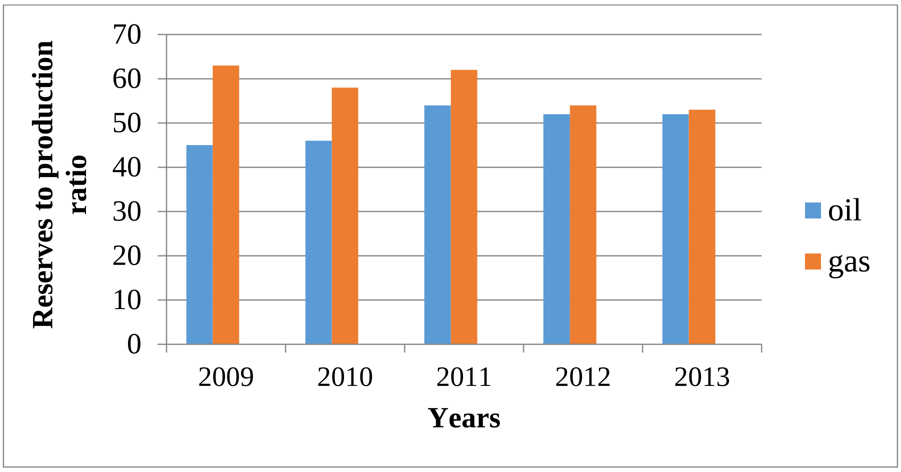

Figure 4.LNG and oil reserves [17]

The upcoming international legislations about reducing sulfur content in the fuel will increase the cost of the fuel. In the bunker market, low sulfur fuel oil (LSFO) is more expensive than heavy fuel oil. Also NOx emissions from ships must be reduced so there are variable systems for the purpose of mitigating NOx gases including Internal Engine Modifications (IEM), Direct Water Injection (DWI), Humid Air Motors (HAM), Exhaust Gas Recirculation (EGR) and Selective Catalytic Reduction (SCR) [11]. However, these systems are made by modification onboard and need necessary spaces so they can cause extra cost. To ensure the present and future NOx regulations, LNG is only solution complying with Tier III. Otherwise, ships have to install systems to mitigate NOx (like selective catalytic reduction (SCR) systems) if still go on running with MDO or HFO in any case [12].

CASE STUDY: LNG AS PROPULSION FUEL ON MODEL RO-RO SHIP

According to May 2015 data, total 63 LNG-fuelled ships (excluding LNG carriers) already sail around worldwide. However, 76 new buildings LNG fuelled ships' orders were confirmed. One Ro-Ro ship and three Ro-Pax ships are operation at seas. At the same time four Ro-Ro ships and three Ro-Pax new buildings have been ordered [7].

The standard Ro-Ro ship propulsion system arrangement contains two pairs of engines of the four-stroke type for the purpose of high maneuvering capability which are connected to the each gearbox for acting the two ship propellers [10].Model Ro-Ro ship has two oil-fuelled 8100 KW powered main engines. In order to obey upcoming IMO Tier III regulations, necessary cost determination is required to find out whether oil-fuelled with SCR system or LNG as propulsion fuel is more attractive. Model ship one-year total fuel consumption and bunker market prices including fuel oil, LNG, and 40% urea solution are parameters of this study. Investment and operational costs of SCR system and also LNG system costs were neglected. In accord with previous studies about SCR system costs, the investment costs of SCR system vary between € 15 and € 70 per kW engine power. Investment cost also depends on engine size and number of main engines existing onboard. In addition to investment cost, running and maintenance costs vary between € 5 and € 7 per MWh engine power[13].Model Ro-Ro ship', sailing around Turkey-Italy-France route, year of 2014 fuel consumption values was given Table 2 below. Model ship has two pieces four stroke engines - MAK 9M43- with 8100 KW powered each one.

Table 2. Model ship's fuel consumption (2014) [14]

Fuel consumption (Total year)	Hours at sea (Total year)
13741,2 tones	6325,2 hours

Table 3. Bunker market prices (2014) [15].

Fuel type	Average market price (USD)
HFO 380 cst (3.5 % sulfur)	632,44 USD/ton
HFO 380 cst (1,0 % sulfur)	713,11 USD/ton
HFO 380 cst (0,1 % sulfur)	946,55 USD/ton
LNG	14,50 USD/MM Btu
40% urea solution	800,00 USD/ton

After necessary conversions made from MM Btu into ton (Table 3), then it could say that one cubic meter of LNG equivalent to 0.5104 tons of fuel oil[16]. According to 2014 market price;
1 ton LNG = 574, 96 US dollar.

Different studies have shown some information about LNG power capacity. In order to produce same power as diesel provides from 1 gallon, 1, 7 gallons of LNG is required. On the other hand, both lower costs of LNG supply and lower emissions make LNG more suitable fuel for ships [17].

Study by *Tzannatos et al. (2015)*about Greek Island ferries, proved that marine engines consumes less 23% LNG fuel than the same marine engine working with oil fuelled. Their study was built up on sea trials of ferries. The oil-fuelled engine consumed 80.2 tons of fuel oil where LNG-fueled engine consumed 60.1 tons of fuel during per those sea trials. In the matter of specific consumption at sea, oil engine and gas engine values are 213 g/kWh and 165 g/kWh, respectively[18].Another study by Germanischer Lloyd (GL) and MAN, shown on Figure 5presented specific consumption values of HFO and LNG on MAN 2 stroke diesel engine (52 MW). Results were too similar like study of *Tzannatos et al. (2015).* There was 23% difference ratio of specific fuel consumption which fuel was more than LNG.

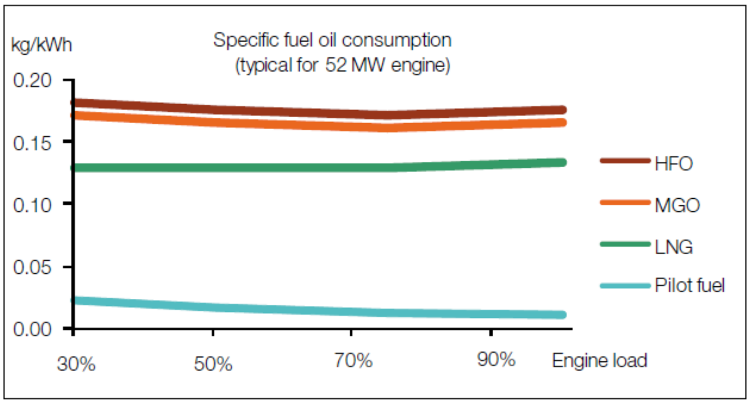

Figure 5. MAN 52MW engine fuel test results [19].

Calculation of both HFO and LNG bunker costs

All parameters, effecting bunker cost of both LNG and HFO with SCR system, was given below Table 4.

Table 4. Comparison of HFO and LNG cost

	HFO with SCR system	**LNG**
Bunker Price (HFO, USD/ton)	713,11	574,96
Urea Price (USD/ton)	800,00	
Yearly Total Consumption (/ton)	13741,20	13741,20
Yearly Total Hours at sea (hour)	6325,20	6325,20
Engine power output (KW) (at %75 load)	14600	14600
Total fuel cost (USD)	**11.031.277,28**	**6.083.493,071**

Assuming model ship with low sulfur HFO with SCR system; the formula should be included with urea consumption and low sulfur HFO (1, 0 % sulfur) consumption.

$TC = Fc + Uc$

Where Fc, Uc are fuel cost and urea cost, respectively.

$$Fc = (713{,}11).(13741{,}2) = 9.798.987{,}132\ US\ dollars$$

2014 year HFO with 1, 0 % sulfur average market price is 713, 11 US dollar/ton

$$Uc = (14{,}6).(15).\frac{1{,}112}{1000}.(6325{,}2).800 = 1.232.290{,}644\ US\ Dollars$$

(Model ship has two main engines with total 16200 KW engine power, but according to average engine loads (75% engine load) of model ships' main engines total output power is 14,600 KW. The typical urea consumption for reducing the NOx emissions from the IMO Tier 2 to the IMO Tier 3 NOx level is 15 l/MWh at 75% engine load [20].

If we mention about other data about formula, 40% urea solution density is 1,112 g/ml and total hours at sea of model ship in the year of 2014 is 6325,2 hours. 2014 year 40% urea solution market price is 800 US dollar/ton.

Then total 2014 year of fuel oil consumption with SCR system is;

$Total\ year\ bunker\ cost\ (Tc) =\ Fc + Uc = 11.031.277{,}78\ US\ Dollars$

Assuming model ship with LNG fuelled ship, then the bunker cost formula is;

$TC = Fc$

$Fc = (0{,}77).(574{,}96).(13741{,}2) = 6.083.493{,}071\ US\ dollars$

Previous studies had proven that LNG fuelled marine engine consumed 23% less amount of LNG, as comparing with same marine engine working with HFO fuel. That's why "0, 77" constant exists on formula. 2014 year LNG market price is800 US dollar/ton and total HFO consumption of model ship in the year of 2014 is 13741, 2 tons.

Bunker costs analyze results showed that using LNG as fuel onboard instead of low sulfur HFO with SCR system makes approximately 5 million USD dollars savings at 2014 year.

CONCLUSION

Upcoming IMO environmental regulations about decreasing NOx, SOx and CO_2 emissions shipping companies were enforced to take precautions such as using low sulfur SCR system, exhaust gas recirculation system (EGR) or LNG system as ship fuel. This study was based on analyzing model ship bunker consumption comparing with LNG and low sulfur HFO with SCR system. Then bunker costs of both LNG and SCR system were compared. As a result of study, LNG has remarkable advantage on bunker costs in comparison of SCR system. However, other costs including investment costs and maintenance costs of both LNG and SCR system were neglected. As an alternative fuel, LNG has more attractive than other fuels. On the other hand, using low sulfur HFOs onboard is risky. Because, at refinement process catalytic fines, named Aluminum (Al) and Silicon (Si), are used in order to mitigate sulfur level. Those catalytic fines stay in fuel and causes highly wearing of engine parts i.e. cylinder liner, piston, and fuel pump. Despite of having many advantages, LNG system has some problems. Especially main ports in Europe, LNG facilities are not adequate to meet ships requirement. Another main difficulty is about well-trained qualified personnel. LNG system is getting more popular for shipping year by year, at the same time there is still lack of qualified personnel both working onboard and at LNG facilities.

This study could be improved by considering all parameters costs of LNG and SCR system including investment costs, running costs and maintenance costs. The Discount Cash Flow Method (DCFM), an appraisal method used to estimate the attractiveness of an investment opportunity, may be used for proper decision. Bunker market prices are another issue as well. For example, it is anticipated that future prices of LNG would increase if LNG demand raises at same rate. Herewith, analyzing sensitivity of fuel costs would improve this study.

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HUMAN FACTOR IN MARITIME TRANSPORTATION MANAGEMENT SYSTEM: THE ANALYSIS OF SHIP ACCIDENTS IN THE STRAIT OF İSTANBUL CAUSED BY HUMAN ERROR

Nur Jale ECE[1]

ABSTRACT

Maritime transportation is the backbone of economic development and world trade. Maritime transportation management system includes a set of procedures related ships, cargo and ports. Safety management in maritime transportation is one of the imperative topics of the shipping industry and marine environment. The principle factor in maritime safety is the human factor which influences maritime safety, security and marine environment. The maritime industry has suffered from accidents that caused by the human error as the primary cause. This paper aims to define maritime transportationmanagement and safety management system;to investigate human factor,the major factors influencing human behavior, the causes of human error contributing to ship accidents; to investigate physical specifications,maritime traffic and regulations of the Strait of İstanbul and major accidents occured in the Strait,to analyse human error contributing to ship accidents have occured in the Strait of İstanbul during 1982 and 2015 by using Pearson Chi Square Analysis (χ2), Cramer's V Test and Spearman's Rho Test. The paper's results as follows; human error remains the most important factor in marine accidents, human error mainly occurred in collisions and respectively grounding and ships without engagement of pilots caused most of the accidents. There is a statistical significant relationship between human error and the years, months, hours, types and region of accidents, ships without engagement of pilots. A general evaluation was conducted and suggestions are proposed to minimize human errors in maritime transportation to ensure safety of navigation and marine environment.

Key Words: Human factor, human error, maritime safety, maritime transportation, ship accidents, the Strait of İstanbul

INTRODUCTION

Maritime transportation is an important factor of economic development and world trade. Around 90% of world trade is conducted by the shipping industry. Maritime transportation system includes management of ships, ports and cargoes.The system covers the components of safe, secure, efficient and marine environmental protection.Safety management in maritime transportation is one of the imperative topics of the maritime industry and marine environment. The principle factor in maritime safety is the human factor which influences maritime safety, security and marine environment protection. The maritime industry has suffered from accidents that caused by the human error as the primary cause. Collisions which are the dominant type of ship accidents are also mostly caused by human error. International Maritime Organization focuses stronger on the human element to improve safety at sea and adopted some resolutions on the human element vision to prevent maritime accidents includes human factors.The Strait of İstanbul is one of the most narrow and risky

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waterways in the world. The Strait has also excessive traffic density. The ships carrying dangerous cargo is a serious threat for safe passage and environment. Many accidents have occured in The Strait of İstanbul which caused serious damage to the lives of crew, cargo and the marine ecosystem**.** In the study, Section 2 covers maritime transportation management and safety management system, human factor, the major factors influencing human behavior, the causes of human error contributing to ship accidents. Section 3 includes physical specifications, maritime traffic and regulations of the Strait of İstanbul and major accidents occured in the Strait, Section 4 presentsthe statistical methods and analysis results concerning human error contributing to ship accidents occured in the Strait of İstanbul in 1982-2015. In conclusion a general evaluation was conducted and suggestions are proposed to minimize human errors in maritime transportation to ensure safety of navigation and marine environment.

HUMAN FACTOR IN MARITIME TRANSPORTATION MANAGEMENT SYSTEM

Maritime transportation management system comprises of coaction and management of its sub-systems such as ships, ports, passengers and/or goods. The objective of the system provides the efficiency and safe movement of ships and cargoes through the destination ports [1]. The quality, efficiency and safety are the most important factors in terms of maritime transport. A safety management system is the organisation and arrangements organized by a transport operator to provide the safer management of its operations to reduce the accidents [2]. Human factor elements within the maritime transportation and safety management system consists of environmental, organisational and job factors [2]. Maritime accidents adversely affect both human and marine environments [3]. IMO reported that more than 75% of the ship accidents worlwide were due to human error [4]. The human role is vital in the shipping industry; ships require well trained and motivated crew in order to operate safely and efficiently[5]. "Salvendy (1997) has defined *"Human factor as a discipline regarding human abilities and limitations in relation to the design of systems, organizations, tools etc. Important parameters are safety, efficiency and comfort"[6].*

The major factors influencing human behavior are mainly composed of psychological and physiological factors, technological and skillful factors, environmental factors, management factors and organizational factors[7,8]. *"Senders and Moray (1991) has defined "Human error is described as a result of observable behavior originated from psychological processes on different levels such as, perception, attention, memory, thinking, problem solving, decision making, evaluated against some performance standards, initiated by an event in a situation where it was possible to act in another way considered to be right"[9].* There are many factors influencing human error. The major factors effects the role of human competence, attitude, motivation, life style, safe and secure working environment, self-actualization, moral values [6]. The causes of human error contributing to ship accident slack of situation awareness and complacency, fatigue, lack of experience, skill, abilities, alertness and memory, absence of p**e**rception, lack of motivation, incorrect decision by the master or crew, an improperly performed action, insufficient communication and knowledge, poor design of automation, economic pressure, disase, equipment design error, bad wheather conditions, organizational factors such as crew organization and company policies or practices[10].

Safety measures are therefore essential in preventing accidents; it is vital to learn lessons from previous accidents to safeguard life, property, and the environment at sea. The IMO takes previous maritime accidents into account when setting rules for ensuring safety at sea [3]. Elements of a Safety Management System are; a safety policy, organisational arrangements, a safety plan, means of reviewing safety and a feedback loop to enhance safety performance [11]. *"The IMO's Code for Investigation of Marine Casualties and Incidents defines marine accidents as, an occurrence or* *event being caused by, or in connection with, the operation of a ship by which the ship or any person is imperiled, or as a result of which serious damage to the ship or structure or the environment might be caused"[*5,12]. Maritime accidents may involve more than one factor, such as human errors, mechanical failures, adverse weather conditions, and traffic density. Maritime accident analyses aim to describe the root reasons of accidents and recommend effective ways to protect similar accidents. *"The IMO's Resolution A.947(23) for "Human Element Vision, Principles And Goals For The Organization" defines the human element as a complex multi-dimensional issue that affects maritime safety, security and marine environmental protection"* [12].

PHYSICAL CHARACTERISTICS, MARITIME TRAFFIC AND MAJOR ACCIDENTS OF THE STRAIT OF İSTANBUL

The Strait of İstanbul which links the Black Sea to the Sea of Marmara is 31 km long, 1,6 km wide and depth of the Strait varies from 13 to 110 m [13]. The factors contributing to accidents in the Strait of İstanbul are narrowness, deep, sharp turns and currents reaching 7 or 8 knots and bad wheather conditions contributes to marine accidents in the Strait. The Strait of İstanbul have also valuable historical and cultural values and a biological corridor for the different marine species [14,15].

The total number of vessels passed through the Strait of İstanbul is 46.532 of which 19 percent was tankers in 2013, 45.529 ships of which 19 percent was tankers in 2014, 43.544 ships of which 20 percent was tankers in 2015 [16]. Many accidents which caused serious damage to human life, cargo and environment. The Montreux Convention which signed on 20 July 1936 regulates the regime of the Turkish Straits. The Traffic Separation Schemes have introduced in accordance with Rule 10 of the Convention on the *"International Regulations for Preventing Collisions at Sea (COLREG 72)"* in 1994 to enhance navigational safety [13]. Maritime Traffic Regulations For The Turkish Straits and the Marmara Region has applied to all ships navigating in the Turkish Straits to provide safety of navigation, life and property and to protect the environment. In 1998, the regulation was revised and reviewed regulation *"Maritime Traffic Regulations for the Turkish Straits"* was adapted [14]. Turkish Straits Vessel Traffic Service (VTS) was established in 31 December 2003 to ensure safety of navigation and environment [13,14,15,17]. The accidents result in human life, cargo damage or loss, enviroment disaster and pollution [18]. Many accidents have occurred in the Strait till today. Independenta tanker collied with a Greek freighter at southern enterence of the Strait in 1979. The Independenta burned for weeks and 95.000 tons of crude oil spilled, 43 crew members lost their life. Nassia tanker collied with a cargo ship and causing the release of 95.000 tonnes crude oil and 29 crew members lost their life [13]. The number of accidents decreased after the adaptation of Regulations, TSS and VTS [19].

THE ANALYSIS OF SHIP ACCIDENTS IN THE STRAIT OF İSTANBUL CAUSED BY HUMAN ERROR

Material and methods

It has been created the ship accidentsdata base occured in the Strait of İstanbul from "right-side up" period 1982 to 2015 [20,21,22,23]. The ship accidents data base occured in the Strait contains 4.944 categorical data involving the years, months, hours, types and zones of accidents, ships without engagement of pilots. The Chi-Square (χ^2) Test was used to define if there is a statistically significant relationship between expected and observed accident data between the years 1982-2015 by using SPSS Statistical Package Programme SPSS 17.00. The asymptotic significance level was set at 5% [24,25]. The χ^2 formula is given as Equation (1):

$$\chi^2 = \sum^{k} \underline{(n_i - np_i^{(0)})^2} = \sum^{k} \underline{(\text{Observed Value -Expected Value})^2} \quad (1)$$

i=1 $np_i^{(0)}$ i=1 ExpectedValue

Cramer's V Test which is used to determine the association between nominal variables for strength test for the Chi-square [26]. The formula for the Cramer's Vtest statistic is given as Equation (2) [27]. Spearman's Rank correlation coefficient (Spearman's Rho) is used to measure the strength between two variables. Spearman's Rho Test Formula is given as Equation (3) [28].

$$V = \sqrt{\frac{\chi^2}{n\ (k-1)}} \qquad (2) \qquad\qquad r_s = 1 - (6\sum d^2)/\ n3\text{-}n \qquad (3)$$

Cramer's V value dispreads between 0 and 1. The value of Cramer's V are; 0.10-0.20 weak association, 0.20-0.40 moderate, 0.40-0.60 relatively strong association, 0.60-0.80 strong association, 0.80-0.10 very strong association between the variables [29]. Spearman's Correlation Coefficient (Spearman's Rho) must lie between -1 and 1 where the value r = 1 means a perfect positive correlation and the value r = -1 means a perfect negative correlation [28]. The value of Spearman's Rho are; 0.10-0.19 very weak association, 0.20-0.39 weak, 0.40-0.59 moderate, 0.60-0.79 strong association, 0.80-0.10 very strong association between the variables [28].

Frequency distrubution, Chi Square Test (χ^2), Cramer's V Test and Spearman's Rho Test between accident year and reason of accident

The most of the accidents occured in the period of 1982-1993 (340 accidents) and respectively in 1994-2003 (266 accidents), 2004-2015 (227 accidents) as shown in Table 1. The most of the accidents occured due to human error (25,6%) in the period 1982-2015.

Table 1. Cross-Tabulation Between Accident Year And Reason Of Accident

Accident year/ Reason of accident	Count % within reason of accident	1982-1993	1994-2003	2004-2015	Total
Unknown	Count	164	92	74	330
	%	49,7%	27,9%	22,4%	100,0%
Human error	Count	67	98	48	213
	%	31,5%	46,0%	22,5%	100,0%
Bad wheather conditions&current	Count	50	23	30	103
	%	48,5%	22,3%	29,1%	100,0%
Breakdown	Count	14	9	56	79
	%	17,7%	11,4%	70,9%	100,0%
Others	Count	45	44	19	108
	%	41,7%	40,7%	17,6%	100,0%
Total	Count	340	266	227	833
	%	40,8%	31,9%	27,3%	100,0%

Hypotesis; H_0: There is not a relationship between accident year and reason of accident and H_1: There is a relationship between accident year and reason of accident. All individual expected counts are more than 1. The Chi Square value is 117,337 and minimum expected count is more than 1 (21,53) and 0,0% of expected counts are less than 5 (no more than 20% of expected counts should be less than 5) as shown in Table 2. Hence, Chi Square Test was used safely.

Table 2. The Chi Square, Cramer's V and Spearman's Rho Tests Between Accident Year And Reason Of Accident

	Value	df	Asymptote Significance (2 sided)
Pearson Chi-Square	117,337 [a]	8	0,000
Likelihood Ratio	105,868	8	0,000
Linear-by-Linear Association	32,517	1	0,000
Cramer's V	0,265		0,0 (Approx. sig.)
Spearman's correlation	0,174		0,0(Approx. sign.)
N of Valid Cases	833		

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 21,53.

According to the result of Chi Square Test, the Null Hypothesis (H_0) is rejected due to P-value=0 < α =0.05 (significance level) as shown in Table 2. Thus, there is a statistical relationship between accident year and reason of accident. Cramer's V value (26,5%) confirms that there is a moderate association between accident year and reason of accident. The Spearman correlation coefficient value of 0,174 confirms that there is a very week association between accident year and reason of accident.

Frequency distrubution, Chi Square Analysis ($\chi 2$), Cramer's V Test and Spearman's Rho Test between accident month and reason of accident

The most of the accidents occured in December-February (242 accidents), respectively September-November (210 accidents) and June-August (205 accidents) for the period 1982-2015 as shown in Table 3. The most of the accidents occured due to human error in December-February (67 accident). H_0 is rejected due to P-value=0 < α =0.05 as shown in Table 3. There is a statistical relationship between accident month and reason of accident. The Chi Square value is 50,457, Cramer's V value (14,2%) confirms that there is a weak association between accident month and reason of accident. The Spearman correlation coefficient value of -0,051 confirms that there is a negative correlation between accident month and reason of accident.

Table3. Cross-Tabulation Between Accident Month And Reason Of Accident

Accident month/ Reason of accident	Count % within reason of acc.	Dec-Feb	March-May	June-August	Sept-Nov	Total
Unknown	Count	84	68	78	100	330
	%	25,5%	20,6%	23,6%	30,3%	100,0%
Human error	Count	67	50	47	49	213
	%	31,5%	23,5%	22,1%	23,0%	100,0%
Bad wheather conditions&current	Count	40	23	15	25	103
	%	38,8%	22,3%	14,6%	24,3%	100,0%
Breakdown	Count	9	12	38	20	79
	%	11,4%	15,2%	48,1%	25,3%	100,0%
Others	Count	42	23	27	16	108
	%	38,9%	21,3%	25,0%	14,8%	100,0%
Total	Count	242	176	205	210	833
	%	29,1%	21,1%	24,6%	25,2%	100,0%

χ^2 = 50,457, P = 0,000, Likelihood Ratio =50,003, P= 0,000, Cramer'V : 0,142,Spearman's Correlation: -0,051.

Frequency distrubution, Chi Square (χ2), Cramer's V and Spearman's Rho Tests between accident hour and reason of accident

The most of the accidents occured in the hours between 20:00 - 24:00 (124 accident), respectively and 08:00 - 12:00 (114 accident) and 12:00 - 16:00 (109 accident) for the period 1982-2015 as shown in Table 4. The most of the accidents occured due to human error in 20:00 - 24:00 (46 accidents) and respectively in 24:00 - 04:00 (37 accidents), 08 – 12.00 (32 accidents). H_0 is rejected due to P-value=0 < α =0.05 as shown in Table 4. Thus, there is a statistical relationship between accident hour and reason of accident. The Chi Square value is 145,527, Cramer's V value is 20,9% confirms that there is a moderate association between accident hour and reason of accident. The Spearman correlation coefficient value of 0,227 confirms that there is a weak association between accident hour and reason of accident.

Table 4. Cross-Tabulation Between Accident Hour And Reason Of Accident

Accident hour/ Reason of accident	Count % within accident hour	Unknown	Human error	Bad wheather cond.&current	Breakdown	Others	Total
Unknown	Count	139	18	12	6	16	191
	%	72,8%	9,4%	6,3%	3,1%	8,4%	100,0%
24:00 - 04:00	Count	22	37	10	12	15	96
	%	22,9%	38,5%	10,4%	12,5%	15,6%	100,0%
04:00 - 08:00	Count	32	25	22	7	13	99
	%	32,3%	25,3%	22,2%	7,1%	13,1%	100,0%
08:00 - 12:00	Count	31	32	20	13	18	114
	%	27,2%	28,1%	17,5%	11,4%	15,8%	100,0%
12:00 - 16:00	Count	44	25	9	13	18	109
	%	40,4%	22,9%	8,3%	11,9%	16,5%	100,0%
16:00 - 20:00	Count	29	30	17	12	12	100
	%	29,0%	30,0%	17,0%	12,0%	12,0%	100,0%
20:00 - 24:00	Count	33	46	13	16	16	124
	%	26,6%	37,1%	10,5%	12,9%	12,9%	100,0%
Total	Count	330	213	103	79	108	833
	%	39,6%	25,6%	12,4%	9,5%	13,0%	100,0%

χ^2 = 145,527, P = 0,000, Likelihood Ratio =144,720, P= 0,000, Cramer'V:0,209,Spearman's Correlation: 0,227.

Frequency distrubution, Chi Square (χ2), Cramer's V and Spearman's Rho Tests between type of accident and reason of accident

The most of the accidents were collision (366 accidents) and respectively grounding (166 accidents), stranding/contact (131 accidents) for the period 1982-2015 as shown in Table 5. Among accidents, collision is the most occurred accident type [14].

Table 5. Cross-Tabulation Between Type of Accident And Reason Of Accident

Type of accident/ Reason of accident	Count % within reason of acc.	Unknown	Collision	Grounding	Stranding/ Contact	Others	Total
Unknown	Count	11	158	44	55	62	330
	%	3,3%	47,9%	13,3%	16,7%	18,8%	100,0%
Human error	Count	3	116	40	38	16	213
	%	1,4%	54,5%	18,8%	17,8%	7,5%	100,0%
Bad wheather conditions&current	Count	1	50	31	9	12	103
	%	1,0%	48,5%	30,1%	8,7%	11,7%	100,0%
Breakdown	Count	0	14	21	10	34	79
	%	,0%	17,7%	26,6%	12,7%	43,0%	100,0%
Others	Count	3	28	30	19	28	108
	%	2,8%	25,9%	27,8%	17,6%	25,9%	100,0%
Total	Count	18	366	166	131	152	833
	%	2,2%	43,9%	19,9%	15,7%	18,2%	100,0%

χ^2 = 115,585, P = 0,000, Likelihood Ratio =121,824, P= 0,000, Cramer'V: 0,186, Spearman's Correlation: 0,146.

All types of accidents are mostly caused by human error. The most of the collisions occured due to human error (116 accidents) in this period**.** The most of the groundings occured due to human error (40 accidents). H_0 is rejected due to P-value=0 < α =0.05 as shown in Table 5. Thus, there is a statistical relationship between accident type of accident and reason of accident**.** The Chi Square value is 115,585, Cramer's V value (18,6%) confirms that there is a weak association between type of accident and reason of accident. The Spearman correlation coefficient value of 0,146 confirms that there is a very weak association between type of accident and reason of accident.

Frequency distrubution, Chi Square (χ2), Cramer's V and Spearman's Rho Tests between zone of accident and reason of accident

The Strait of İstanbul is divided four regions due to many observation numbers at the accident regions. Region I: Haydarpaşa-Eminönü and Ortaköy-Çengelköy, Region II: Ortaköy-Çengelköy and Yeniköy-Paşabahçe, Region III: Yeniköy-Paşabahçe and Rumeli Kavağı-Kavak Burnu, Region IV: Rumeli Kavağı-Kavak Burnu and Anadolu Feneri-Rumeli Feneri. The most of the accidents occured in Region I (298 accidents) due to domestic traffic congestion and respectively in Region II (223 accidents) due to the currents, in Region III (122 accidents) and in IV. Region (91 accidents) for the period 1982-2015 [14]. The accidents occured in Regions I, II and III are mostly caused by human error. The most of the accidents occured due to human error (98 accidents) in Region I, respectively in Region II (54 accidents), in Region III (31 accidents) and Region IV (20 accidents) as shown in Table 6.

Table 6. Cross-Tabulation Between Zone of Accident And Reason Of Accident

Zone of accident/ Reason of accident	Count % within reason of acc.	The Strait of İstanbul	Region I	Region II	Region III	Region IV	Total
Unknown	Count	75	121	63	43	28	330
	%	22,7%	36,7%	19,1%	13,0%	8,5%	100,0%
Human error	Count	10	98	54	31	20	213
	%	4,7%	46,0%	25,4%	14,6%	9,4%	100,0%
Bad wheather conditions&current	Count	5	30	51	16	6	108
	%	4,6%	27,8%	47,2%	14,8%	5,6%	100,0%
Breakdown	Count	3	22	26	21	31	103
	%	2,9%	21,4%	25,2%	20,4%	30,1%	100,0%
Others	Count	6	27	29	11	6	79
	%	7,6%	34,2%	36,7%	13,9%	7,6%	100,0%
Total	Count	99	298	223	122	91	833
	%	11,9%	35,8%	26,8%	14,6%	10,9%	100,0%

χ^2 = 139,985, P = 0,000, Likelihood Ratio =127,894, P= 0,000, Cramer'V: 0,205, Spearman's Correlation: 0,236.

H_0 is rejected due to P-value=0 < α =0.05 as shown in Table 6. There is a statistical relationship between zone of accident and reason of accident as shown in Table 6. The Chi Square value is 139,985, Cramer's V value (20,5%) confirms that there is a moderate association between zone and reason of accident. The Spearman correlation coefficient value of 0,236 confirms that there is a weak association between zone of accident and reason of accident.

Frequency distrubution, Chi Square (X2), Cramer's V nd Spearman's Rho Tests between ships without engagement of pilot and reason of accident

A total of 78,3% of the ships involved in the accident were without engagement of pilot, 21,7% of the ships involved in the accident were with engagement of pilot. The ratio of human error in ships without engagement of pilot involved in the accident was 74,2%.

Table 7. Cross-Tabulation Between Ships Without Engagement Of Pilot And Reason Of Accident

Ships with/without engagement of pilot/Reason of accident	Count % within reason of acc.	Ships without engagement of pilot	Ships with engagement of pilot	Total
Unknown	Count	295	35	330
	%	89,4%	10,6%	100,0%
Human error	Count	158	55	213
	%	74,2%	25,8%	100,0%
Others	Count	199	91	290
	%	68,6	31,4%	100,0%
Total	Count	652	181	833
	%	78,3%	21,7%	100,0%

χ^2 = 53,256, P = 0,000, Likelihood Ratio =44,718, P= 0,000, Cramer'V: 0,253, Spearman's Correlation: 0,231.

H_0 is rejected due to P-value=0 < α =0.05 as shown in Table 7. There is a statistical relationship between ships without engagement of pilot and reason of accident. The Chi Square value is 53,256, Cramer's V value is 25,3% confirms that there is a moderate association between ships without engagement of pilot and reason of accident. The Spearman correlation coefficient value of 0,231 confirms that there is a weak association between ships without engagement of pilot and reason of accident. IMO Resolutions encouraging the engagement of pilots on board ships in certain locations [30].

CONCLUSION

Maritime transportation management system depends on interaction and management of ports, passengers and goods covers the components of safe, secure, efficient and marine environmental protection. Safety management in maritime transportation has vital importance on maritime industry and marine environment. The principle factor in maritime safety is the human factor that influences safety navigation, human life and marine environment protection.The growing number of the ships and expecially tankers in the Strait of İstanbul have become a serious threat to safety of navigation, human life and environment.This paper's findings concerning accidents occured in the Strait of İstanbul in 1982-2015 consist of the following; the most of the accidents occured in the period of 1982-1993. After adaptation of The Maritime Traffic Regulations, TSS and VTS, the accidents in the Strait of İstanbul have dropped dramatically. All types of accidents are mostly caused by human error and human error mainly occurred in collisions and respectively grounding in the period 1982-2015.The most of the accidents occured due to human error in December-February. The most of the accidents occured due to human error in the hours 20:00 - 24:00. The most of the accidents occured in Region I (Haydarpaşa-Eminönü and Ortaköy-Çengelköy). The accidents occured in Regions I, II and III (Haydarpaşa-Eminönü and Anadolu Feneri-Rumeli Feneri) are mostly caused by human error. A total of 78,3% of the ships involved in the accident were without engagement of pilot. The ratio of human error in ships without engagement of pilot involved in the accident was 74,2%. There is a statistical significant relationship between human error and the years, months, hours, types, regions of accidents, ships without engagement of pilots involved in the accident. The results of the analysis indicate that the primary reason of accidents was human error and most of the ships involved in the accident have not taken a pilot. The pilots are at the most importance for navigation safety and reducing human error and the ships without engagement pilots substantially increase the accidents risks in the Strait. Therefore, the use of pilots on board ships should be encouraged to ensure innocent passage, human life and marine enviromental protection. Furthermore, Safety Management System for the Strait of İstanbul should be build up including safety policy, organisational arrangements, a safety plan, safety regulations, risk assessment and improve safety measurements to provide navigation and environmental safety.

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A STUDY FOR UNDERSTANDING CYBER SECURITY AWARENESS AMONG TURKISH SEAFARERS

Pelin Bolat[1], Gizem Yüksel[2], Selen Uygur[3]

ABSTRACT

From the perspective of cyber security, ships are one of the critical structures as they are technologically equipped for safe navigation. As every system that is controlled and programmed through IT technologies, ships can also encounter vulnerabilities in cyber space. These vulnerabilities can be turned into cyber threats or cyber-attacks by cyber criminals or human factor based errors. In the literature, it is seen that initial cyber-attacks against ships were eventuated through ship network by manipulation of AIS, GPS, ECLIS, RFID and radar system. Illegal access to ship network can be achieved by the ship crew's misuse of network. Accordingly, lack of IT knowledge and cyber risk prevention measures on a board can obstruct safe navigation and can be resulted with catastrophic events. Based on facts above, the seafarer cyber security awareness has arisen as an important topic for maritime security. In this context, it is purposed to analyze the worldview of Turkish seafarers to ship cyber security and their cyber security awareness level by collecting data with surveys and interviews. It is also aimed to introduce cyber security literature for ship domain throughout the study.

Keywords – cybersecurity, maritime domain, situational awareness

INTRODUCTION

“Cyber" subject prefix is one of the most widely used concept in the preceding today's world. “Cyber” was derived from “kybernetes”, a Greek origin word, which means capable for judgement or management. It is a common term used for information technology, computer and internet environment. Therefore, cyber security simply can be defined as taking the necessary measures for the protection of these information environment. International Telecommunication Union (ITU, 2013) describes cyber security concept as the hardware, policy, security concept, protection measures, guidelines, risk management approaches, measures, training, applications that can be used for protection of values of institution, individuals and cyber space. Turkey's National Cyber Security Strategy and Action Plan 2013-2014 (TUSGS, 2013) defines cyber security as a concept that includes protection of the information system which creative cyber space from the IT attacks, guaranteeing the confidentiality, integrity and accessibility of processing information, identification of cyber-attacks and security incidents, the deployment of response mechanisms to these determination, and then being returned back to the system of pre-conditions experienced cyber security incident. However, the literature seems to not reach a consensus on the concept of cyber security. Although cyber security has a similar use with information security or information and communication technologies security in

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some studies, it can be said that cyber security need to be addressed as opposed to two security definitions. For example, according to Solms ve Nierk's studies (2013), cyber security does not cover all space of the information security, but Information and Communication Technology (ICT) cover all space of the information security. Solms ve Nierk brings forward that the reason of addressing information and communication technologies into the cyber security concept is that attack methods is vulnerabilities arised from ICT (Solms ve Nierk, 2013).

Computer systems has emerged as system which interacts with technology and human factor and includes potential threats. these systems which have inherent confusion should be evaluated in circles they are available. For example, if we categorize the technology according to the applied fields, technology can be grouped into four categories namely land, air, sea and space. When examined under this heading, it would not be wrong to say that cyber security parameters become different under each heading.

When examining the literature, it has been seen studies in the land, air and marine area related to cyber security. When examined this study it is found that cyber security study related to land and air technological systems is more than a sea area.

Marine transportation system has a structure which cover the critical process for the sustainability of the world economy. An important part of international trade is done by sea transport. One possible glitch in the maritime transport system will affect the entire supply chain and can be costly cause damage. In this respect, maritime sector has low cyber security awareness but has high cyber security risks. In the international area, major organizations and companies such as European Union (AB), DNV AND BIMCO step with meetings, workshops or workbooks in the maritime sector. On the national level it has not been seen in a special cyber security work for the maritime industry in Turkey. The aim of this study in this regard has emerged.

Our study aimed to make a cyber security situation analysis on the ship based cyber space. Besides that it aimed to contribute to the national maritime literature as a first study on this subject by the interpretation of cyber security concept in the maritime area, examining cyber security concept on the international and national levels. In this context, the work is composed of six sections. After scope and objectives of thesis is explained in the introduction section, examples are given in the literature. In the second part, cyber security parameters is presented by supporting with international reports. The third part is designed as that cyber security which is examined specifically to ports and ships in the maritime sector, maritime sector which is exposed to cyber incidents, recommended measures to be taken and the regulations announced on cyber security in the maritime sector. Cyber security asessment is performed for Turkey in the fourth part. Cyber security applications disinclude in this part because it has not been met to a study in the literature. The fifth part include how a situation analysiz in terms of cyber security make between ships and ports employers and data and discussion which is provided for the evaluation of the obtained results. Study was completed, giving a terse conclusion in chapter six.

LITERATURE REVIEW

Cyber security in the maritime field is concerned with the physical and information infrastructure at the intersection with the sea area and cyber space. When we look at the definition of the critical infrastructure, it is expected to be hurt in the economic and social order nationally by any attack next to these structures (USA, 2001). Ports and ships, in this context, can be found as critical infrastructure and industrial control systems have been integrated with information technology. Therefore, there is not many study of cyber security and cyber security awareness in the maritime field yet; however it is an issue that increasingly needs important studies. Studies which led to increased awareness of cyber security in the maritime field is the evalution report of European Union Network and Information Security Agency entitled Maritime Sector regard to Cyber Security at the 2011. This report has presented a basic analysis on cyber security in marine areas and policies associated with this. According to this analysis, seven important vulnerability in terms of cyber security were found at the offshore areas. These vulnerebilities are that:

- Low awareness and focus
- It is a complex structure of the information processing system in the maritime sector
- The absence of a holistic management approach in international and national context in the maritime field
- There is inadequacies regulations about cyber security in the maritime sector
- The lack of a holistic approach against cyber security
- The lack of incentives and initiatives to work towards increasing economic aspects of cyber security in the maritime sector
- The lack of incentives to motivate studies (ENISA, 2011).

Besides, U.S. Coast Guard Cyber Security has made cyber security guide by the development of an annual process for evaluating marine world (2015). According this studies, following results was found:

- ➢ Risk assesment
- ➢ Risk management
- ➢ Priority strategies for Marine Critical Infrastructure Protection (ports, ships, facilities)
- ➢ It should be given important to the infrastructure to operate the cyber space

Kramek made an syber security analysis toward ports and he found low cyber security awareness. Therefore, cyber security and awareness are begun to be studied in the literature as an important issue in terms of the maritime industry.

When analyzing the international literature a number of studies in marine areas focus on the hardware (Robinson ve ark., 2015; Sen, 2016; Gartzke, 2013) and the other parts of studies in marine areas focus on the software (Yang et al., 2016). Private companies and international organizations have published the guidelines and reports on cyber security and awareness. For example, BIMKO, Clia, INTERTANGO and INTERCARGO have published the cyber security guideline for ships. In addition to the technical information stating that the human factor is a very important parameter for cyber security have drawn attention to cyber security awareness. ABS have published the cyber security guideline for marine operations(2016). These guidelines which are intended as a series of cyber security strategies include policies, processes, tools of the safety assessment and audit plan.

Besides that cyber security requires the situational awareness of individuals because it includes processes which needs to be applied by individual. Situational awareness is the individual's cognitive capacity in complex business environments especially in the environment includes low frequency / high-risk events(Endsley, 1998). When we examine studies on situational awareness we can see that researches have done in the fields of military control (Dudfield and friends., 2001; Gorman and friends., 2006), nuclear reactor operations(Licao, 2010), in air traffic control (Mogford, 1997) and navigation (Lee and Sanquist, 2000).

CYBER SECURITY IN MARITIME TRANSPORTATION

Maritime Cyber Space

From the point of maritime domain, the computer and network information technologies and systems of ports and ships are the main constitutes of maritime cyber space. In addition the information network systems of maritime companies have vulnerabilities for cyber security risks. Accordingly, their network and information systems can be also a member of maritime cyberspace. However, in this study, we focus on ship base cyber space. Thus this chapter includes a literature for ship base cyber space and cyber risk.

Ship Based Cyber Space

Due to the continual development of technology, information technologies and operational technologies of ships have been connected to the world wide network. Cyber-threats or unauthorized access to this network connection increase the probability of security risks (BIMCO, 2016). Accordingly, each part of the machinery, navigation and communication systems of a ship can subject to cyber threats. These attacks can be occurred by a human based error of a staff or cyber criminals who find the vulnerabilities of the ship network system (Steven, 2016).

The main cyber space of a ship can be characterized as (Bowline,2016);

- GPS
- AIS
- ECDIS

which are the communication and network technologies that have electromagnetic area.

In addition, RADAR, VDR, INMARSAT, GNSS, DSC, LORAN are the other information technologies that are used for safe navigation on board. In Figure 3, the information technology system of a ship has been illustrated (U.S Homeland Security, 2015).

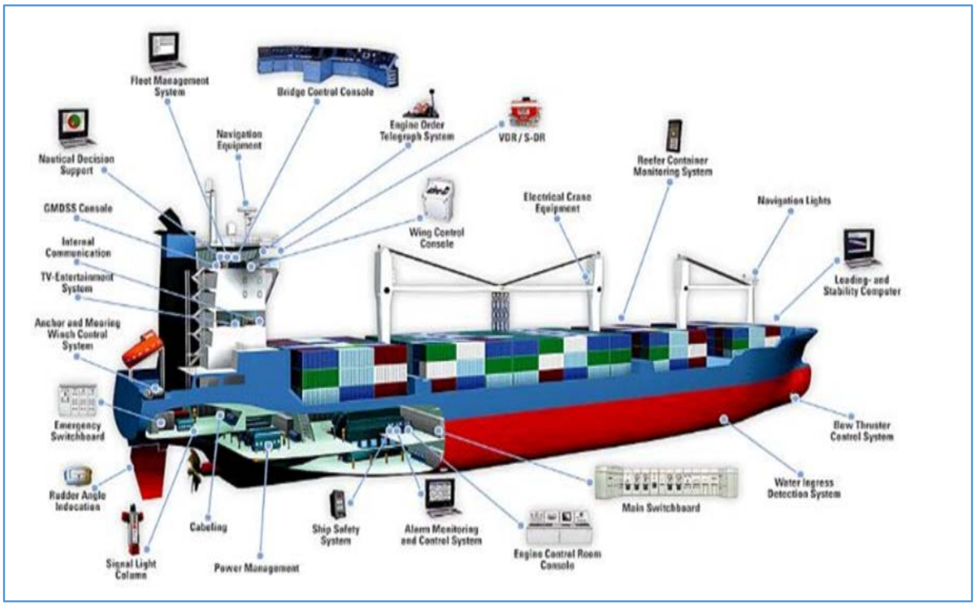


Figure 1 Information and Network Technologies of a Ship (U.S Homeland Security, 2015).

i. GPS: Global Positioning System has been originated from NAVSTAR GPS (NAVigation Satellite Timing And Ranging Global Positioning System) project in the year 1973. The development of this technology was completed at the end of 1994 and it has begun to be used in vessel control systems. GPS System which is showed in Figure 5, is consisted of 3 main segments(Uzel et al., 1997). These parts can be classified as

- The space segment: the GPS satellites themselves,
- The control system, operated by an authority,
- The user segment, which includes both military and civilian users and their GPS equipment

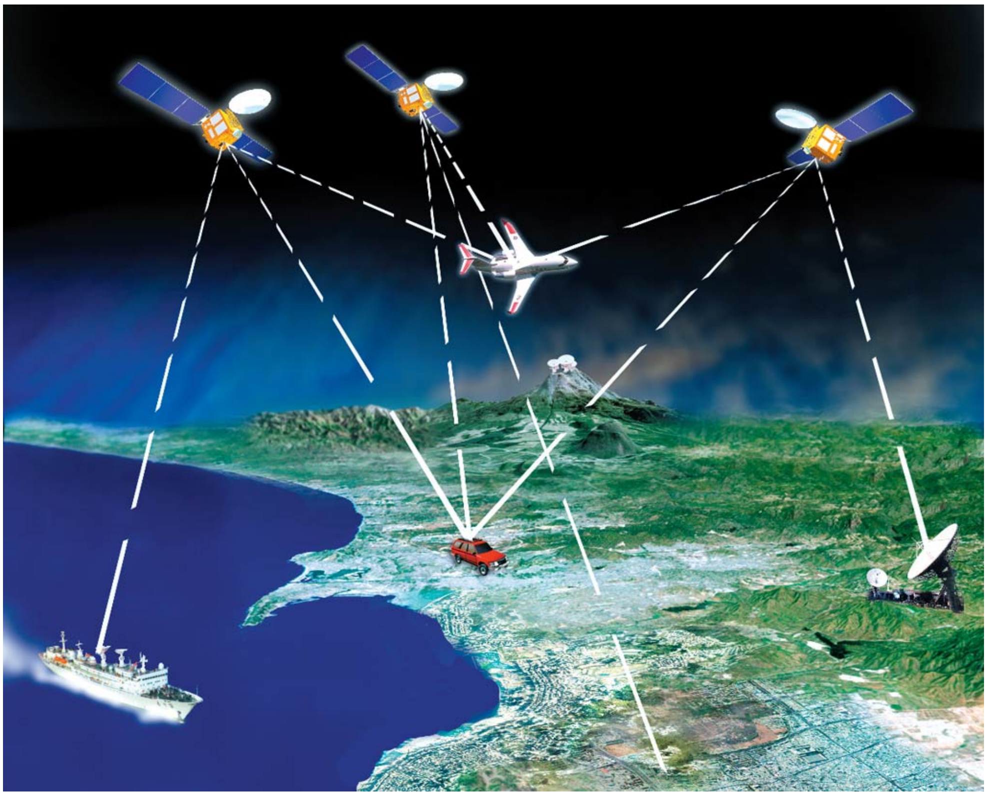
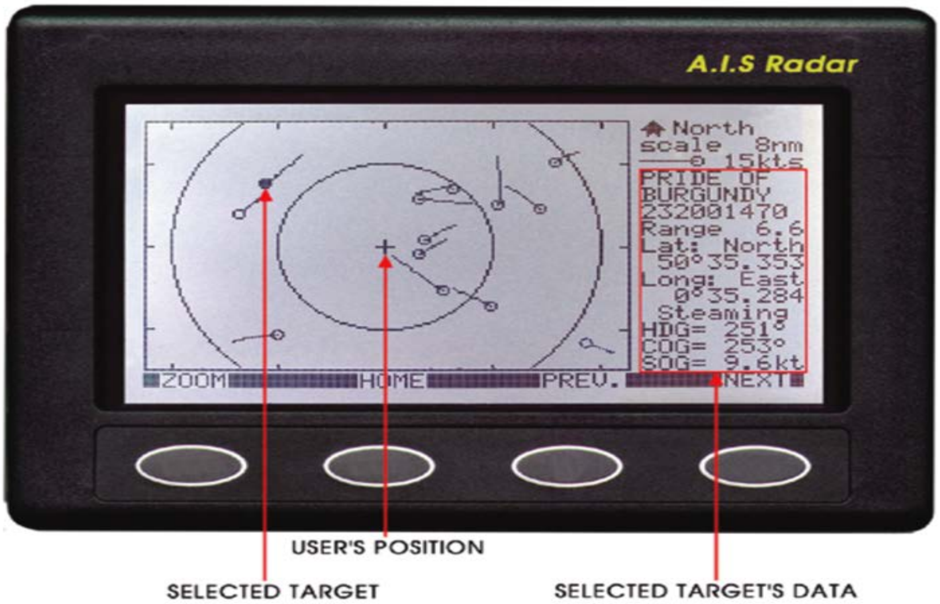


Figure 2. Illustration of a GPS system principle (techcrunch.com, accessed 18.07.2016)

ii.Automatic Identification System - AIS: Picture a shipboard radar or an electronic chart display that includes a symbol for every significant ship within radio range, each as desired with a velocity vector (indicating speed and heading). Each ship "symbol" can reflect the actual size of the ship, with position to GPS or differential GPS accuracy (US Coast Guard-Navigation Center of Excellence, accessed 18.07.2016).



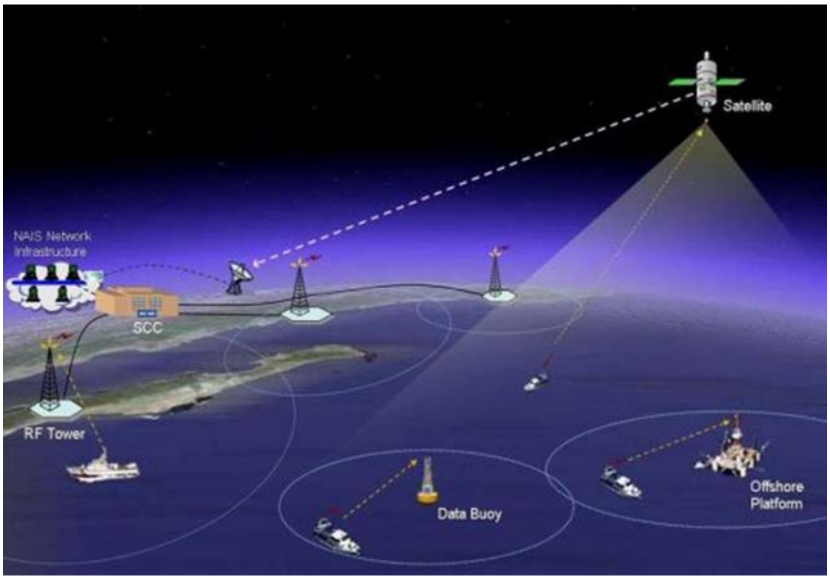


Figure 3 AIS Device and System Operation

iii.ECDIS : ECDIS system which built on the bridge of the ship in general is a PC workstation running Windows XP (NCC Group,2015). It typically includes radar, but it also has sensor supply related with Navigational Telex (NAVTEX), Automatic Identification Systems (AIS), Sailing Directions, Position Fixing, Speed Log, Echo Sounder, anemometer, and fathometer This sensor supplies are often connected to the ship's LAN (via special serial/NMEA to LAN adaptors) including gateways to the internet. ENC is loaded into the ECDIS and it used by ship officer to piloting, navigating, monitoring the ship's speed and a lot more important indicator. This charts is downloaded either via internet directly or by staff using CD/DVD or USB manually.

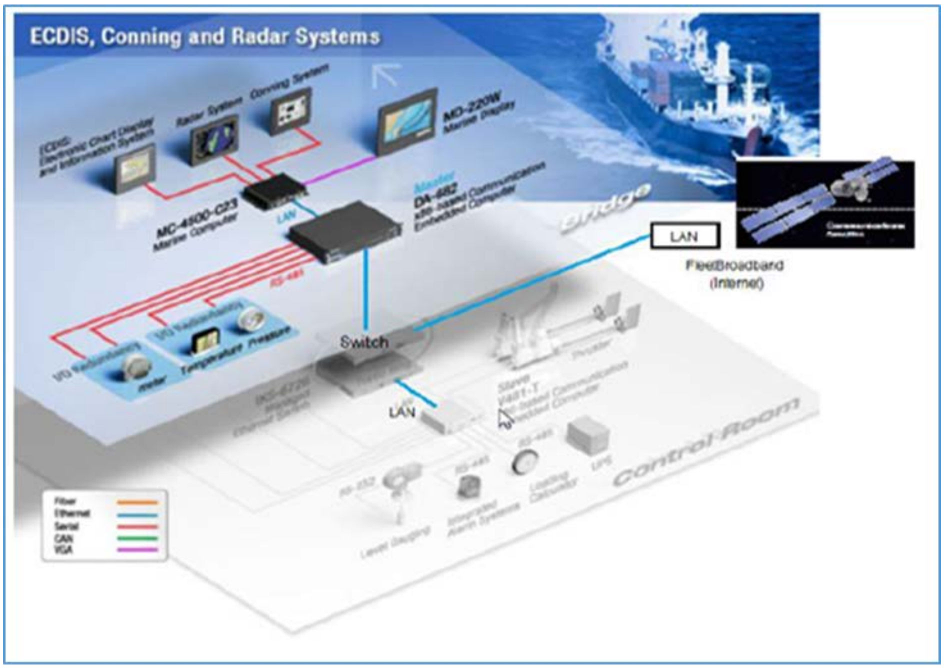


Figure 4 ECDIS Links and Radar Systems

Besides that, SCADA, spare parts ordering Just-in-time, CCTV systems, Bridge Navigation Watch Alarm System (BNWAS), history tracking and electronic logbook, remote monitoring, onboard Wi-Fi or Internet connection (ship personnel or for guests) were integrated to LAN and VOIP technology for power supply control and monitoring machinery as shown in Figure 5 (Nautic EXPO, 2016).

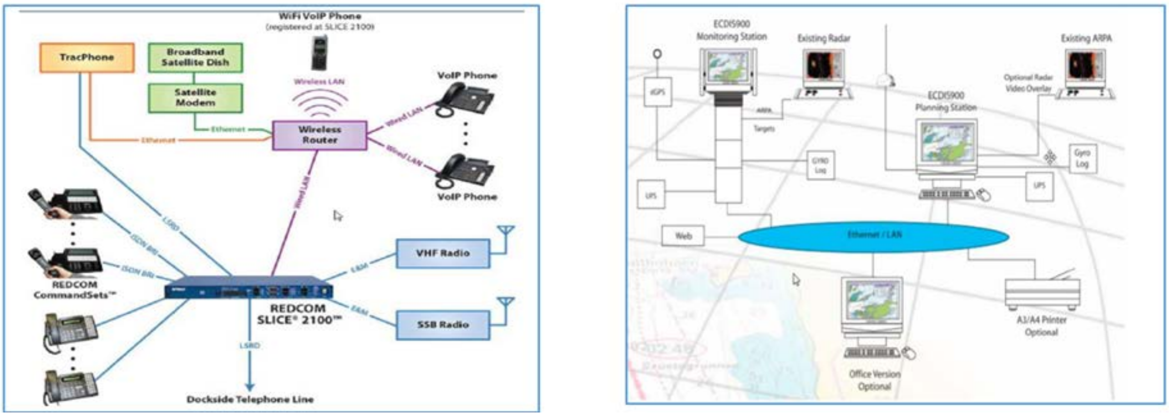


Figure 5 LAN and VOIP sistems on the ships (Nautica Expo, 2016).

Cyber Attacks Pathways Against Ships

Threats to ports and ships could be a matter of the national states (Russia and China), other political actors, rival companies (Private charter parties, ship design, customer list / to customer information), criminal organizations, independent / free hackers and users. It is therefore a variety of risks for ship and port systems and can be listed as follows:

- onboard systems (communication, navigation, loading)
- navigation information 'Realm of Imagination "(" in the cloud ")
- system in the main port
- host systems in shipping companies
- Laptop (offices and staff)
- Smartphones
- USB

We consider four basic attack emerge in terms of ports (US Homeland Security, 2016). These attacks:

i. Shipping cargo tracking system by accessing the database, delete or change
ii. Port control system as the cause interruptions in accessing automated crane system handling, to avoid making the loading and unloading operations
iii. be hampered by port operations by cutting off the GPS signal
iv. Changing the billing or accessing data on lending to the control system

Ship-based attacks can be categorized as (US Homeland Security, 2016),

i. Degradation of GPS Broadcast

ii. ECDIS and AIS Manipulation, distortion of the sensor data

iii. Changing the speed of ships entering the control system

ANALYZING THE PERCEPTION OF TURKISH SEAFARERS FOR MARITIME CYBER SECURITY

We are giving below the results of our survey to measure the cyber security awareness in the maritime sector for the seamen.

i.In your opinion, has the maritime industry became overly dependent on information and communication technologies?

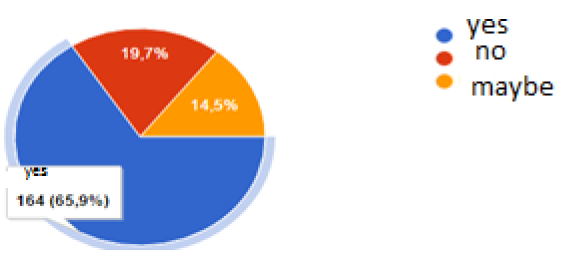


Figure 6

These survey was made by 249 seafarers. 167 of them think that the maritime industry has become overly dependent on information and communication technologies, 49 number of them responded as the maritime industry has not became overly dependent on information and communication technologies and 36 number of people said the maritime industry has maybe become overly dependent on information and communication technologies. It is understood that the maritime industry has become overly dependent on information and communication technologies like so many sector. Researches have already carried supportive information on this hypothesis. Usage of global communication and information technologies has an important place for increasing their trading capacity of private sector organizations, achieving competitive advantage and strategic objective focused on the long-term growth.

ii. How much do you think that is vulnerable to malicious attacks on the deck system?

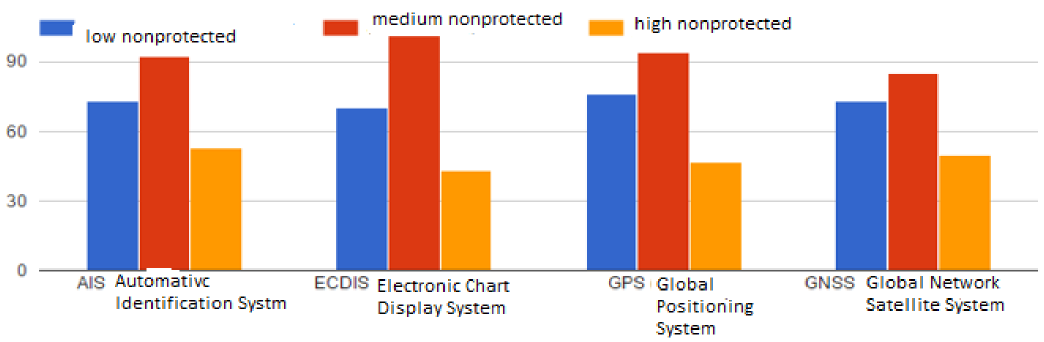


Figure 7

AIS, ECDIS, GPS VE GNSS systems which is a type of electronic devices are approached in the survey. 92 number of seafarer who made the survey, thought AIS was middle rate of unprotected, 101 number of seafarer who respond the survey, said ECDIS was middle rate of unprotected, 76 number of seafarer thought GPS was middle rate of unprotected and 85 number of them thought that GNSS was unprotected against walware attacks. When examining the survey, it is understood that devices which have been used on ships, have medium level of cyber security system. Update situation of institutions and networks of USA was examined and 3,200 institutions were observed to be quite different from each other about cyber security capacity and practices. In some of these institutions, IT and OT systems are working closely with each other but in other institutions they are working independently from each other. In many institutions, same staff and the team are responsible for policies and practices in cyber security for the fulfillment of their daily routine security screening requirements and regulations. In some cases, IT staffs who are inadequate on technical capacity interfere on the operation field and they get involved in the decision-making process which are highly critic behaviors in terms of cyber security.

iii. To what extent do you think the ship's captain and system operators can identify errors in the data which came to them and they can interrogate accuracy of these data?

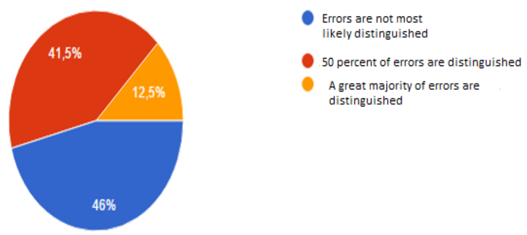


Figure 8

114 number of seafarer responded as errors were not most likely distinguished, 103 number of them thought 50 percent of errors were distinguished and 31 number of seafarer said a great majority of errors were distinguished. It was said that to understand the attack with the devices and systems which took place at studies made by Gebze High Technology Institute. There is a safe and a distributed architecture in intrusion detection systems because of the multi sensor intrusion detection systems. Intrusion detection is done with multiple detection engines and each motors are distributed to different network. This gives us flexible, secure and distributed management facilities. Actually there are systems to realize the attacks and if these systems are used correctly the attacks are determined easily.

iv. Do you think ship's crew can understand the security protocols for online transactions in general and they comply with these?

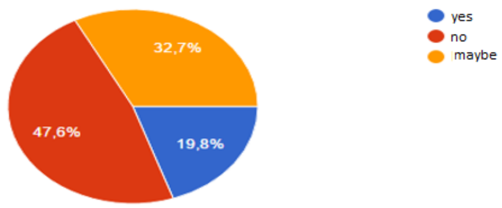


Figure 9

188 number of seafarer gave "no" answer to this question, 81 number of them said "maybe" and 49 people of them said "yes". According to survey assessment ship's crew cannot sufficient understand the security protocols for online transactions and they do not comply with these. It is understood from researches that there has not been situational awareness of cyber security in the maritime sector and it verifies the above hypothesis.

v. Which factors does the maintenance and updates of ship's electronic devices prevent?

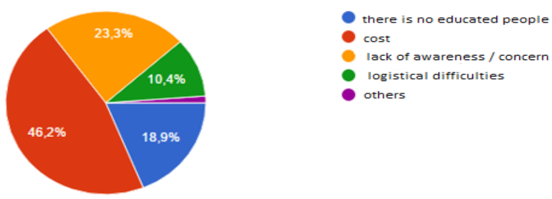


Figure 10

115 number of seafarer respond as cost prevents the maintenance and updates of ship's electronic devices, 58 number of seafarer respond as the lack of awareness prevents it, 47 number of seafarer respond as the lack of education prevents the maintenance and updates of ship's electronic devices, 26 number of seaman said logistical difficulties prevent the maintenance and updates of ship's electronic devices and 3 number of seaman said other factors prevent. the maintenance and updates of ship's electronic devices. According to the researches there is lack of education and concern about the maintenance and updates of ship's electronic devices. The reason of this is unknowing what kind of vulnerability in case of any attack. Besides that cost is the important factor because the security firewall is expensive.

CONCLUSION

Maritime sector is constituted of critical infrastructure such as ships and ports. The continual usage of information technologies makes maritime sector more dependent to worldwide communication systems. Thus it is one of the main high level risk sector for cyber security as the networks can include vulnerabilities. In the literature, the low awareness of cyber security has been seen as one of the other threat that increase risk in maritime cyber security. Thus accordingly researches should be increased in this topic. Based on this fact, our paper is a preliminary study for cyber security in Turkish Maritime Sector, which should be developed by further researches.

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ANALYSIS OF GROUNDING ACCIDENTS IN THE MEDITERRANEAN AND THE AEGEAN SEA COAST OF TURKEY

Ayşe Taş[1], Güler Alkan[2]

ABSTRACT

In this paper, the data of 205 grounding accidents occured in the Mediterranean and Aegean Sea Coasts of Turkey during the periods 1997 - 2015 and prepared by Ministry of Transport, Maritime Affairs and Communications will be analyzed by using the statistical methods Frequency Distribution and Chi-Square (χ2) test. The statistical method will be analyzed through the instrument of SPSS 17.00. Statistical Package Programme.Data used in the analysis include categorical variables related such as type of accident, reason of accident, location of accident, type of ship, years, hours of accident and ship flag and gross tonnage involved in the grounding accidents. The aim of the study is to put forward a general profile of grounding accidents taken place in the Mediterranean and Aegean Sea coast of Turkey and present properly data set intended for use of decision makers in maritime companies, stakeholder and legislative organizations in order to build knowledge-based systems and information in the field of safety policy and management.

Keywords - Grounding Accidents, Chi-squared (χ^2)Test , Frequency Distribution Analysis, The Mediterranean , Aegean Sea Coasts of Turkey

INTRODUCTION

Shipping is the fundamental as well as dominant means of transport for the world trade as the Earth is almost covered by sea [1]. Shipping plays an important role in Sea of Turkey as well, because Turkey is surrounded by the Mediterranean Sea, Aegean Sea, Sea of Marmara and the Black Sea. The Aegean sea is a continuation of the Mediterranean coast. The Aegean is connected through the straits of the Dardanelles, the Sea of Marmara and the Bosporus to the Black Sea.

Whenever and wherever there is shipping, there exist risks of accidents such as grounding, collision,fire and explotion, sinking, strike [1]. Subsequently, such accidents at sea may result in potential economic loss, environmental pollution and fatalities [1]- [4]. Despite modern bridge equipment, new technologies, and improved safety measures, maritime accidents still occur, and an analysis of their causes is essential in preventing future accidents [6].

Collisions and groundings represent 71% of accidents in European waters: ship groundings being one of the most prevalent [10]. Ship grounding accident is one of the major accidents in shipping industry. Ship grounding is a type of marine accident that involves the impact of a ship on the seabed or waterway side. It results damage of the submerged part of her hull and in particularly the bottom structure, potentially leading to water ingress and compromise of the ship's structural

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integrity and stability. Grounding applies extreme loads onto ship structures and is a marine accident of great importance due to its impacts. In less grave accidents, it might result to just some damages to the hull; however in most serious accidents it might lead to oil spills, human casualties and total loss of the vessel. Grounding accidents represent significant potential incidents which may result in very unfavorable consequences to both human life and environment[5]- [4]. The grounding of a ships may well result in fire and / or explosion particularly should a large tanker involve in such an accident [10].

There may be several causes for grounding accidents. The affecting factors are atmospheric factors or weather conditions, technical failures, route conditions, ship-related factors, human or personal errors and cargo related factors [10]- [1].

There are a lot of grounding accidents occurred in coast of Turkey till today. Determining the causes of these accidents is as important as determining preventive measures against future incidents. Moreover, categorising the causes assists in determining and assessing preventive measures, producing accident prevention measures derived from maritime accident reports, similar studies [3]- [10]. In this study, the data of 205 grounding accidents occured in the Mediterranean and Aegean Sea Coasts of Turkey during the periods 1997 – 2015 were analyzed by using the statistical methods Frequency Distribution and Chi-Square (χ2) test to describe relationship among the categorical variables related grounding accidents such as the main causes of accident, type of accident, location of accident, type of ship, years, hours of accident and ship flag and gross tonnage involved in the grounding accidents.

This paper's findings can be used by decision makers in maritime companies, stakeholder and legislative organizations in order to build knowledge-based systems and information in the field of safety policy and management.

MATERIAL AND METHODS

Data Collection

The historical data of 205 grounding accidents occured in the Mediterranean and Aegean Sea Coasts of Turkey during the periods 1998 - 2015 was acquired from by T.C. Republican of Ministry of Transport, Maritime Affairs and Communications. Data include variables such as accident year, ship flag, the type, hours, reason and location of ship grounding accidents were used in the analysis. The vessels (ship) include all reported grounding accidents involving commercial such as general cargo, dry bulk, container, Ro-Ro, tanker, tugboat, passenger, fishing vessels and others.

Data Analysis

The statistical analysis was used to analyse the accidents occured in the Mediterranean and Aegean Sea Coasts of Turkey during the periods 1997 - 2015 by using SPSS Statistical Package Programme SPSS 17.00. The nonparametric variables such as accident year, ship flag, the type, reason and zone of accident were used in the analysis. The classification scale was used to define the non parametric variables and to divide sub groups.

In this paper, the descriptive statistics such as frequency distribution and non parametric statistics such as Chi- Square Test (χ2) is used. Frequency Distribution was used to show a summarized grouping of the nonparametric data. The Chi-Square Test was used to determine the relationships between the non parametric variables. The significance level was set at 5% [3].

Frequency Distribution

The Frequency Distribution Analysis computes frequencies and relative frequencies. The frequencies are simply the number of respondents that selected a choice, while the relative frequencies are the percentage of respondents or observation that selected the choice. Prior to chi squared ($\chi 2$ test) analysis, the frequency distribution of 205 ship grounding accidents occured between the years of 1997 and 2015 in the Mediterranean and Aegean Sea Coasts of Turkey has be been carry out .

Table 1: Frequency Distribution of Ship Accidents by Years

Years	Frequency	Percent
1997	12	5,9
1998	13	6,3
1999	14	6,8
2000	11	5,4
2001	13	6,3
2002	6	2,9
2003	10	4,9
2004	9	4,4
2005	8	3,9
2006	6	2,9
2007	11	5,4
2008	15	7,3
2009	14	6,8
2010	15	7,3
2011	9	4,4
2012	11	5,4
2013	8	3,9
2014	12	5,9
2015	8	3,9
Total	205	100,0

For every year from 1997 to 2015, ship grounding accidents dataset includes the information depicted in Table 1. In this table, frequency and the percentages (%) of total grounding accident for each year are given. with the frequency 177 (22.5%) in the years between 2004 and 2010. According to Table, It is seen that the highest number of the grounding accidents occured in 2008 and 2010 years with 7,3% (15 frequency), then in 1999 and 2009 years with 6,8 % (14 frequency). It is seen that the lowest number of the grounding accidents occured in 2013 and 2015 years with 3,9 % (8 frequency).

The frequency distribution of ship grounding accidents by region is analyzed in table 2. It is seen that the highest number of the grounding accidents occured in Eagean Sea Region with 78% (160 frequency), then in Mediterranean Region with 22% (45 frequency).

The longest coast of Turkey constitutes Eagean Sea by 2800 km. length. Eagean Sea is a sea covering provinces such as Edirne, Çanakkale , Balıkesir, İzmir, Aydın and Muğla located in the West of Turkey [9]. Fort his reason, Eagean Sea is divided two subregions such as İzmir and Çanakkale by Turkey Ministry of Transport, Maritime Affairs and Communications. Çanakkale is a province that are located in Northwestern of Turkey and it has area borders both Eagean and Marmara Region. Bozcaada and Gökçeada that are located in Eagean Sea belong to Çanakkale province [12].

Mediteranean Region is divided two subregions such as Antalya and Mersin by Turkey Ministry of Transport, Maritime Affairs and Communications [9] because of covering provinces Antalya, Mersin, Adana ve Hatay.

When the frequency distribution by subregions of the grounding accidents is analysed Table 3 , it is seen that the highest number of the grounding accidents occured in Izmir forming Eagean Region with 51.7% (106), then in Canakkale with 26.3% (54). It is seen that the lowest number of the grounding accidents occured in Mersin forming Mediterranean Region with 10.7% (22).

Table 2: Frequency Distribution of Ship grounding Accidents by Region

Accident occurance region	Frequency	Percent
Mediterranean	45	22,0
Eagean Sea	160	78,0
Total	205	100,0

Table 3: Frequency Distribution of Ship Grounding Accidents by subregion

Accident occurence subregion	Frequency	Percent
Antalya	23	11,2
Mersin	22	10,7
izmir	106	51,7
Çanakkale	54	26,3
Total	205	100,0

When the frequency distribution by types of ship is analysed Table 4, it is seen that the highest number of vessel types are vessels of general Cargo+dry bulk+Ro-ro with 48.8% (100), then vessels of boat, yatch, passenger with 28.3% (58). It is seen that other vessel (tugboat, rescue vessel e.g.) has the lowest value with 2% (4).

Table 4 : Frequency Distribution of Grounding Accidents by type of ship

Types of ship	Frequency	Percent
Boat+yatch+ passenger ship	58	28,3
Fishing vessel	13	6,3
General cargo+dry bulk+Ro-Ro	100	48,8
Tanker+Liquid bulk	13	6,3
Others	4	2,0
Container	17	8,3
Total	205	100,0

Table 5: Frequency Distribution of Grounding Accidents by reason

Reasons of accident	Frequency	Percent
Human error	49	23,9
Bad weather	57	27,8
Breakdown	33	16,1
Unknown reason	53	25,9
Other reason	3	1,5
Foundering	10	4,9
Total	205	100,0

As shown in table 5, the most common reason of ship grounding accident is bad weather conditions with 27.8 % (57), followed by unknown reasons with 25.9 % (53), human errors with 23.9 % (49), ship equipment failures (breakdown) with 16.1 % (33 frequency). It is clear that ship grounding accident in Eagean Sea and Mediterranean mostly end up with bad weather conditions, followed by unknown reasons, human errors, ship equipment failures (breakdown) . It is seen that other reason (fire, overload e.g.) has the lowest value with 2% (4 frequency).

Chi Square Analysis

Chi-square, symbolized as $\chi 2$, is a non- parametric test of significance appropriate when the data is in form of frequency counts occurring in two or more mutually exclusive categories. A Chi-square test compares proportions actually observed in a study with the expected to establish if they are significantly different. The Chi-square value increases as the difference between observed and expected increase. Whether the calculated Chi-square value is significant is determined by comparing it with the value from contingency table [7].

A crosstabulation is a joint frequency distribution of cases based on two or more categorical variables. Displaying a distribution of cases by their values on two or more variables is known as contingency table analysis and is one of the more commonly used analytic methods in the social sciences. The joint frequency distribution can be analyzed with the chi-square statistic to determine whether the variables are statistically independent or if they are associated.

Table 6 : Cross Tabulation between Type of the Ship and Sub Region of Accident

Accident occurence subregion	Types of ship						Total
	Boat+yatch+passenger ship	Fishing vessel	General cargo+dry bulk+Ro-Ro	Tanker+ Liquid bulk	Others	Container	
Antalya	13	3	6	1	0	0	23
	56,5%	13,0%	26,1%	4,3%	,0%	,0%	100,0%
Mersin	4	4	8	3	1	2	22
	18,2%	18,2%	36,4%	13,6%	4,5%	9,1%	100,0%
izmir	34	4	50	9	1	8	106
	32,1%	3,8%	47,2%	8,5%	,9%	7,5%	100,0%
Çanakkale	7	3	35	0	2	7	54
	13,0%	5,6%	64,8%	,0%	3,7%	13,0%	100,0%
Total	58	14	99	13	4	17	205
	28,3%	6,8%	48,3%	6,3%	2,0%	8,3%	100,0%

$\chi 2$ = 34,746 P = 0,003

Cross Tabulation between Subregion of the Accident and Type of Ship variables is shown in Table 6. According to table 6, general cargo+dry bulk+ Ro-Ro ships were involved in the most grounding accidents with frequency of 50 (50 %) in sub region of İzmir and respectively with frequency of 35 (35%) in subregion of Çanakkale. Then, boat+yatch+passenger ships were involved in grounding accidents with the frequency of 34 (58.6%) in subregion of İzmir and with the frequency of 13 (22.4%) in subregion ofAntalya. Container ships ships were involved in accidents with frequency of 8 in İzmir and with frequency of 8 in Çanakkale. Other ships (tugboat, rescue vessel, research ship e.g.) were involved in at least grounding accidents.

To determine whether there is a significant association between the two variables such as type of the accident and region of accident is used Chi-Square Test.

Chi Square Hypothesis for between type of the ship and sub region of accident:

Hypotesis;
H0: There is not a relationship between type of the ship and sub region of accident
H1: There is a relationship between type of the ship and sub region of accident

The Chi Square ($\chi 2$) value is 34,746. The test result indicated that since the P-value (P=0.003) is less than the significance level (α =0.05), the null hypothesis (H0) is rejected, alternative hypothesis (Hı) is accepted. Thus, It is concluded that there is a statistical relationship between type of the ship and sub region of accident.

Cross Tabulation between subregion of the accident and reason of accident variables is shown in Table 7. The table 7 shows that the most of grounding accident occured due to unknown reasons with the frequency of 35 (33%), bad weather conditions with the frequency of 28 (26.4%) and human error with freuency of 22 (20.8%) in Subregion of İzmir; then due to human error with freuency of 21 (38.9%), bad weather conditions with frequency of 12 (22.2%) and unknown reasons with frequency of 18.9% (10) in Subregion of Çanakkale. The least number of grounding accident occured due to other reasons (fire, overload e.g.) with the frequency of 1 (0.9%) in İzmir and with the frequency of 2 (9.1%) in Mersin.

Table 7: Cross Tabulation between Subregion of the Accident and Reason of Accident

	Reasons of Accident						Total
	Human error	Bad weather	Breakdown	Unknown reason	Other reason	Foundering	
Antalya	2	8	3	6	0	4	23
	8,7%	34,8%	13,0%	26,1%	,0%	17,4%	100,0%
Mersin	4	9	4	2	2	1	22
	18,2%	40,9%	18,2%	9,1%	9,1%	4,5%	100,0%
izmir	22	28	17	35	1	3	106
	20,8%	26,4%	16,0%	33,0%	,9%	2,8%	100,0%
Çanakkale	21	12	9	10	0	2	54
	38,9%	22,2%	16,7%	18,5%	,0%	3,7%	100,0%
Total	49	57	33	53	3	10	205
	23,9%	27,8%	16,1%	25,9%	1,5%	4,9%	100,0%

$\chi 2$ = 34,825 P = 0,003

Chi Square Hypothesis for between Subregion of the accident and reason of accident:

Hypotesis;

H0: There is not a relationship between subregion of the accident and reason of accident

H1: There is a relationship between subregion of the accident and reason of accident

The Chi Square ($\chi 2$) value is 34,825 . The test result indicated that since the P-value (P=0.003) is less than the significance level (α =0.05), the null hypothesis (H0) is rejected, alternative hypothesis (Hı) is accepted. Thus, It is concluded that there is a statistical relationship between subregion of the accident and reason of accident.

Table 8: Cross Tabulation between Type of Ship and Tonnages of Ship

	Tonnages of ship						Total
Types of ship	499 under	500-999	1000-4999	5000-9999	10000-19999	20000 above	
Boat+yatch+ passenger ship	55	0	1	1	0	1	58
	94,8%	,0%	1,7%	1,7%	,0%	1,7%	100,0%
Fishing vessel	13	0	0	0	0	0	13
	100,0%	,0%	,0%	,0%	,0%	,0%	100,0%
General cargo + dry bulk+Ro-Ro	1	15	62	10	5	7	100
	1,0%	15,0%	62,0%	10,0%	5,0%	7,0%	100,0%
Tanker+Liquid bulk	6	1	1	1	0	4	13
	46,2%	7,7%	7,7%	7,7%	,0%	30,8%	100,0%
Others	2	0	1	0	0	1	4
	50,0%	,0%	25,0%	,0%	,0%	25,0%	100,0%
Container	0	3	3	3	4	4	17
	,0%	17,6%	17,6%	17,6%	23,5%	23,5%	100,0%
Total	77	19	68	15	9	17	205
	37,6%	9,3%	33,2%	7,3%	4,4%	8,3%	100,0%

$\chi 2$ = 212,508 P= 0,000

Cross Tabulation between type of ship and tonnage of ship variables is shown in Table 8. According to table 8, General Cargo+dry bulk +Ro-Ro vessels with 1000-4999 tonnages, Boat+yatch+passenger ship with 499 under tonnages and General Cargo+dry bulk +Ro-Ro vessels with 5000-9999 tonnages and with 500-999 tonnages were involved in the most grounding accidents with the frequency of 62 (%62), 55 (94.8%), 15 (%15) and 10 (%10) respectively.

Hypotesis;

H0: There is not a relationship between type of ship and tonnages of ship

H1: There is a relationship between type of ship and tonnages of ship

The Chi Square (χ2) test value is 212,508. The test result indicated that since the P-value (P=0.000) is less than the significance level (α =0.05), the null hypothesis (H0) is rejected, alternative hypothesis (H₁) is accepted. Thus, It is concluded that there is a statistical relationship between type of ship and tonnages of ship.

Table 9: Cross Tabulation between Reason of Accident and Flag States of Ship

	Reason of accident						
Flag State	Human error	Bad weather	Breakdown	Unknown reason	Other reason	Foundering	Total
T.C.	29 59,2%	19 33,3%	18 56,3%	18 34,6%	1 33,3%	8 80,0%	93 45,8%
FOC	9 18,4%	27 47,4%	10 31,3%	15 28,8%	0 ,0%	0 ,0%	61 30,0%
U.S.A.	0 ,0%	2 3,5%	0 ,0%	2 3,8%	1 33,3%	0 ,0%	5 2,5%
Asia	5 10,2%	1 1,8%	1 3,1%	5 9,6%	0 ,0%	1 10,0%	13 6,4%
Europe	6 12,2%	8 14,0%	3 9,4%	12 23,1%	1 33,3%	1 10,0%	31 15,3%
Total	49 100,0%	57 100,0%	32 100,0%	52 100,0%	3 100,0%	10 100,0%	203 100,0%

χ2 = 43,829 P=0,002

Cross Tabulation between Reason of Accident and Flag States of Ship variables is shown in Table 9. The table 9 shows that Turkish flag (T.C) vessels were involved in the most accidents with the frequency of 93 (45%), respectively FOC (Flag of Convenience=Panama,Liberia, Marshal Islands, Bahamas, St. Vincent e.g.) vessels with the frequency of 61 (30%), European flag (Belgium, Holland, England, Romania, Denmark, Croatia, Germany e.g.) vessels with the frequency of 31 (15.3%), Asian (Syria, Egypt e.g.) vessels with the frequency of 13 (6.4%).

Turkish flag (T.C) vessels faced the most grounding accident due to human errors with the frequency of 29 (59.2%), bad weather conditions with the frequency of 19 (33.3%) and breakdown and unknown reasons with the frequency of 8 . Flag of Convenience vessels faced the most grounding accident due to bad weather conditions with the frequency of 27 (47.4%), unknown reasons with the frequency of 15 (28.8%), breakdown reasons with the frequency of 10 (31.3%). European flag vessels faced the most grounding accident due to unknown reasons with the frequency of 12 (23.1%), bad weather conditions with the frequency of 8 (14%).

Hypotesis;

H0: There is not a relationship between reason of accident and Flag states of ship

H1: There is a relationship between reason of accident and Flag states of ship

The Chi Square (χ2) test value is 43,829. The test result indicated that since the P-value (P=0,002) is less than the significance level (α =0.05), the null hypothesis (H0) is rejected, alternative hypothesis (Hı) is accepted. Thus, It is concluded that there is a statistical relationship between reason of accident and Flag states of ship.

Hypotesis;

H0: There is not a relationship between reason of accident and Flag states of ship

H1: There is a relationship between reason of accident and Flag states of ship

hours of accident and type of ship

The test result indicated that since the P-value (P=0,300) is more than the significance level (α =0.05), the null hypothesis (H0) is accepted, alternative hypothesis (Hı) is rejected. Thus, It is concluded that there isn't a statistical relationship between type of the ship and sub region of accident.

Cross Tabulation between hours of Accident and type of ship variables is carried out. It is seen that there is no relationship between hours of Accident and type of ship variables. The test result indicated that since the P-value (P=0,300) is more than the significance level (α =0.05), the null hypothesis (H0) is accepted, alternative hypothesis (Hı) is rejected. Thus, It is concluded that there isn't a statistical relationship between type of the ship and sub region of accident.

Figure 1: Map of grounding accident location mostly occured in the Eagean Sea and Mediterranean Region of Turkey.

Source: Figure were generated from Statistics of T.C. Republic of Ministry of Transport, Maritime Affairs and Communications [8]

Locations of grounding accident that are occured in the Eagean sea (Çanakkale and İzmir subregion) and Mediterranean coasts during 1997-2015 periods mostly, are shown in Figure 1 respectively.

CONCLUSION

Shipping plays an important role in Sea of Turkey as well, because Turkey is surrounded by the Mediterranean Sea, Aegean Sea, Sea of Marmara and the Black Sea. The Aegean sea is a continuation of the Mediterranean coast. Whenever and wherever there is shipping, there exist risks of shipping accidents. Ship grounding accident is one of the major accidents in shipping industry and represent significant potential incidents which may result in very unfavorable consequences to both human life and environment.

This study will shed light on the studies concerning the grounding accidents occured in the Mediterranean and Aegean Sea coast of Turkey and present properly data set intended for use of decision makers in maritime companies, stakeholder and legislative organizations in order to build knowledge-based systems and information in the field of safety policy and management. The findings of the paper can be summarized as:

When he frequency distribution of ship grounding accidents by Region is analyzed, ıt is seen that the highest number of the grounding accidents occured in Eagean Region with 78% (160 frequency), then in Mediterranean Region with 22% (45 frequency). It is the highest number of the grounding accidents occured in Izmir and Canakkale subregion with forming Eagean Region respectively. It is seen that the lowest number of the grounding accidents occured in Mersin forming Mediterranean Region. When Locations of grounding accident that are occured in the Eagean sea (Çanakkale and İzmir subregion) and Mediterranean coasts (Antalya and Mersin subregion) during 1997-2015 periods are examined (figure 1), the highest number of grounding accident take place in Bozcaada belonging to Çanakkale subregion, then, in Yenikale-Izmir Bay and Aliağa belonging to İzmir subregion, respectively. These locations are the most risky areas in terms of grounding. Therefore, necessary precautions such as navigational aids, safety measures should be taken in these areas where most of grounding accidents occurred.

It is seen that the most of accident occured due to unknown reasons, bad weather conditions and human error in İzmir; then due to human error , bad weather conditions, and unknown reasons in Çanakkale subregion. Unknown reasons occupy an important place in the occurance of grounding accidents Former accidents are the most significant data used for reducing potantial accide nt risky by maritime authorities throughout the world. Therefore following accident, a satisfactory investigation should be conducted by experts in the scene of the accident, technical accident report should be prepared and analyzed and the results should be observed exactly.

Human errors occupy an important place in the occurance of grounding accidents. Human error is the most significant factor in all types of accidents, not just groundings[10]. Human errors are individual errors such as Fatigue, alcohol, stress, lack of training & education, watchkeeping officer who is unfamiliar with bridge; application errors such as Position Fixing, Inefficient usage of bridge navigation equipment, Faulty maneuvering, Interpretation Errors , Unsafe speed; Team management error such as Deficiency in safety management system, in proper look-out [11]- [10]. Due to the fact that most of accidents arise from human error, the methods for checking th conformity of ship master and crew to IMO standards and STCW conventions should be determined and implemented.

It seen that General Cargo+dry bulk +Ro-Ro vessels with 1000-4999 tonnages, Boat+yatch+passenger ship with 499 under tonnages and General Cargo+dry bulk +Ro-Ro vessels with 5000-9999 tonnages and with 500-999 tonnages were involved in the most grounding accidents respectively. Grounding accidents should be minimised. Therefore, necessary precautions should be determined and implemented.

It is seen that, general cargo+dry bulk+ Ro-Ro ships were involved in the most grounding accidents in İzmir and Çanakkale subregion. Then, It is seen that boat+yatch+passenger ships were involved in the most grounding accidents in İzmir (34) and Antalya subregion, container ships were involved in accidents in İzmir (8) and Çanakkale subregion (7).

It seen that Turkish flagged vessels were involved in the most accidents, respectively the vessel with Flag of Convenience, European flag (Belgium, Holland, England, Romania, Denmark, Croatia, Germany e.g.), The vessel with a " Flags of Convenience" Panama,Liberia, Marshal Islands, Bahamas, St. Vincent, Honduras, Cambodia, Bolivia, Comoros, Belize e.g) are known to be substandard vessels [2].

Turkish flagged vessels were higly involved in accidents. Therefore, as a "Flag State" Turkey should make the vessels having her flag comply with the international standards required for security of sailing, life, property and envireonmental safety. In a similar way, as a "Port State", Turkey should audit and check more strictly according to Mediterranean Memorandum and Blacksea Memorandum the conformity of the vessel having a flag of convenience which are known to be low-standard vessels.

European flag (Belgium, Holland, England, Romania, Denmark, Croatia, Germany e.g.), Asian (Syria, Egypt e.g.) vessels. Turkish flag vessels faced the most grounding accident due to human errors and bad weather condition. Flag of Convenience vessels faced due to bad weather conditions, breakdown. European flag vessels faced the most grounding accident due to unknown reasons and bad weather conditions .

The chi square ($\chi 2$) test was used the data of 205 grounding accidents occured in the Mediterranean and Aegean Sea Coasts of Turkey during the periods 1997 - 2015. The results of Chi Square analysis there is a statistical relationship between the non parametric variables as follows: - region of accident and type of ship, - region of accident and reason of accident, - region of accident and tonnage of ship, - type of ship and tonnage of ship, - reason of accident and ship Flag State, - reason of accident and tonnage of ship, - ship Flag State, tonnage of ship.

The results of Chi Square analysis there isn't a statistical relationship between the non parametric variables as follows: - Hours of accident and Reason of accident, - Hours of accident -Type of ship, - Reason of accident and type of accident

Necessary precautions for grounding accidents should be initiated regarding the following issues: obligation to have Electronic Chart Display and Information Systems (ECDIS) and compulsory ECDIS training for watchkeeping officers; Compulsory Bridge Resource Management (BRM) training for watchkeeping officers, captains, and pilots; increasing the number of seafarers, especially the number of watchkeeping officers, improvements in the International Safety Management, Increasing situational awareness for emergency management and ensuring that the crew can respond in a timely and effective manner in contingency situations [11]- [10], [6], improvement of navigation aids; increasing control such as State flag and Port State Control, ensuring environmental security, determination of grounding accident black spots in the Mediterranean and the Aegean Sea Coast of Turkey.

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A STUDY ON DANGEROUS CARGO OPERATIONS AND SECURITY MANAGEMENT IN CONTAINER TERMINALS

Ali Umut Unal[1], Güler Alkan[2], Serap Incaz[3]

ABSTRACT

Maritime transport is still preserving its everlasting dominance in the global trade. Among cargo types requiring high levels of security and care in maritime transport, dangerous cargo is the most important. While dangerous cargo transport involves transportation of many types of cargo, each type of cargo brings one or several risk of danger specific to it. While crude oil and petrol products constitute the primary dangerous cargo, chemical materials, radioactive materials and biological materials are frequently observed in transportation. Due to developing technology, dependency on dangerous materials increases everyday especially in the energy sector. Recently, containers have been increasingly preferred for the most secure and economical transportation of these cargos. In terms of dangerous cargo and container transportation, this has rendered container terminals as the most important locations in harbors. In dangerous cargo transportation, such cargo may carry risks because of their structures. These are risks of explosion, fire due to bursts, spreading of fire and injuring harbor personnel, death, sea and environmental pollution. These risks constitute significant dangers starting from acceptance of containers, in in-harbor movements, storing of containers, discharging from storage areas and loading/unloading operations. Losses of lives and commodity were experienced due to operational accidents resulting from ships and harbors. Due to such accidents, container terminals are altering dangerous cargo container operations in line with the international regulations which stipulate strict security rules. This study explains the dangerous cargo operations held in container terminals of harbors and the results of the study conducted on the security management of dangerous cargo transportation in the harbors included in the study are examined.

Keywords: Container Terminals, Dangerous Cargo Operations, Terminal Security Management

INTRODUCTION

In maritime transport, container transport is always potentially hazardous and requires operations at a high security level. As much as shipmen experience hazardous situations on board, land personnel also encounter many potentially hazardous situations in harbors.

Changing work environment issues can be summarized as new work organisational forms, new contractual relationships and use of working time, new technologies, changes in the workforce, and changes in occupational safety and health systems. [1]

Harbors and their operation units also continually renew themselves and implement new courses of action in order to provide a more secure and healthier working environment for their personnel against the changing technology and the increasing cargo traffic.

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Due to a rapidly expanding world trade,the traditional multi-purpose general-cargo liner became increasingly labour and cost intensive. A system was required to accommodate the needs of physical distribution,a system that would o!er convenience,speed, safety and above all low cost. By this system,goods should be able to be moved from manufacturer to "nal distribution using a common carrying unit,compatible with both sea and land legs of transportation. The result was expected to be that all costly and complicated transhipment operations at seaports would be eliminated. The whole process resulted in the development and introduction of the `freight containera,a standard box, "lled with commodities, detachable from its carrying vehicle,and as easy to carry by sea as by air,road and rail.[2]

Container transport is recently a rising star in marine transport and is preferred widely, since cargoes can be carried in a homogenous placement. Since containers are sturdy packing materials, they reduce packing costs together with a higher level of reliability during transport. It is also a reliable means of transport due to the fact that cargo are loaded by the shipper and and unloaded by the purchaser. In addition, due to the regular and constant nature of ship navigation, clients can easily ship their products with low costs. Container terminals are important transition points where containers are transferred between land and sea. Containers also receive cargo loading & unloading and warehouse services at terminals. These services may pose the risk of becoming hazardous operations due to the content being serviced.

‘Dangerous goods’ mean the substances, materials and articles covered by the International Maritime Dangerous Goods (IMDG) Code.[3]

In a broad sense, the concept of "hazardous material" includes all materials in natural or waste form, which damage the environment and human health. After WWII, which was a significant turning point for the world history, this has become an important necessity for re-development of war countries. They are currently the most important raw materials in many large industrial branches such as construction, mining, paint/dye and cosmetics.

During the past 30 years, also the sea transportation of chemicals experienced significant changes, from drum and container use to larger tankers, originally used only for oil products transportation. Chemicals shipped by containers are gaining increasing popularity with the process industry. Discrete storage of hazardous chemicals in transportable containers poses different hazards as compared to conventional storage installations. The hazards connected with handling and storage of hazardous materials in port areas mainly originate from the complicated nature of activities taking place, the possibility of hardware failure, either in the ship, or in the inland and loading/unloading equipment, or from external events, such as bad weather conditions or fire/explosion in a ship close. [4]

Traditionally, the transport interfaces and the relevant hazards have always been controlled through directives, regulations and guidelines originating from the transportation sector. These are summarised in the so-called “Orange Book” (UN/ECOSOC, 1993), while special rec ommendations for each transport mode are also in use (such as the ADR recommendations for road transport. [5]

From the safety viewpoint, difficulties arise from the fact that the port authority has to depend on documentation provided by shippers, regarding chemical identity, classification and connected hazards. [6]

During container transportation, dangerous materials can cause significant unexpected accidents due to disturbing of container structural integrity or alteration of the cargo content. These accidents can occur when containers enter terminals, during warehousing, handling or transportation. These accidents significantly affect terminal personnel together with harbor personnel and the nearby civilian population.

Port management and handling operators should establish the security program to be implemented in port and ship operations. Security meetings should be periodically conducted, accidents should be reviewed and potential accidents within the operation system, together with their outcomes, should be discussed. Port security units should have full support from top management and security policies should be established by the port master, or senior managers of the port. [7]

In terms of container terminals and dangerous cargo handled in these terminals, it is indicated, by reference to the IMCO handbook of recommendations on handling dangerous cargo in ports, that the responsible and authorized party is port management. [8]

Along with the responsibility of all kinds of cargo, the port management should exercise utmost care in its approach to all stages of operations starting from cargo packaging, handling and to storage, against the risk of harming the environment, human life and port facilities due to inherent qualities of dangerous cargo. [8]

RESEARCH AND METHOD

This study discusses the approaches of 10 large and leading container ports in Turkey against dangerous cargo container operations. Selected container ports are the largest ports and they have the highest handling capacity. This study portrays a view of the priorities given to dangerous cargo handling operations, along with the order of importance pertaining to dangerous cargo types.

The study employs the Analytic Hierarchy Process (AHP) method.

AHP is a powerful and easy-to-understand method which enables reconciliation of qualitative and quantitative factors in the decision-making process. [9]

AHP is a measurement theory based o paired comparison according to a common criteria. AHP provides significant assistance to the decision maker in resolving of problems with multiple criteria and multiple options. An AHP problem is established with a hierarchical structure which consists of multiple levels. In the Analytic Hierarchy Process, a hierarchical structure, which consists of a purpose, criteria, possible sub-criteria levels and alternatives for every problem. [9]

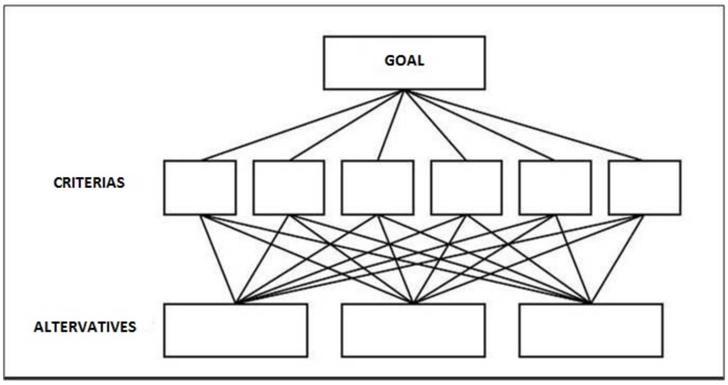

Figure 1. Three Level Analytical Hierarchy Model

The information prepared by IMO as suggestions regarding container terminals were utilized. Under the light of these information, questions were asked to the ports regarding their dangerous cargo operations. The information acquired were analyzed using the SuperDecision software.

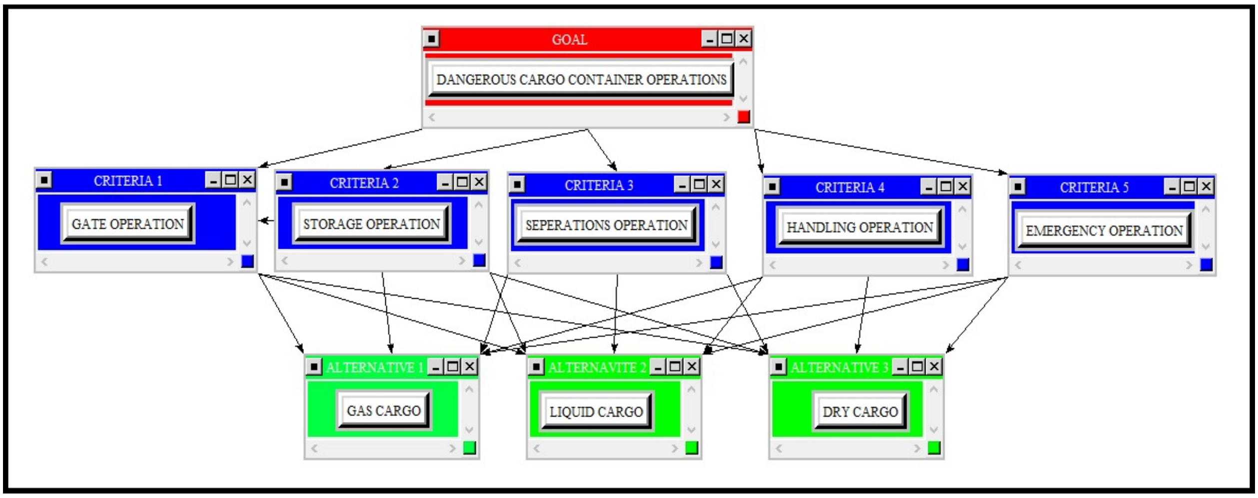

Figure 2. Dangerous Cargo Contaıner Analytical Hierarchy Model

The evaluations in the first stage of the research were analyzed under 5 main categories. These categories are; port entrance operations, storage operations, separation operations, handling operations and emergency operations for dangerous cargo. The study emphasizes the differences among the approaches of container ports in terms of dangerous cargo security management.

Second part of the study discusses the priorities of ports in terms of dangerous cargo types. Dangerous cargo are categorized into three main groups based on their structures. These groups are gas loads, liquid loads and dry loads.

DANGEROUS CARGO SECURITY MANAGEMENT STUDY

Container Port Dangerous Cargo Container Operation Priorities

The order of priorities of the 10 container ports in terms of dangerous cargo container operations is expressed in numerical values, as follows:

Table 1. Numerical Values Of The Responses Given To Operations Of Hazardous Cargo Container

PORTS	DANGEROUS GOODS CONTAINER OPERATIONS				
	GATE OPERATION	STORAGE OPERATION	SEPERATION OPERATION	HANDLING OPERATION	EMERGENCY OPERATION
PORT A	0,02163	0,10435	0,20129	0,05233	0,6204
PORT B	0,04528	0,26671	0,09219	0,17062	0,4252
PORT C	0,03289	0,07578	0,13726	0,14907	0,605
PORT D	0,10813	0,04726	0,08963	0,1	0,65498
PORT E	0,60952	0,08927	0,10829	0,14849	0,04443
PORT F	0,4446	0,10445	0,10552	0,17272	0,17271
PORT G	0,1077	0,0298	0,12906	0,12906	0,60438
PORT H	0,08503	0,08893	0,08176	0,23854	0,50574
PORT I	0,02963	0,14666	0,13626	0,03045	0,657
PORT K	0,03369	0,14095	0,09189	0,17065	0,56282

As seen above, the values of operations significantly vary among the ports. Every port approaches operations on different levels, therefore scoring them accordingly. It is observed that entrance operations and emergency operations include the highest amount of differences.

Based on the information acquired, the types of operations for the 10 container ports, sorted in terms of dangerous cargo importance priority, are as follows:

Table 2. Dangerous Cargo Container Operations Order Of Precedence

	DANGEROUS GOODS CONTAINER OPERATIONS				
PORTS	**1.OPERATION**	**2.OPERATION**	**3. OPERATION**	**4.OPERATION**	**5.OPERATION**
PORT A	EMERGENCY OPR.	SEPERATION OPR.	STORAGE OPR.	HANDLING OPR.	GATE OPR.
PORT B	EMERGENCY OPR.	STORAGE OPR.	HANDLING OPR.	SEPERATION OPR.	GATE OPR.
PORT C	EMERGENCY OPR.	HANDLING OPR.	SEPERATION OPR.	STORAGE OPR.	GATE OPR.
PORT D	EMERGENCY OPR.	GATE OPR.	HANDLING OPR.	SEPERATION OPR.	STORAGE OPR.
PORT E	GATE OPR.	HANDLING OPR.	SEPERATION OPR.	STORAGE OPR.	EMERGENCY OPR.
PORT F	GATE OPR.	HANDLING OPR.	EMERGENCY OPR.	SEPERATION OPR.	STORAGE OPR.
PORT G	EMERGENCY OPR.	HANDLING OPR.	SEPERATION OPR.	GATE OPR.	STORAGE OPR.
PORT H	EMERGENCY OPR.	HANDLING OPR.	STORAGE OPR.	GATE OPR.	SEPERATE OPR.
PORT I	EMERGENCY OPR.	STORAGE OPR.	SEPERATION OPR.	HANDLING OPR.	GATE OPR.
PORT K	EMERGENCY OPR.	STORAGE OPR.	HANDLING OPR.	SEPERATION OPR.	GATE OPR.

As seen in the above table, while emergency operations are generally given priority, some ports prioritize entrance operations.

Calculating the average values of data acquired from container ports, we get the below order of importance for dangerous cargo container operations:

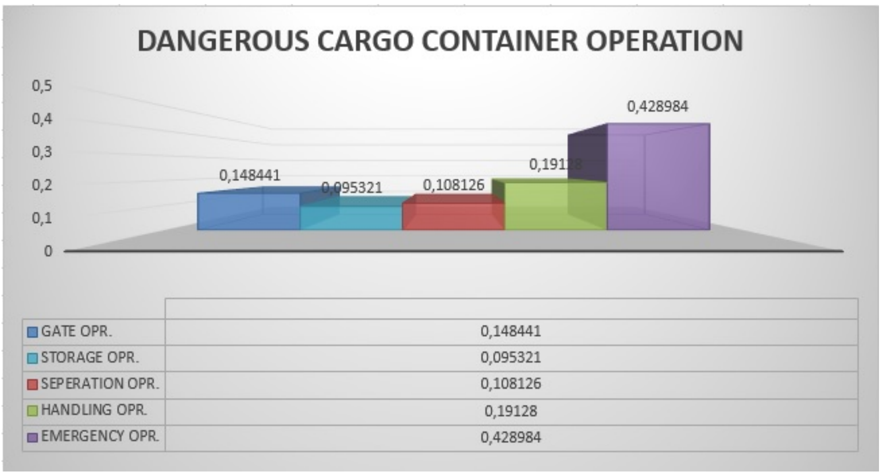

Figure 3. Dangerous Cargo Container Operations

Under the light of the above information, it is understood that ports prioritize emergency operations. Handling operations follow emergency operations in this regard. The reason for this is the inherent qualities of dangerous cargo that pose a risk to the environment.

Container Port Dangerous Cargo Type Priorities

Container ports answered the questions based on the types of dangerous cargo in the containers they handle. The analyses on the answers of 10 container ports on the types of dangerous cargo are presented below:

Table 3. Numerical Values Of The Responses Given To The Types Of Dangerous Goods

PORTS	DANGEROUS GOODS TYPES		
	GAS CARGO	LIQUID CARGO	DRY CARGO
PORT A	0,7104	0,23028	0,05932
PORT B	0,77849	0,17993	0,04158
PORT C	0,6175	0,29687	0,08563
PORT D	0,56347	0,34893	0,08761
PORT E	0,52647	0,42076	0,05277
PORT F	0,70161	0,18253	0,11587
PORT G	0,73415	0,20226	0,06359
PORT H	0,77662	0,18145	0,04194
PORT I	0,46251	0,46251	0,07498
PORT K	0,73021	0,2041	0,06569

Upon studies, the above data clearly indicates that gas loads are the most important dangerous cargo type. Since gases are in the most dangerous cargo class, they are at the top of the order of importance. However, one port is seen to assign the same values to both gas and liquid loads.

Based on the information acquired, the order of importance established by the 10 selected container ports is, as follows:

Table 4. The Order Of Importance Given The Dangerous Loads

PORTS	DANGEROUS GOODS TYPES		
	1.TYPE CARGO	2. TYPE CARGO	3.TYPE CARGO
PORT A	GAS CARGO	LIQUID CARGO	DRY CARGO
PORT B	GAS CARGO	LIQUID CARGO	DRY CARGO
PORT C	GAS CARGO	LIQUID CARGO	DRY CARGO
PORT D	GAS CARGO	LIQUID CARGO	DRY CARGO
PORT E	GAS CARGO	LIQUID CARGO	DRY CARGO
PORT F	GAS CARGO	LIQUID CARGO	DRY CARGO
PORT G	GAS CARGO	LIQUID CARGO	DRY CARGO
PORT H	GAS CARGO	LIQUID CARGO	DRY CARGO
PORT I	GAZ AND LIQUID CARGO		DRY CARGO
PORT K	GAS CARGO	LIQUID CARGO	DRY CARGO

The order of importance on the dangerous cargo types above indicates that gas loads are given priority. Gas loads are then followed by liquid loads and dry loads.

Calculating the average values of data acquired from container ports, we get the below order of importance for dangerous cargo container operations:

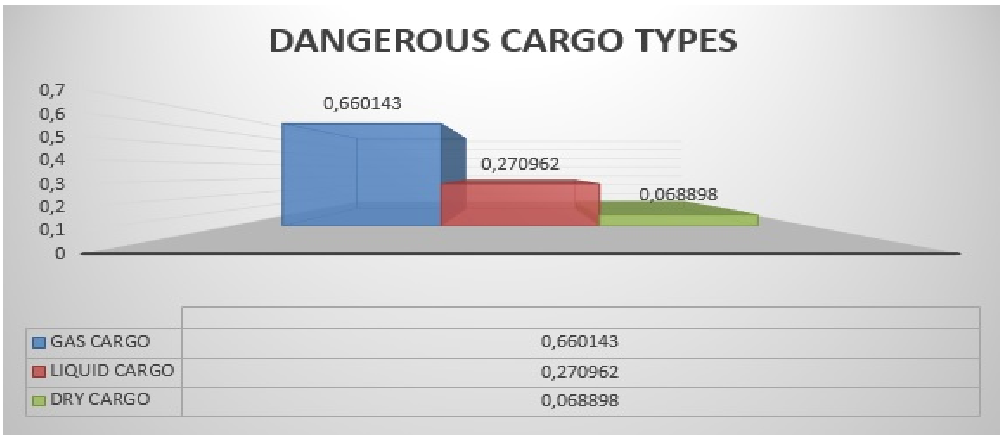

Figure 4. Dangerous Cargo Types

EVALUATION AND CONCLUSIONS

First section of the study discusses the order of importance for dangerous cargo container operations. This discussion leads to the finding that, most ports prioritize emergency operations. The fact that ports prioritize these operations in terms of importance indicates the value attached to the safety of the personnel and the important attached to environment-sea pollution. Handling operations are the second most important operation type. It is known that dangerous cargo suffer damages due to accidents happening during the stages of carrying, loading and unloading. Other operations are at approximately the same level of importance. This indicates that ports prioritize emergency and handling operations. Based on the data acquired in the study, it is observed that two ports prioritize entrance operations in terms of the order of importance. Through strict checks at port entrances, it is made sure that risky and dangerous cargo safely enter the ports. Other ports attach less importance to entrance operations. This is open to discussion.

Here it is concluded that the ports vary in terms of security management. This outcome is further supported by the varying levels of priorities attached by the ports to different types of operations. Even though they are subject to the same international and national rules, container ports differ in their security management. Every port defines its own security priorities within the framework of their own rules and security policies.

Second part of the study analyzes the order of importance established by the container ports in terms of dangerous cargo types. According to this, most of the ports prioritize gas loads in terms of importance. The fundamental reason for this is the fact that gases can, inherently, quickly disperse into an environment, therefore posing a threat to the personnel. No discord was observed among the ports in terms of this subject. Acquired data exhibits only one port attaching the same level importance to gas and liquid loads. Liquid loads are in the second level of importance, in that they can disperse to and damage a comparatively more limited area. dry loads inherently have the lowest risk of dispersion. Intervention operations for gas and liquid loads include more serious threats. However, dry loads can be controlled more easily.

Based on these findings, we can say that all ports have the same approach against dangerous cargo. Security managements have the same perspective in terms of the risks of danger caused by cargos. The importance levels and operations of cargos are defined according to their risk levels. The fact that ports share the same approach in this subject indicates the great level of care in the ports regarding dangerous cargos.

The study shows that container ports may establish different security management systems. It is also observed that ports centralize human life and environmental security within their common security management. Although the levels of priority for operations are different, the level of importance attached to dangerous load types is identical. This indicates the great level of rigor and care exercised in dangerous cargo operations. Ports spend efforts to maintain their operations in line with international and national rules, and respect fundamental values.

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INVESTIGATION OF MARINE ACCIDENTS IN ISTANBUL STRAIT

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ABSTRACT

Istanbul Strait, connecting the Marmara and Black sea, is an extremely risky waterway due to the geographical features. On average, 50000 vessels pass through Istanbul Strait per year and 894 marine accidents/incidents took place within the last 15 years. Istanbul Strait contains high risks for marine accidents such as collision and grounding of the vessels due to the intense marine traffic in the strait and sharp turns with crosscurrent. İstanbul Strait is a waterway that there should be done nearly 20 alterations of course and 4 of them require a sharp alteration of course more than 45º. In this study, the marine accidents occurred between January 2001 and March 2016 are analyzed and an attempt made to find root cause of collision and grounding type of accidents. It is find out that collision is the most encountered accident and the grounding is the second; furthermore, accident locations are plotted on the map to determine risk areas. Finally, counter measures proposed and discussion made to prevent occurrence of the accidents.

Key Words: Marine Traffic, İstanbul Strait, Marine accident, Turkish Straits, grounding and collision

INTRODUCTION

Approximately 90% of world and Turkey’s trade is carried by sea transport. Sea transportation allows the transport cargoes in large quantities at one time. It’s cheaper than railway transport by 3.5 times, 7 times compared to road transport and 22 times compared to air transport [1]. Due to being the cheapest and greater for the goods to be transported in large quantities, and in spite of ever-increasing safety standards, marine transportation is always full with the risk and it will continue to be [2].

On average, 50,000 vessels pass through Istanbul Strait. As an inevitable consequence of intense marine traffic, high number of marine accidents take place in such waterway. In the recent years, volume of the local marine traffic, fishing activity and yacht traffic increased. Thus, risk of collision and grounding in such narrow space has increased. In the study conducted by Hoyos in 2004, 6 accidents happen in 1 million passage at Turkish Straits; also, it is stated that this ratio is double of the ratio in Suez Canal [3]. According to T.C. Ministry of Transport, Maritime Affairs and Communications Search And Rescue Coordination Center (SRCC) data, 894 marine accidents have occurred in the last 15 years. Istanbul Strait contains

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high risks for marine accidents such as grounding and collision of the vessels due to not only intense marine traffic but also strong current.
The size of commercial vessels passing through the Istanbul Strait have not changed much but tonnage of the cargo especially dangerous good has increased in recent years. In fact, the chemical and hazardous materials carried by the ships which is varied has increased. According to Turkish Straits Marine Traffic Regulations rule 13, transit speed of a ship should not be more than 10 knots over water in the Istanbul and Çanakkale Straits. Therefore, not having enough rudder angle force, vessels might not make sharp alterations which may result in many accidents [4]. There is various study analyze marine accidents in the Istanbul Straits with various methods. Due to importance of the issue, an attempt is made in this study to look to marine accidents from a different perspective with latest marine accident statistics.

LITERATURE REVIEW

Istanbul Strait, connecting the Marmara and Black sea, is an extremely risky and important waterway due to the geographical, economical and political features. So it is important to analyze marine accidents that took place to prevent reoccurrence and also protect the Istanbul Strait. There are numerous academic studies related to marine accidents and risk analyzes in İstanbul Strait. Some of them as follows.

Atasoy C. analyzed the volume of local traffic and tried to determine hazards to be considered by using variables such as pick hours, natural difficulties due to environmental conditions [5]. Environmental Stress Model was used in his study. He calculated risks during pick hours and other than pick hours respectively as %61.2 and %51.4.

Ece J.N. analyzed the geographical, meteorological, hydrological, oceanographic, economic and strategic features, marine traffic, marine accidents and statistics, existing safety measures and innocent passage requirements of the Istanbul Strait [7]. Accident maps produced by doing statistical analysis. It was found that there was linear relation between numbers of accidents also, having pilot on board, meteorological and ship tonnage play an important role in accidents.

Or I. and Kahraman I. analyzed the contributing factors in the accidents by using Bayasian Analysis and simulation modeling[8]. According to simulation results, the increase in transit vessel traffic, local traffic volume, higher share of the longer ships and the weather conditions are important factors for the increase of the number of accidents.

In addition to these, Koldemir B. performed application study regarding marine accidents in Istanbul Strait and determined risk areas by using accident black point analysis method [9]. It was found that areas between Rumelihisarı - Anadoluhisarı and Ortaköy – Beylerbeyi are most risk areas.

Accidents occurred in the Istanbul Strait in the studies mentioned above have been examined by various methods. In this study, the most experienced 2 types of accidents occurred in Istanbul Strait (collision-grounding) is discussed, the location of this accidents founded and precautions are suggested. Not only classification is made with regards to gross tonnage for collision but also the need of focus on small gross tonnage to prevent marine accidents in the Istanbul Strait is highlighted.

ISTANBUL STRAIT

Geographical Features of Istanbul Strait

Istanbul Strait is the second busiest waterway after Malacca Strait and has many risks in terms of vessel traffic with the length of 17 miles. It connects Black Sea to Marmara Sea. The narrowest point is between Anadolu Hisarı and Rumeli Hisarı with 700 meters while the widest point in the north is between Anadolu Lighthouse and Türkeli Lighthouse with 3600 meter, in the south between Ahırkapı Lighthouse and İnciburnu lighthouse with 3220 meter [10].

When the vessels pass through Istanbul Strait, they must alter their course 12 times. These alterations are especially at the narrowest area around 700 meters width with 45 degrees turn between Kandilli-Aşiyan and 80 degrees at Yeniköy with regard to both turn and current most risky areas [11].

Figure 1.The Istanbul Strait satellite photo

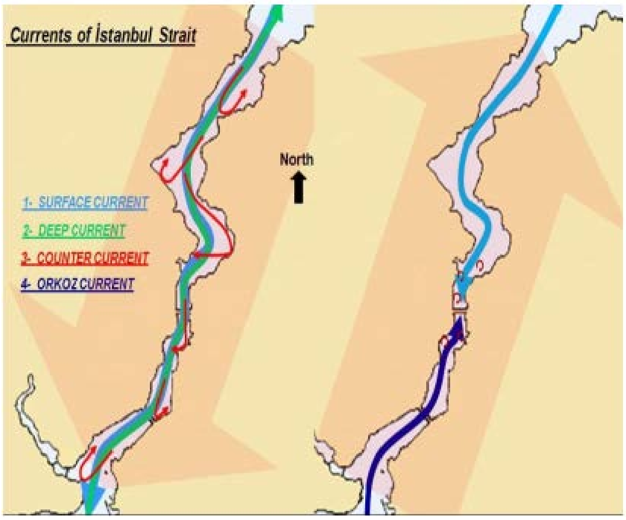

Figure2. Current chart of Istanbul Strait.

Depths

The depth ranges from 30 meters to 110 meters in Istanbul Strait. The depth increases from south to north. Although the depth does not affect the navigation negatively at Istanbul strait, the depth is 10 meters in certain areas. And sometimes, any failure of the vessels may result in a grounding directly at shore. [10].

Banks

Kız Kulesi in Istanbul Strait is surrounded by rocks and banks and the bank is connected to the shore from east with a shallow. The depth of Sarayburnu banks change between 1-10 meters [10].

The Current System of Istanbul Strait

There is a two layered current pattern in Istanbul Strait. The current from Black Sea to Marmara Sea flows on surface and Mediterranean water flows from Marmara Sea to Black Sea at the bottom of the Istanbul Strait. Sometimes, the reverse currents can also be seen on the surface [12]. Current system is affected by the dominating winds. Current speed increases up to 7 knots when the North winds are effective. Normally the current speed is around 3-4 knots [13].

Visibility

Poor visibility is another factor effecting the accidents in Istanbul Strait time to time. Because of fog, snow and rain, the accident rate is high when the visibility falls to 0.5 miles and below. The best visibility is in the evening between December-January, at noon in other months [14].

METHOD

In this study, SRCC's data are used for the marine accidents in Istanbul Strait between 2001 and 2016. The following table illustrates the sample of accident data located in the SRCC's website.

Table 1. The Sample of accident data located in the SRCC's Web Site

Sıra No	Tarih	Saat	Bölge	Adı	GRT	Tipi	Bayrağı	Yeri	Kaza nedeni	Kaza tipi	Kişi Bilgileri	Düşünceler (Sonuç)	
1	06.05.2016	22:25	ISTANBUL	CMB EDOUARD MOBİDİK	20846 1	KURUYÜK GEMISI	HONG KONG	KURUÇEŞME Koordinatlar ENLEM:41. 03 BOYLAM:029.02	BİLİNMİYOR	Çatisma/ Collision	Kurtarılan İnsan: 0 Kayıp:0 Ölü:0 Yaralı:0 Hasta:0	06.05.2016 günü saat 22:25?de İstanbul Boğazı Kuruçeşme açıklarında Hong Kong bayraklı CMB EDOUARD isimli kuru yük gemisi MOBİDİK İsimli gezi teknesine sürtmüş olup, her iki gemide de hafif hasar oluşmuş olayda can kaybı ve yaralanma rapor edilmemiştir. Bahse konu gemi Türkeli Demir yerine sevk edilerek idari tahkikat başlatılmıştır.	detay
2	08.04.2016	03.44	ISTANBUL	SW MONACO KAAN SONAY	25108 856	TANKER	PANAMA TÜRK	TÜRKELİ FENERİ ÖNLERİ Koordinatlar ENLEM:41. 15 BOYLAM:29.25	HATALI SEYİR	Çatisma/ Collision	Kurtarılan İnsan: 0 Kayıp:0 Ölü:0 Yaralı:0 Hasta:0	08/04/2016 GÜNÜ SAAT 03:44 DE GÜNEY KUZEY BOĞAZ GEÇİŞİ YAPAN TÜRK BAYRAKLI KAAN SONAY GEMİSİ İLE PANAMA BAYRAKLI SW MONACO İSİMLİ TANKER TÜRKELİ FENERİ 2 MİL KUZEY DOĞUSUNDA ÇATIŞARAK DENİZ KAZASINA SEBEBİYET VERMİŞLERDİR.ÇATIŞMA NETİCESİNDE CAN KAYBI ÇEVRE KİRLİLİĞİ RAPOR EDİLMEMİŞ HER İKİ GEMİNİNDE YARDIM TALEBİ OLMADIĞI BİLDİRİLMİŞTİR.	detay

It is observed that there is missing data regarding marine accidents and a need of improvement of SRCC database to be able to make a detailed statistical analysis. For instance, in the tables some vessels gross tonnages are not input and vessel types are not determined in some other accident data. Furthermore, accident location sometimes expressed with area and sometimes with coordinate. The coordinates given in the accident do not have second degrees and minutes. Also marine accidents have been classified into different ways by different expression. For example, dragging anchor resulting with contacts with other ships classified as "collision", in another accident it is expressed as "contact". The classification of types of ships involved in the accident shows the differences. For instance, the ship types which can participate in same categories such as "tanker", "other tankers", "oil tanker", expressed in different categories. In the classification by the flag of the ship involved in the accident shows the differences. It is seen that national flags classified under different expression such as "not known", "TC", "Turkish". Due to certain shortcomings of accident data used in the study, we could not achieve full objectives of the study but sufficient amount to present in this paper and to reach a conclusion.

Graphics have been created by the Microsoft Office Excel program and consequently, the accidents are analyzed. Not only the vessels are divided according to the type and gross tonnage, but also the accidents are categorized into types. Finally, graphics are created. In this study, the types of vessels are classified as shown in Figure 3.

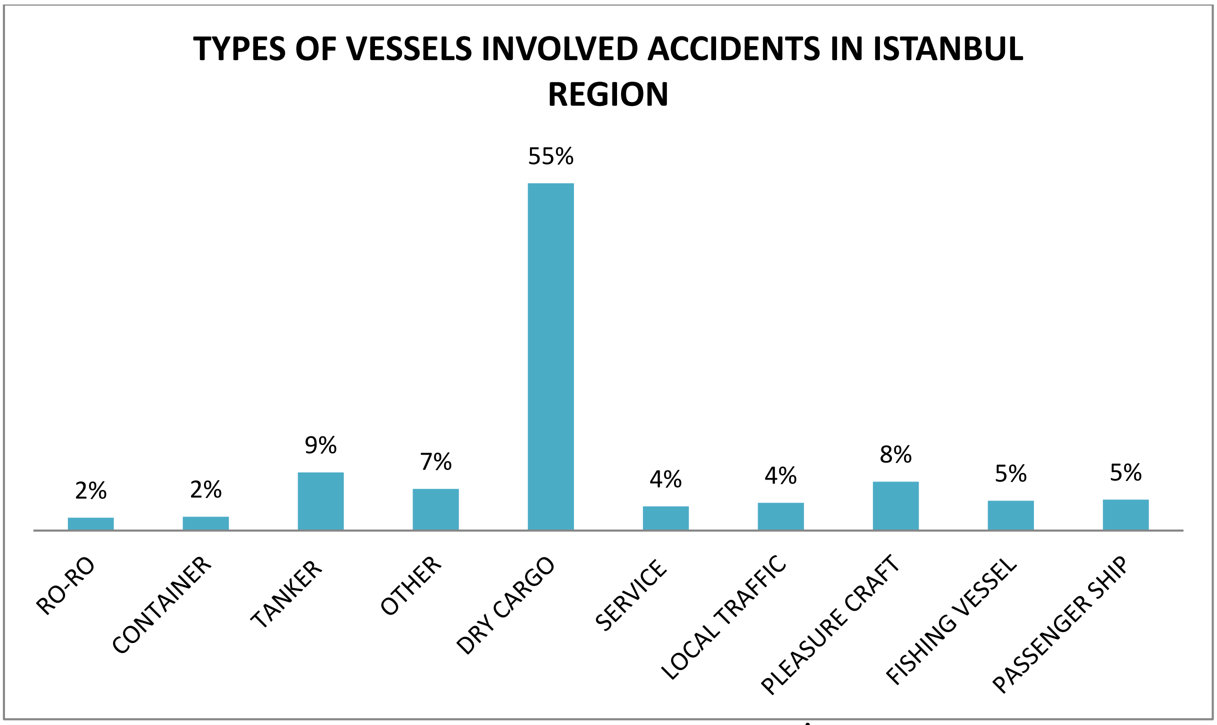

Figure 3.Typesof Vessels Involved Accidents in İstanbul Region

Vessels passing through the Istanbul Strait are classified as shown in Figure 4. 56% of the accidents occur 0-2999 gross tonnage vessels in this area.

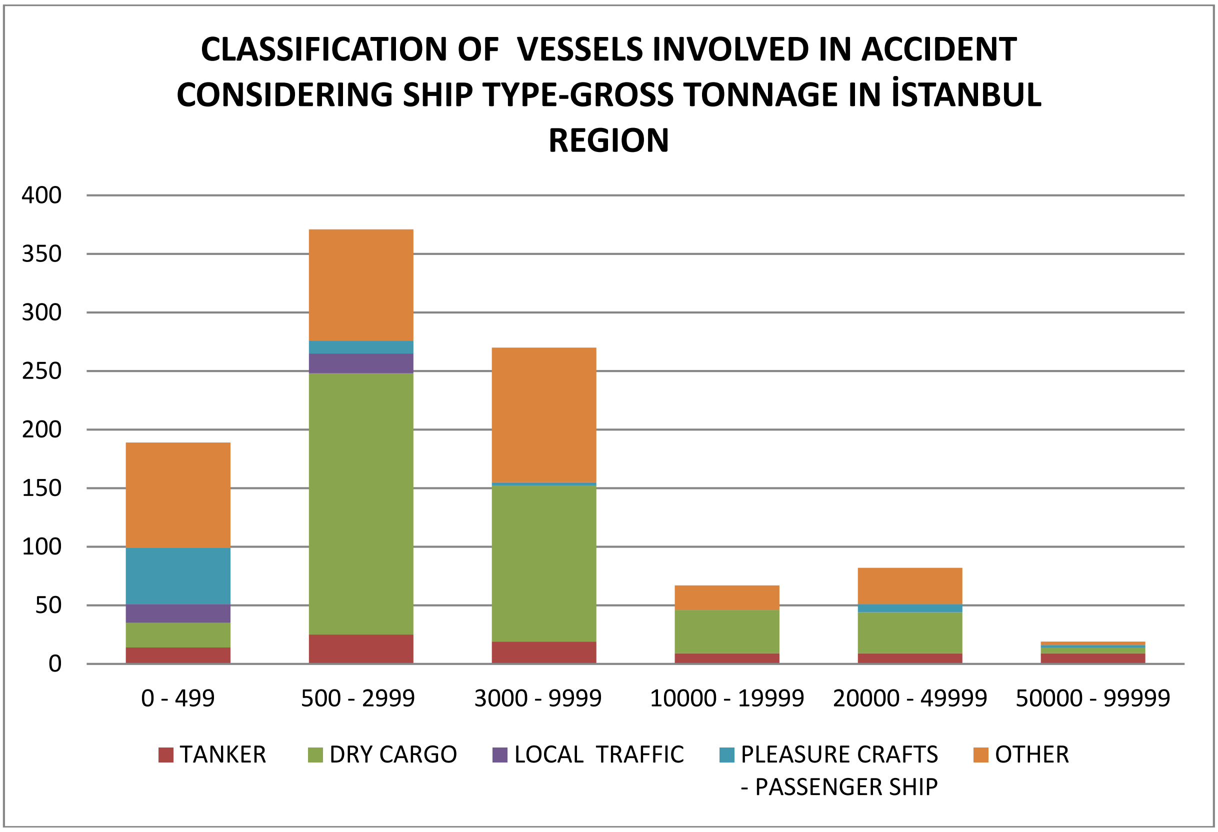

Figure 4. Classification of vessels involved with accident considering ship type - gross tonnage in Istanbul Region

The types of accidents in this study are made to be the same as SRCC's classification (Figure 5).

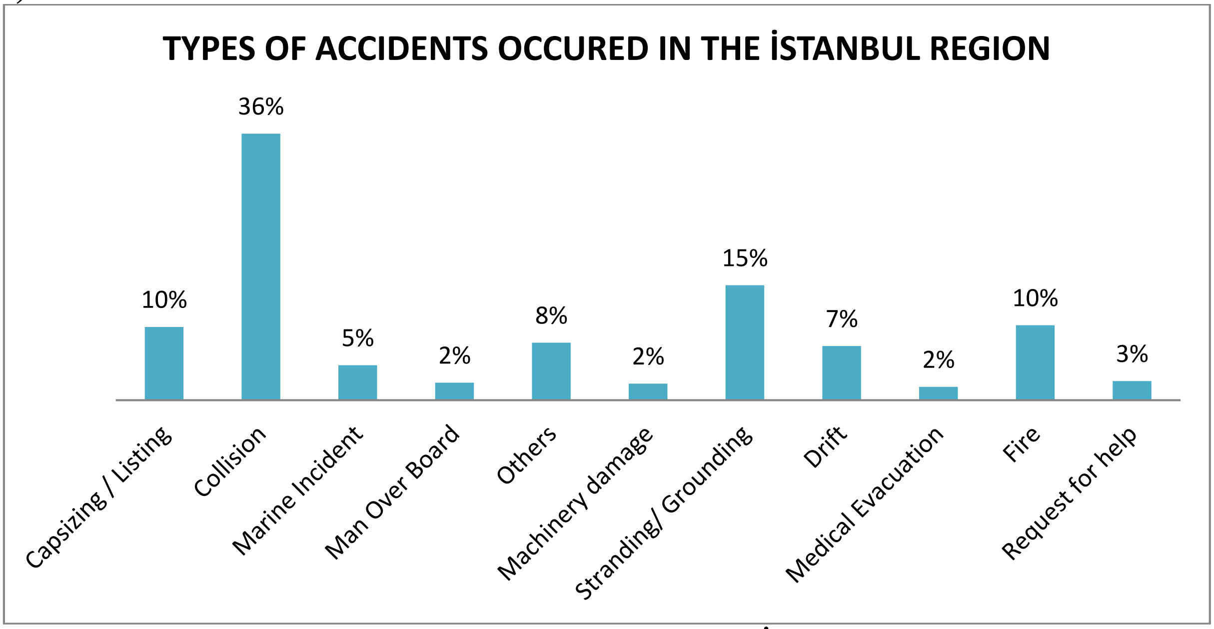

Figure 5.Typesof Accidents Occurred In İstanbul Region

ANALYSIS OF MARINE ACCIDENTS OCCURRED IN İSTANBUL REGION AND THE FINDINGS

894 marine accidents take place between January 2001 to April 2016 in İstanbul region. While the most experienced type of the accident is collision with 36%, the least common type accidents piracy with one incident. In the study of Ece (2005) collision was also the most experienced type of accident in Istanbul Strait [7]. In this study it is pointed that 1234 vessels were involved to 894 marine accidents. Due to more than one vessel's involvement in one collision accidents, the number of vessel is more than the number of accident. The dry cargo is the most accident involved ship type by 47% (584 vessels). Gross tonnage analyses of the ships involved to accidents indicate that the highest accident involvement rate is 37% of vessel between 500-2999 gross tonnage. It is determined that the total accident rate of the vessels up to the 10,000 gross tonnage is 83% of all accidents.

Apart from these, it is found out that grounding and collision accidents are 51% of total accident. Thus, accidents of this type have been examined in detail. These accidents are plotted on to the map by using Google Earth where grounding type accidents demonstrated by yellow and collisions by red as shown in Figure 6. Hence, the areas that accidents occur frequently and requires special precautions are illustrated.

Figure 6. The Locations of Grounding and Collision/Contact Accidents Occurred İstanbul Strait

Figure 7 shows the fluctuation of grounding and collision/contact accidents occurred İstanbul Strait according to gross tonnage.

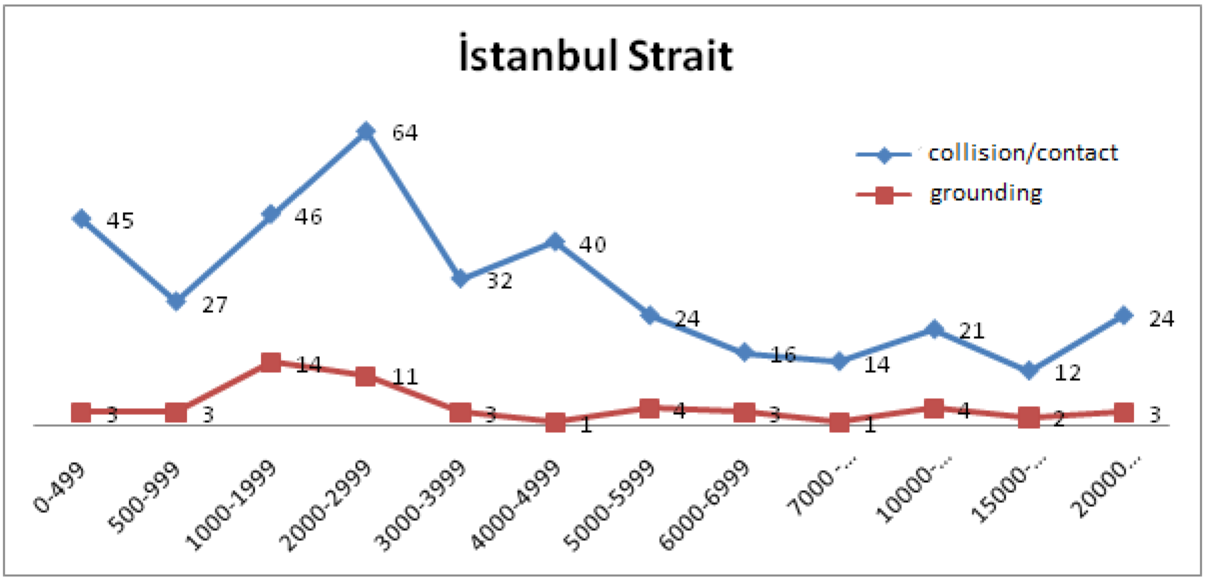

Figure 7. The Fluctuation Of Grounding And Collision/Contact Accidents Occurred In İstanbul Strait According To Gross Tonnage.

In last 16 years, 175 collision/contact and 52 grounding accidents have occurred in Istanbul Strait. Besides, totally out of 31 collision/contact accidents, 11, 11 and 9 accidents occurred at Türkeli, Kartal and Tuzla anchorage area respectively.

As to the analysis regarding areas, on the one hand, 130 grounding and 27 collision/contact accident occurred at around Sarayburnu-Haydarpaşa. On the other hand, grounding accidents occurred between Yeniköy-Umuryeri. The accidents occurring especially in the coastal Yeniköy are considered as aground but it is thought that this area is shallow and this type of accident is considered as allison to the land. As a matter of fact, whereas Ahırkapı anchorage area along with the area between Sarayburnu- Haydarpaşa are the most risky area with regards to collision/contact accident, the area between Yeniköy and Umuryeri is the most risky area in terms of grounding.

254 of 365 vessel involved in the accident are between 0-4999 gross tonnage, 54 are 5000-9999, 33 are 10000-19999, and 24 are 20000 gross tonnage and over.

When the accidents analyzed according to watch hours, it is observed that the highest rate belongs to the middle (Midnight-0400) watch with the rate of 25% and the lowest rate is 8% in the morning (0400-0800) watches. The highest rate of involved accidents is the vessels with Turkish flag with 47%, and 53% of the accidents are due to the foreign vessels.

Sinking and collision risks caused by ships carrying dangerous cargo are threatening the marine ecosystem of İstanbul Strait, coastal settlements miles away from shore and settlement areas [15]. As in the example of crude oil tanker Exxon Valdez which grounded in Alaska shores in March 1989, Although the accident happens miles away from settlements, hazards of ship sourced pollution to environment might be very excessive [16]. 3 billion USD is spent for cleaning the pollution after the Exxon Valdez disaster; however, it is known that only very small part of the pollution could be cleaned.

CONCLUSIONS AND RECOMMENDATIONS

As a result of the analysis the most occurred marine accidents types is collision which is followed by grounding. Most of the collision and grounding types of accident occurred around Ahırkapı anchorage area. Accidents take place in this area due to high utilization of anchorage which is triggered by heavy weather conditions and poor seamanship practices. Due to banks around Kız kulesi, strong surface currents and the narrow water way grounding and collision type of accidents takes place in the Istanbul Strait. Despite the fact that pilotage reduce risk of marine accident, it is not mandatory having pilot onboard during passage. While the number of the ships having pilot on board is increasing by years, it is still not sufficient enough. It is known that the number of bigger ships having pilot on board are more than the small sized ships. There are serious precautions implemented for big size vessel. However, the vessels less than 10,000 gross tonnage ships that involve in 85% of the marine accidents are considered as low risk factor based on result of face to face non-structured interview with VTS operators. Due to high accidents statistics, small size vessel should be considered as high risk in the maritime traffic planning.

It is concluded that education level of captain and officers works on small tonnage ships are lower compared to bigger ships. High accident rate indicates need of improvement on the education quality in order to prevent accidents.

Dense marine traffic in the Istanbul Strait is another factor that increase the risk of accidents in the region. According to accident statistics, local traffic involves in 8% percent of the marine accidents. It is suggested to conduct practical training and increasing awareness of officer on local traffic vessel and small size ship to improve the navigational safety.

Under Maritime Traffic Regulations for The Turkish Straits according to article 15 “Vessels which involved in an accident, having equipment / machinery failures or dropped anchor in an emergency, shall immediately notify the Traffic Control Center and request instruction. After the safety assessment for the vessel and the environment are taken by the relevant port authority such vessel may resume passage with a pilot on board and in compliance with other necessary requirements of the Administration for the safe passage.” In this respect it is compulsory to have pilot on board after the accident. In order to reduce groundings and collision type accidents, having pilot on board should be encouraged.

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EVALUATION OF MARINE POLLUTION CAUSED BY TANKER SHIPS AND PREVENTING UNDER FOCUS OF THE INTERNATIONAL REGULATIONS

Ersoy Kacmaz[1], Gökhan Kara[2], Murat Yıldız[3]

ABSTRACT

Oil has been important good to industry since 19th century, Despite of oil has been known for antique age. After that time, produce oil has increased. Carry of oil has increased on ships from sources of oil to industrial countries. Shipping industry and related sides in world were introduced to new problem, that is called ''Marine Pollution''. It's believed that caused by vessels mainly, especially tanker ships. In case of pollution that caused by vessel, reason is an accident or a neglect. Governments and international organizations have been issued regulations about prevention pollution and reducing risk of pollution. When governments apply their national regulations, they aim protected regional area. International regulations' target is over all seas. Accordance to statistics, new applying regulation has reduced spillage of oil and other polluted substances from tanker ships. In this study, International regulations to marine pollution prevention caused by vessel are reviewed and evaluated affecting on accident that caused pollution from tanker ships.

Keywords – Marine Pollution, International Maritime Regulations, Accident, Tanker Ships

INTRODUCTION

Oil and oil product are carried from sources and refineries to markets and refineries by vessels and this transportation is being increased with global economy situation. Petrol and It's products are needed by various industries and refineries as raw, semi raw or final product with great tonnage.

Every carrying cargo at sea caused pollution risks. Especially cargoes vessels as below own high risk on any spillage or accident cases. The world was introduced to a new term that is called "Marine Pollution" in early of 20th century, by the time carriage of crude oil had just started [1]. Polluted cargoes own environmental risks. It's believed that vessels pollution risks consist to cause. In case of pollution that caused by vessel, reason is accident or neglect. At the same time facilities and ports might be responsibility parties. Governments and international organizations have been published and

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applied regulations about prevention pollution a reducing pollution risks. This study reveals precautions and analyses affecting to reduce pollution by forced regulations at sea.

International regulations' target over all seas. In fact that, MARPOL (International Convention for the prevention of pollutions from ships) is significant and main regulation about it. This study reveals effect of regulations on reducing pollution at sea by vessel.

OIL TANKERS POLLUTIONS

Oil Tankers

Oil and oil products are carried by specific vessels. They are named tanker ships. They are known petroleum tankers or oil tankers. They are separated into groups as crude tankers and product tankers. Crude tankers are carried crude oil from terminal, where is next to source area from refineries. Product tankers are carried gasoil, gasoline, jet fuel, kerosene, asphalt, naphtha that produced from crude petroleum. Product tankers are loaded these cargoes at refineries and carried to other petroleum terminals, refineries on presented to markets. First modern tanker was seen in Baku, Azerbaijan and dated in 1877's. A lot of tankers have been built various tonnages, sizes from past to the present time. There are oil tankers different tonnages between 10,000 tones and 550,000 tones in world merchant fleet [2].

Table 1. Oil tankers sizes as class [3]

Class 1st	**Size in Deadweight**	**Class 2nd**	**Size in Deadweight**
General Purpose tanker	10,000–24,999	Product tanker	10,000–60,000
Medium Range tanker	25,000–44,999	Panamax	60,000–80,000
LR1 (Large Range 1)	45,000–79,999	Aframax	80,000–120,000
LR2 (Large Range 2)	80,000–159,999	Suezmax	120,000–200,000
VLCC (Very Large Crude Carrier)	160,000–319,999	VLCC	200,000–320,000
ULCC (Ultra Large Crude Carrier)	320,000–549,999	ULCC	320,000–550,000

Pollution at Sea Caused by Oil Tankers

Oil and oil products cargoes on carried by tanker vessels have risks. One of the main risk is pollution of environment due to various reasons. In case of pollution that caused by vessel, reason is accident or neglect. At the same time facilities and ports might be responsibility parties. Governments and international organizations have been published and applied regulations about prevention pollution and reducing pollution risks.

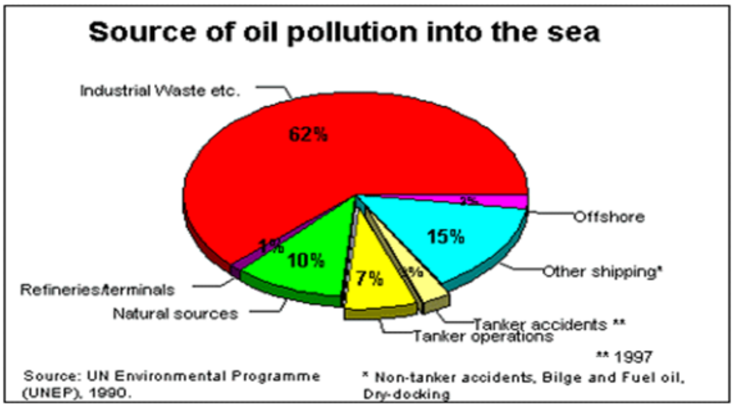

Figure 1. Source of Oil Pollution Into Sea [4]

In fact those tanker vessels have share percent 10 in all pollution reasons as per figure 1. All international organizations and governments try to reduce this ratio with regulations in that despite of a few accident relevant tanker accidents, there was large scale pollution in a few tanker accidents.

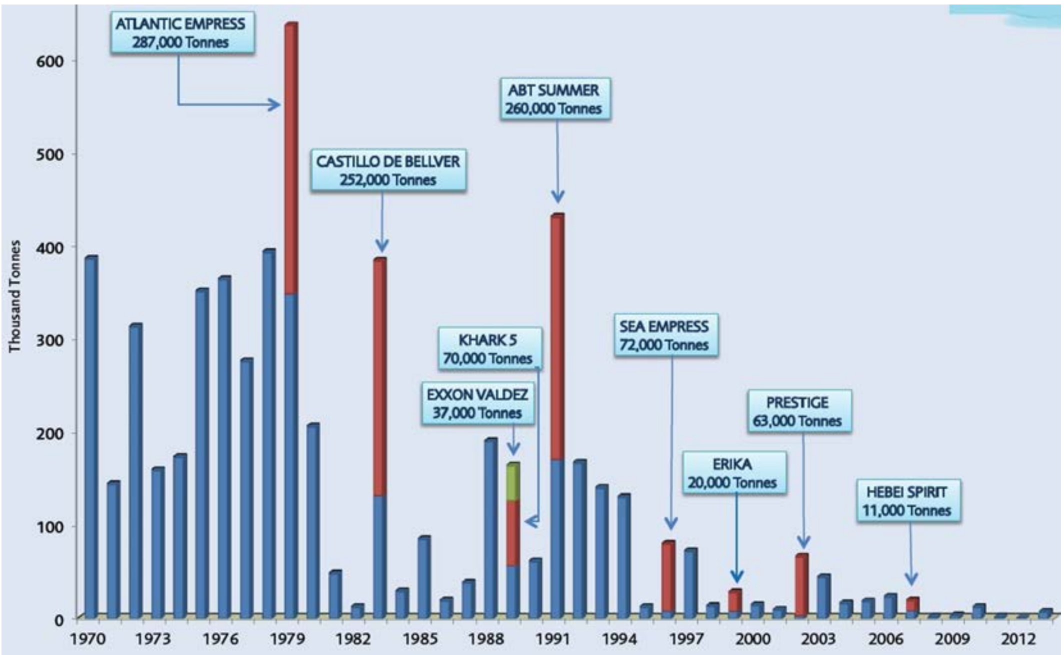

Figure 2. Number of Large Spillage [5]

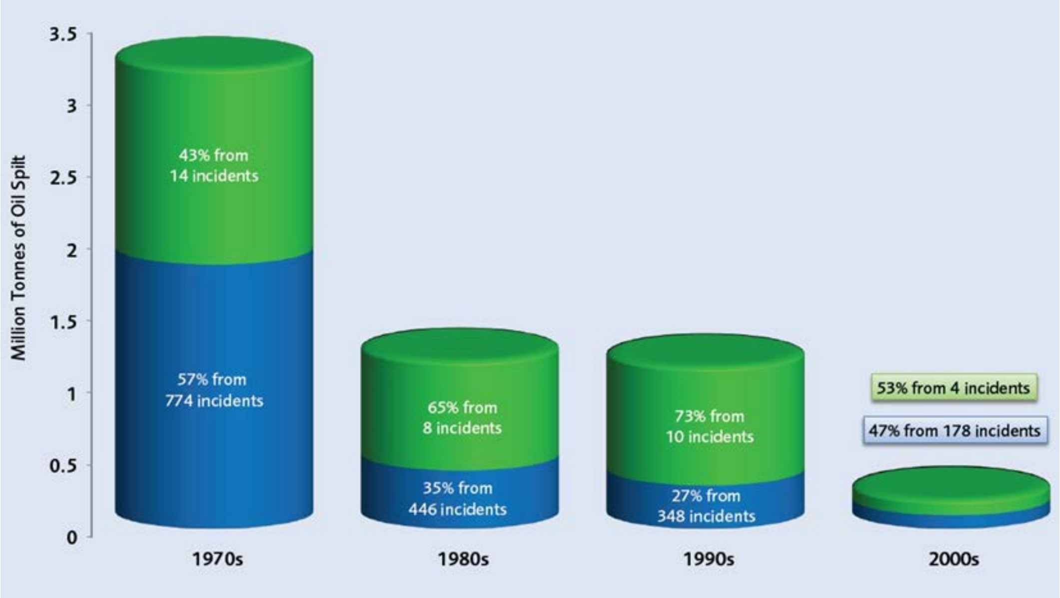

Figure 3. Comparing large spills on overall accidents [5]

When Governments apply their national regulation, they aim protected local area. International regulations' target over all seas. In fact that, MARPOL (International Convention for the prevention of pollutions from ships) is significant and main regulation about it. Especially, Annex 1st in MARPOL includes prevention of pollution with oil, oil product caused by vessels. After that Oil Pollution Act 1990 (OPA), International Safety Management (ISM) Code, Ship Inspection Report (SIRE) Program, International Convention of Standards of Training and watchkeeping and seafarers 1978 (STCW), Tanker Management and Self-Assessment 2004 and 2008 (TMSA) are entered regulations and applications mainly.

MARPOL

The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. The MARPOL Convention was adopted on 2 November 1973 at International Maritime Organization (IMO). The Protocol of 1978 was adopted in response to a spate of tanker accidents in 1976-1977. As the 1973 MARPOL Convention had not yet entered into force, the 1978 MARPOL Protocol absorbed the parent Convention. The combined instrument entered into force on 2 October 1983. In 1997, a Protocol was adopted to amend the Convention and a new Annex VI was added which entered into force on 19 May 2005. MARPOL has been updated by amendments through the years.

The Convention includes regulations aimed at preventing and minimizing pollution from ships - both accidental pollution and that from routine operations - and currently includes six technical Annexes. Special Areas with strict controls on operational discharges are included in most Annexes. Annex I Regulations for the Prevention of Pollution by Oil (entered into force 2 October 1983). Annex II Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (entered into force 2 October 1983). Annex III Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form (entered into force 1 July 1992). Annex IV Prevention of Pollution by Sewage from Ships (entered into force 27 September 2003). Annex V Prevention of Pollution by Garbage from Ships (entered into force 31 December 1988). Annex VI Prevention of Air Pollution from Ships (entered into force 19 May 2005) [6]

OPA 1990

The Exxon Valdez Tanker vessels spilled over 11 million gallons of Alaskan crude into the water of Prince William Sound on 24th March 1989. There were many lessons learned the aftermath of the Valdez oil spill. Two of the most obvious were The United States lacked adequate resources, particularly Federal funds, to respond to spills, and The scope of damages compensable under federal law to those impacted by a spill was fairly narrow. Although the environmental damage and massive cleanup efforts were the most visible effects of this casualty, one of the most important outcomes was the enactment of the Oil Pollution Act of 1990 (OPA), which addressed both these deficiencies [7].

ISM CODE

The International Safety Management Code's origins go back to the late 1980s, when there was mounting concern about poor management standards in shipping. Investigations into accidents revealed major errors on the part of management and in 1987 at IMO which called upon the Maritime Safety Committee to develop guidelines concerning shipboard and shore-based management to ensure the safe operation of ro-ro passenger ferries. The ISM Code evolved through the development of the Guidelines on Management for the Safe Operation of Ships and for Pollution Prevention, adopted in 1989 by the IMO Assembly [6].

entry into force, on 1 July 1998, of the 1994 amendments to the International Convention for the Safety of Life at Sea (SOLAS), 1974, which introduced a new chapter IX into the Convention, the International Safety Management (ISM) Code has been made mandatory [8].

SIRE

Ship Inspection Report (SIRE) programme was originally launched in 1993 to specifically address concerns about sub-standard shipping. The SIRE Programme is a unique tanker risk assessment tool of value to charterers, ship operators, terminal operators and government bodies concerned with ship safety.

SIRE has focused tanker industry awareness on the importance of meeting satisfactory tanker quality and ship safety standards. Program is maintained by Oil Companies International Marine Forum (OCIMF). SIRE is configured with tanker inspection and database of tankers [9].

STCW

International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978 was adopted on 7 July 1978 and entered into force on 28 April 1984. The main purpose of the Convention is to promote safety of life and property at sea and the protection of the marine environment by establishing in common agreement international standards of training, certification and watchkeeping for seafarers [6].

STCW Convention establishes a baseline standard for the training and education of seafarers throughout the world accordance to change in 1995. By placing an emphasis on quality control and competence-based training, it establishes a structure that can ensure not only that the required standard is met, but that it is met. STCW 95 stipulates the required competences associated with different tasks, the knowledge and understanding required to perform them, methods for demonstrating competence and criteria for evaluating it [10].

TMSA

Tanker Management and Self-Assessment (TMSA) is maintained by Oil Companies International Marine Forum (OCIMF). OCIMF's Tanker Management and Self-Assessment programme was introduced in 2004 as a tool to help vessel operators assess, measure and improve their safety management systems. It complements industry quality codes and is intended to encourage self-regulation and promote continuous improvement among tanker operators. The TMSA programme can help all vessel operators to improve their safety management systems.

TMSA helps their management system on twelve points. These are;

- Management, leadership and accountability.
- Recruitment and management of shore-based personnel.
- Recruitment and management of vessel personnel.
- Reliability and maintenance standards.
- Navigational safety.
- Cargo, ballast and mooring operations.
- Management of change.
- Incident investigation analysis.
- Safety management.
- Environmental management.
- Emergency preparedness and contingency planning.
- Measurement, analysis and improvement.

OCIMF madde significant change at TMSA in 2008. TMSA 2008 was adopted and applicated on world tanker fleet. It's named TMSA 2 [11].

Relationship Between Regulations and Pollution

All regulations are issued and applicated for good works on maritime. One of them is oil pollution preventing and minimized accident for causing oil pollution. Statistics are shown that number of accidents with spill reason for pollution, are decreased as per year.

However, quantities of oil spill are also decreased as per year. By comparison, this problem that large scale spilt at a few accidents were been more than recent accidents.

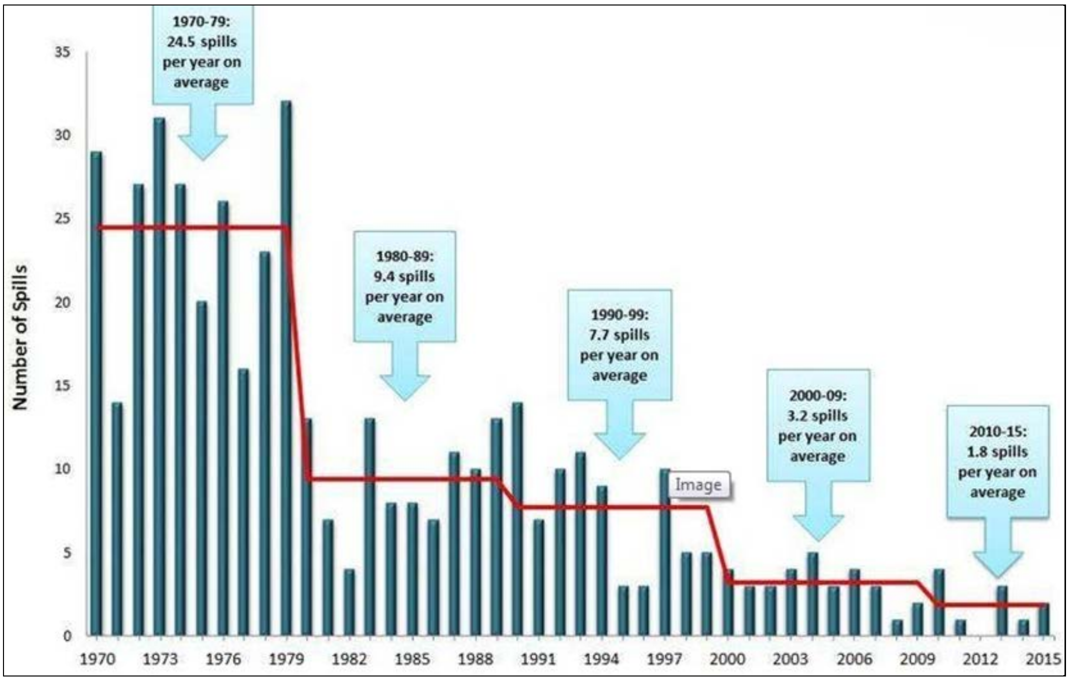

Figure 3. Total Spillage Volume and ratio of spills as decades [5]

This decreasing could be evaluate with impact elements. It’s a lot of element as safety, management, training, education and additional using equipment on board. It’s seen that all of elements of pollution and accident preventing are obligated by regulations and several mandatory programmes. Regulation development on maritime against preventing spills on figure 4.

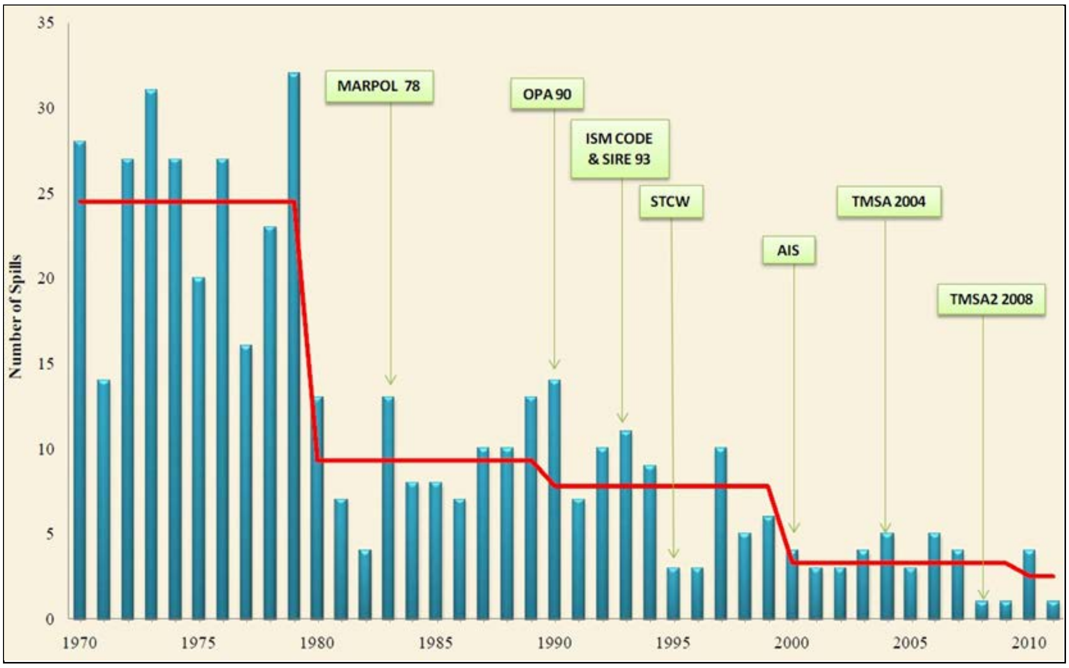

Figure 4. Major regulations and affecting on tanker accidents [12]

CONCLUSION

Maritime industry is important for global transportation. All countries need petroleum and its product and they are carried on tanker ships with great values. This way is dangerous for ships, sea, seaman and nature of sea due to polluted cargo. These routes is long from departure ‘’source area’’ to arrival ‘’refinery or consumption point’’. At the same time these way has wild sea and weather condition and complex vessel traffic. This risks arise pollution at sea caused by tanker vessels. Large spills source this pollution generally. However large or small, all pollution case are harmful on environment.

International organizations issue several rules, regulations and various inspection programs due to preventing and precaution of pollution at sea caused by vessels. Especially tanker vessels. It’s believed that they own higher risks than other vessels’ types.

Despite of taken precautions, issued regulations, spillage and pollution has been occurred each year from 1970 to 2015. However accident and amount of spillage was getting to decrease on tanker vessels. It’s seen that, regulations and other precautions are affected. These main regulations and applications are MARPOL78, OPA90, SIRE93, ISM Code, STCW, TMSA2004 and TMSA2008. Despite of everything, all operations involve pollution risks on tanker vessels. Pollution and incidents could be minimized safely working conditions with application of rules.

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PERCEPTION OF SAFETY CULTURE AMONGST PORT WORKERS

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ABSTRACT

Systematic and organized operation of the ports, which are one of the most important legs of maritime transportation, is extremely crucial for the traffic and commerce. Continual increase in trade volumes affects ports as well as maritime transportation. Due to their intensity and hard labour standards, working conditions of port areas are considered high risk. Safety education of port workers is ultimately important in order to reduce the number of accidents. Perception of safety culture can be increased as the individuals internalize the education and canalize it to their conducts. Naturally, accident risk decreases for the individuals who internalized the safety culture. In this study, safety culture amongst port workers is examined and interpreted. A survey has been conducted with 60 port workers and the data are analysed with SPSS software. In conclusion, it is determined that port workers require further safety education in order to perform safer operations.

Keywords - Safety Culture, Port Workers, Education, Transportation

INTRODUCTION

A great majority of foreign trade in Turkey consists of maritime transport. Turkish vessels constitute an important branch of industry in Turkey and affect the country's economy directly [1]. Maritime transport is known to be the most common, the cheapest and the safest mode of transport internationally. Too large and vast amounts of goods as well as cargoes suitable for container transportation are carried by the maritime line. Since maritime transport is 22 times cheaper than airline transport, 7 times cheaper than road transport and 3,5 times cheaper than railways, it is the most preferred mode of transport throughout the world [2]. Ports play a fundamental role in maritime transport. They are important constituents of the sector. On the other hand, the transport sector is one of the most risky occupational groups in terms of occupational accidents and professional diseases [3]. The question of preventing occupational accidents or at least reducing the number of their occurrence has been examined by researchers and scholars from many discipline areas for many years. It is an indisputable truth that the human resources of a business are significantly effective on the performance of the business itself. Both government organizations and

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private corporations have made many legal and corporate regulations in order to be able to prevent occupational accidents from past to present. However, the statistics regarding occupational accidents have revealed the fact that these regulations are not sufficient in preventing the accidents. This situation shows that the given problem should not be considered as just a technical subject. The ‘human’ factor should also be considered as an important component of work life as well as the technical aspect. It is stated that between 80-95% of occupational accidents are caused by the unsafe behaviors of the workers. Therefore, ‘culture’ is a significant factor and is accepted to be a behavior corrector in preventing work-related accidents. Safety culture is an efficient vehicle which provides the necessary motivation for the workers to work in safer working conditions and in a safer way all the time [4].

Ports are crucial in the sector of maritime transport as they are intersection points of seaways, highways and railways. In these spots, extensive flow of goods and/or people are delivered to land after being divided into minor flows with the help of land vehicles and the reverse of this situation is the matter in marine distribution [5]. Ports have become indispensable parts of the cities they are in and have also affected the development of the nearby cities positively. Ports can be regarded as the pulse of the economy owing to the fact that they allow for the storage and distribution of the cargo in their hinterlands [6].

Within the concept of this study, safety culture perceptions of the dock workers of the port of Trabzon are examined. Moreover, the necessary steps to be taken for the development of positive safety culture are investigated.

The Port of Trabzon

The Port of Trabzon which was located in the Moloz district of Trabzon and was moved to where it is now in 117-119 BC. The foundation of the new port was laid in 1946 and it was put into service after being completed in 1954. In the 1980s, the port became incapable because of the increasing vessel traffic and therefore steps were taken for the modernization of the port. The restoration was completed 1990 and the port reached its present state [7].

The Port of Trabzon includes 6 quays. The total quay length is 1.525m and the port’s depth changes between 2,5m and 10m. Information about the length, depth and ship acceptance capacity of the port is given in Table 1 below.

Table 1. Information about quays in the Port of Trabzon [8].

Quay Number	Length (m)	Depth (m)	Ship Acceptance Capacity (Number)
Quay 1	30	9	-
Quay 2	400	9	3
Quay 3	580	9,3	5
Quay 4	290	10,3	3
Quay 5	200	2-5	1
Ro-Ro Quay	25	9,3	1

Information about cargo handling, stowage and ship acceptance capacity of the Port of Trabzon is given in Table 2 below.

Table 2. The capacity and the physical state of the Port of Trabzon [8].

Cargo handling capacity	10 Million tons/year
Stowage capacity	5 Million tons/year
Ship acceptance capacity	2500 number/year

The Port of Trabzon has always been one of the most important ports of the Black Sea in terms of both its history and function. It is clearly seen from the data given in the tables above that the Port of Trabzon is considerably active and has work load density.

Safety Culture

The term 'culture' has lots of definition in both national and international literature. For the first time in international literature, two American researchers Kroeber and Kluckhohn compiled in their article about culture all the explanations about culture consisting of 164 different definitions made up to that date and they ultimately summarized and defined culture as ''consisting of patterns, explicit and implicit, of and for behavior acquired and transmitted by symbols, constituting the distinctive achievements of human groups'' [9].

In addition, another definition suggests that the essential core of culture consists of historically derived traditional ideas and their attached values, culture systems are both products of action and conditioning elements of further action [10].

The term safety culture which already existed but neglected appeared in literature after the Chernobyl disaster [11]. HSE (1993) defines safety culture as a product of individual and group values, attitudes, perceptions and patterns of behavior that determine the style and proficiency of an organization's health and safety management [12]. Culture is a product of the direct interactions among individual (psychological), job (behavioral) and organizational (situational) features whereas safety culture is the set of enduring values and attitudes regarding safety issues, shared by every member of every level of organization [13]. Reason (1997) defined safety culture as the perfect combination of reporting, organizational learning, justice and flexibility. In addition, it is crucial to make proper assignments in consideration of personal abilities and dispositions of the people [14]. Wiegmann vd (2002) defined safety culture as the enduring value placed on workers and their commitment to personal responsibility for safety, act to preserve, enhance and communicate safety concerns, strive to learn, adopt and modify behavior based on lessons learned from mistakes and be rewarded in a manner consistent with these values [15].

The Study

The safety culture concept is one of the subtitles of the culture perception of individuals. There are a lot of factors affecting safety culture in the process of development. Using the survey method, these factors about the perception of safety culture are included in a questionnaire and a total of 60 dock workers in the Port of Trabzon were asked the survey questions face to face. The safety culture perception questionnaire consists of 38 questions prepared using the likert scale. The answers to the likert-type questions consist of typical five-level likert items which are 'strongly disagree', 'disagree', 'neither agree nor disagree', 'agree' and 'strongly agree'. Survey results are gathered and the answers to the questions are marked to determine the safety culture perception. All the data collected were analyzed using the SPSS program and the findings were presented.

Hypotheses ;

Hypothesis 1. There is not a statistically significant relationship between the dock workers' ages and their safety culture perceptions.

Hypothesis 2. There is not a statistically significant relationship between the dock workers' work experiences and their safety culture perceptions.

RESULTS

The statistical data of the dock workers' perceptions of safety culture according to age groups is given in Table 3 below.

Table 3. The statistical data of the dock workers' safety culture perceptions according to age groups

					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
20-29	10	2,7930	,65960	,20858	2,3212	3,2648	1,34	3,87
30-39	24	3,0075	,55322	,11293	2,7739	3,2411	1,74	3,76
40-49	19	3,3337	,60125	,13794	3,0439	3,6235	1,97	4,05
50 and older	7	3,0543	,89108	,33680	2,2302	3,8784	1,66	4,05
Total	60	3,0805	,64313	,08303	2,9144	3,2466	1,34	4,05

As seen in Table 3, the average values are approximate to one another. In order to test Hypothesis 1 which asserts that there is not a statistically significant relationship between the dock workers' ages and their safety culture perceptions, the one-way ANOVA analysis was carried out and the data obtained are presented in Table 4 below.

Table 4. The relationship between the dock workers' ages and their safety culture perceptions

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2,177	3	,726	1,829	,152
Within Groups	22,226	56	,397		
Total	24,403	59			

Table 4 tests if there is any difference between the age groups of the workers and their safety culture perceptions. The p value is (Sig. = ,152) as seen in table 4 above. The p value > a and therefore the hypothesis 'There is not a statistically significant relationship between the dock workers' ages and their safety culture perceptions' (Hypothesis 1) cannot be denied. In that case, it cannot be said that there is a difference between the dock workers' ages and their safety culture perceptions.

The statistical data of the safety culture perceptions of dock workers according to their work experience is presented in Table 5 below.

Table 5. The statistical data of the dock workers' safety culture perceptions according to their work experiences

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1-3 Years	8	2,8888	,63845	,22572	2,3550	3,4225	1,66	3,87
4-7 Years	14	2,8486	,74087	,19801	2,4208	3,2763	1,34	3,76
8 Years and older	38	3,2063	,58738	,09529	3,0132	3,3994	1,97	4,05
Total	60	3,0805	,64313	,08303	2,9144	3,2466	1,34	4,05

As seen in Table 5, the average values are approximate to one another. In order to test Hypothesis 2 which asserts that there is not a statistically significant relationship between the dock workers' work experiences and their safety culture perceptions, the one-way ANOVA analysis was carried out and the data obtained are presented in Table 6 below.

Table 6. The relationship between the dock workers' work experiences and their safety culture perceptions

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1,649	2	,824	2,065	,136
Within Groups	22,755	57	,399		
Total	24,403	59			

Table 6 tests if there is any difference between the dock workers' safety culture perceptions and their work experiences. The p value is (Sig. = ,136) as seen in table 6 above. The p value > a and therefore the hypothesis 'There is not a statistically significant relationship between the dock workers' work experiences and their safety culture perceptions' (Hypothesis 2) cannot be denied. In that case, it cannot be said that there is a difference between the dock workers' work experiences and their safety culture perceptions.

Table 7. Age distribution of the dock workers

	Frequency	Percent	Valid Percent	Cumulative Percent
20-29	10	16,7	16,7	16,7
30-39	24	40,0	40,0	56,7
40-49	19	31,7	31,7	88,3
50 and older	7	11,7	11,7	100,0
Total	60	100,0	100,0	

Age.

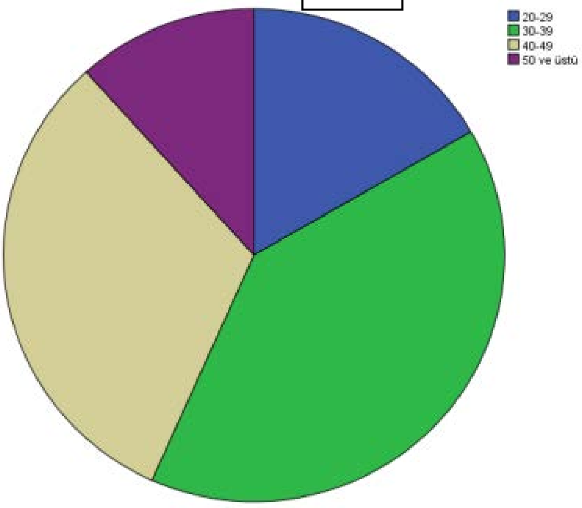

Figure 1. Age distribution of the dock workers

Table 8. Distribution of the dock workers according to their work experiences

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-3 Years	8	13,3	13,3	13,3
	4-7 Years	14	23,3	23,3	36,7
	8 Years and older	38	63,3	63,3	100,0
	Total	60	100,0	100,0	

Experience

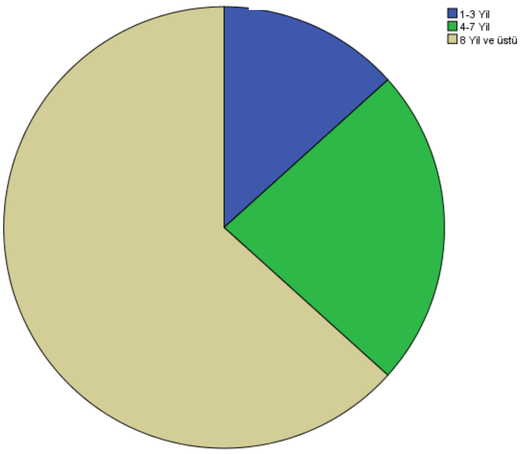

Figure 2. Distribution of the dock workers according to their work experiences

Table 9. Distribution of the dock workers' safety culture perception scores

	N	Minimum	Maximum	Mean	Std. Deviation
Average	60	1,34	4,05	3,0805	,64313
Valid N (listwise)	60				

CONCLUSIONS

The results of the study showed that the dock workers' safety culture perceptions do not vary by their ages or their work experiences. In spite of the fact that the dock workers' safety culture perceptions are at the average level in general, the results are seen to be lower than expected. The answers given to the survey questions showed that the necessity of safety equipment at work is neglected, the safety factor is trivialized in stressful jobs, work and rest hours are ignored by organizations and furthermore there are extreme communication disorders. In addition to these, dock workers are in agreement that lessons should be taken from dangerous situations. On the other hand, the fact that the workers do not find their wages sufficient influence their motivations negatively and low motivation reflects on safety behavior. Another attitude against the development of safety culture is the 'Nothing would happen to me' belief. The reason of this thought is stated to be the instant physical ailment the workers feel because of safe work. For this reason, equipments should be more practical for safe working practices. Likewise, workers should internalize the fact that the equipments they use are protective and preventive and that they are not life-threatening. It is also very important to bring under control any emergency cases before they occur, to reduce the risks to minimum and to provide and popularize the use of personal protective equipments. The most important thing among all is the necessity that both organizational managements and workers should approve and adapt safety culture [16].

Ports are key spots where intense work activities are carried out against the clock. It is essential to improve the dock workers' safety culture perceptions to minimize the risk of exposure to accidents under the stressful and intense work pressure. Besides, workers should receive necessary job training activities before starting work in order to improve safety culture awareness. On the other hand, organizations should inform their workers about training and current activities periodically to raise awareness. Workers should be working in an environment where they can express themselves freely and near misses about unsafe situations should be reported. At this point, it is necessary to take into consideration the fact that prevention is better than cure and prevention can be possible only when everyone in the field are conscious about safety culture. It should also not be forgotten that raising consciousness would not be possible without overcoming the thought that activities and actions about safety cause some economic burdens, operating setbacks and loss of time.

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EVALUATION OF PORT STATE PERFORMANCE OF TURKEY

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ABSTRACT

Port State Control has been developed to ensure that ships meet international regulations which aim to reduce the risks arising from maritime shipping. Port states carry out safety inspection on foreign-flagged ships visiting its ports according to international regulations in force. Effectiveness and efficiency of this inspections are very important for eliminating of sub -standard ships. Turkey is a member of Black Sea and Mediterranean MOUs. In this context, this study aims to evaluate performance of port state of Turkey.

Keywords − *Black Sea MOU, maritime transport, Mediterranean MOU, port state control, safety*

INTRODUCTION

Port State Control mechanism has been developed to ensure that ships meet international regulations which are regulated to provide protection of the marine environment and life. This mechanism allows port states to carry out safety inspection on foreign-flagged ships visiting its ports according to international regulations in force. Regional agreements on PSC (Memorandum of Understanding on Port State Control- MOU) have been established in order to ensure the effectiveness of inspections, effective monitoring and uniformity of inspections [1]. These MOUs which cover most of the world seas creating respectively are the Paris MOU (Europe and North Atlantic region), Acuerdo de Vina del Mar Agreement (Latin American region), the Tokyo MOU (Asia-Pacific region), the Caribbean MOU (Caribbean region), the Mediterranean MOU (Mediterranean region), the Indian Ocean MOU (Indian Ocean region), the Abuja MOU (West and Central African region), and the Black Sea MOU (Black Sea region).

Effectiveness and efficiency of inspections are very important for eliminating of sub-standard ships and reducing risks in maritime shipping. Turkey is a member of the Black Sea MOU and the Mediterranean MOU. While PSC inspections in the Black Sea ports of Turkey are carried out according to the Black Sea MOU, these inspections are carried out according to the Mediterranean MOU in the Mediterranean Ports of Turkey. In this context, this study aims to evaluate performance of port state of Turkey and it discusses importance of Port state control inspections.

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PORT STATE CONTROL INSPECTIONS IN THE BLACK SEA AND MEDITERRANEAN REGIONS

Turkey has geographic and strategic importance. It is located between land of Asia and Europe continents. It is covered by seas on three sides. Due to its position, it is both member of the Black Sea MOU and the Mediterranean MOU.

The Black Sea MOU includes Black Sea region and it was signed in 2000. As well as Turkey, other member authorities are Bulgaria, Georgia, Romania, Russian Federation and Ukraine. Black sea MOU aims to establish an effective Port State Control regime in the Black Sea region in order to eliminate sub-standard shipping and enhance maritime safety [2].

Regulations taken into consideration during Port State Control in the Black Sea MOU are [2]:

- "The International Convention on Load Lines, 1966 (Load Lines 66);
- The International Convention for the Safety of Life at Sea, 1974 (SOLAS 74);
- The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978, (MARPOL 73/78);
- The International Convention on Standards of Training Certification and Watch keeping for Seafarers, 1978 (STCW 78);
- The Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREG 72);
- The International Convention on Tonnage Measurement of Ships, 1969 (TONNAGE 69);
- The Merchant Shipping (Minimum Standards) Convention, 1976 (No. 147);
- The Maritime Labour Convention, 2006 (MLC, 2006);
- International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001;
- The International Convention on Civil Liability for Bunker Oil Pollution Damage, 2001 (BUNKERS 2001)"

The Mediterranean MOU was established in 1997, before the Black Sea MOU. Today it has 10 members namely; Algeria, Cyprus, Egypt, Israel, Jordan, Lebanon, Malta, Morocco, Tunisia and Turkey. It includes Mediterranean Region and it aims to protect their region from the risks posed maritime shipping, same as Black Sea MOU.

For the purpose of the MOU, the relevant instruments which are the basis for PSC inspections in the region are [3]:

- "The International Convention on Load Lines, 1966;
- The International Convention for the Safety of Life at Sea, 1974 (SOLAS 74);
- The Protocol of 1978 relating to the International Convention for the Safety of Life at Sea,1974;
- The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978, (MARPOL 73/78);
- The International Convention on Standards of Training Certification and Watch keeping for Seafarers, 1978 (STCW 78);
- The Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREG 72);
- The Merchant Shipping (Minimum Standards) Convention, 1976 (No. 147);
- The Maritime Labour Convention, 2006 (MLC, 2006)";

Black Sea MOU inspections data between 2010 and 2014 are given in Table 1. Mediterranean MOU inspections data between 2010 and 2013 are given in Table 2. Average number of inspection in the Black Sea MOU is 4873 for this period, average number of inspection in the Mediterranean MOU is 5838. Percentage of detentions and percentage of inspection with deficiencies have decreased since 2010 both Black sea MOU and the Mediterranean MOU.

Table1. Number of inspections, percent of deficiencies and detention of Black Sea MOU (2010-2014) [4]

Years	2010	2011	2012	2013	2014
Number of Inspections	4929	4657	4607	5080	5092
Deficiencies Percentage (%)	64,74	67,77	65,16	65,08	59,92
Detention Rate (%)	5,80	5,35	4,67	3,62	2,97

Table 2. Number of inspections, percent of deficiencies and detention of Mediterranean MOU (2010-2013) [5]

Years	2010	2011	2012	2013
Number of Inspections	6783	6225	5645	4698
Deficiencies Percentage (%)	59,75	58,25	55,96	54,28
Detention Rate (%)	7,77	6,63	7,37	5,58

PORT STATE PERFORMANCE OF TURKEY

Figure 1 shows contribution of member Authorities into inspections of Mediterranean MOU for the period 2010-2013 [5]. Total number of 23351 inspections are performed for this period. The greatest contributions into inspections are from Egypt with 33 % and Turkey with 28% in this period. Turkey and Egypt have the highest number of calling ship.

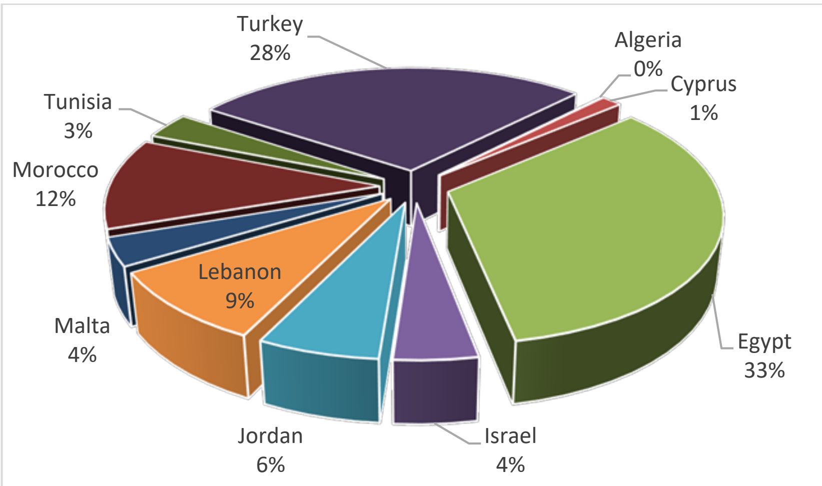

Figure 1. Inspection percentage of member Authorities for the period 2010-2013 in the Mediterranean MOU

Figure 2 shows contribution of member Authorities into detentions of Mediterranean MOU for the period 2010-2013 [5]. Total number of detentions are 1617 for this period. Members that have the greatest detention percentage are Turkey with 47% and Egypt with 32 % in this period. That is, 47% of total number of detention (1617) are detained by Turkey.

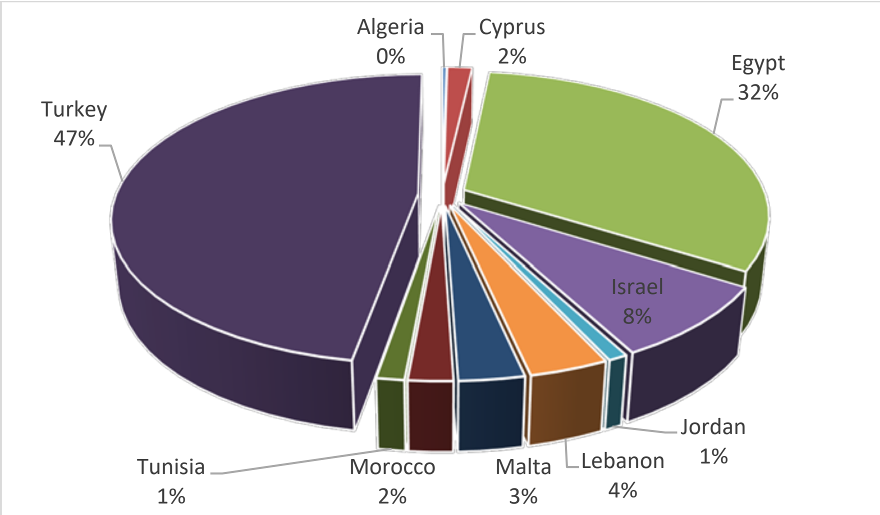

Figure 2. Detention percentage of member Authorities for the period 2010-2013 in the Mediterranean MOU

Figure 3 shows inspection rates of member Authorities from 2010 to 2013 [5]. Inspection rate is the ratio of the total number of inspections to total number of individual ship visited, that is, it shows inspection performances of members. It is seen that Turkey, Egypt and Lebanon have high inspection rates. Turkey, Egypt and Morocco have about 5000 calling number of individual ship, Cyprus, Lebanon and Malta have below of 1000 number of individual ship, others have number of individual ship between 1000 and 2000 annually.

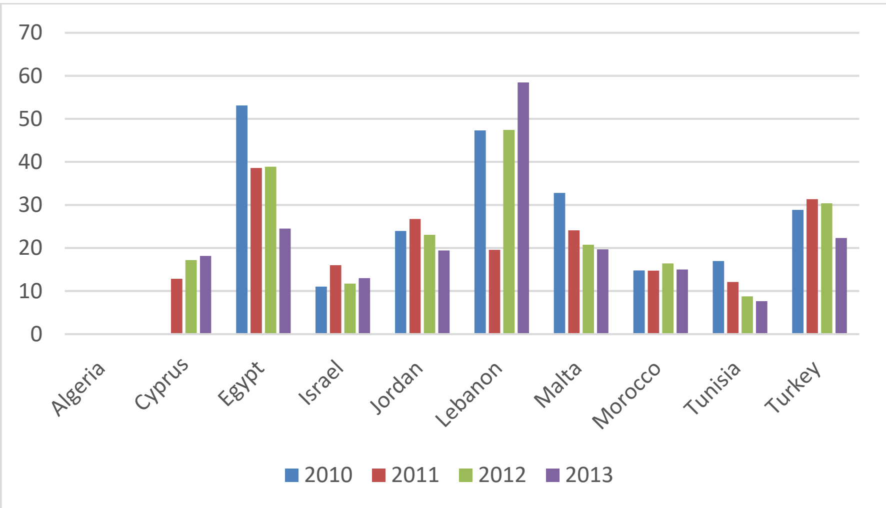

Figure 3. Inspection rates of member Authorities for the period 2010-2013 in the Mediterranean MOU (%)

Figure 4 shows contribution of member Authorities into inspections of Black Sea MOU for the period 2010-2014 [6]. Total number of 24 365 inspections are performed for this period. The greatest contributions for inspection are from Russia with 27 % and Ukraine with 26% in this period. Also, these authorities have the highest number of visiting ship.

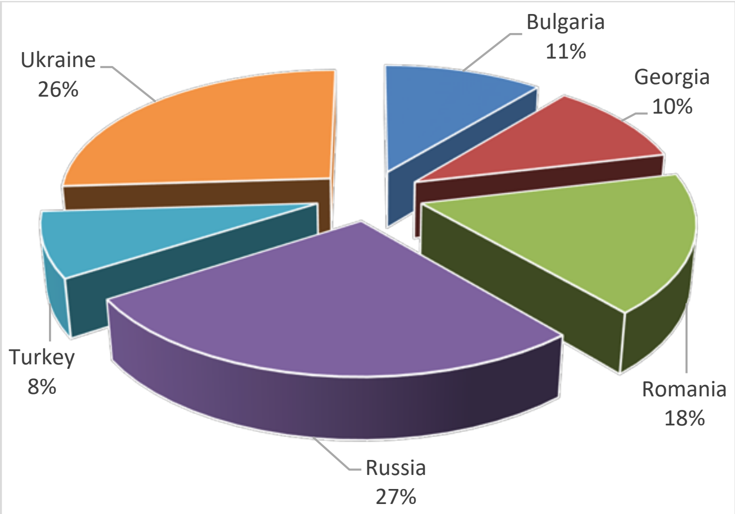

Figure 4. Inspection percentages of member Authorities for the period 2010-2014 in the Black Sea MOU

Figure 5 shows contribution of member Authorities into detentions of Black Sea MOU for the period 2010-2014 [6]. Total number of detentions are 1085 for this period. Members that have the greatest detention percentage are Russia with 42% and Ukraine with 20 % in this period. Turkey is a member that have the third highest value.

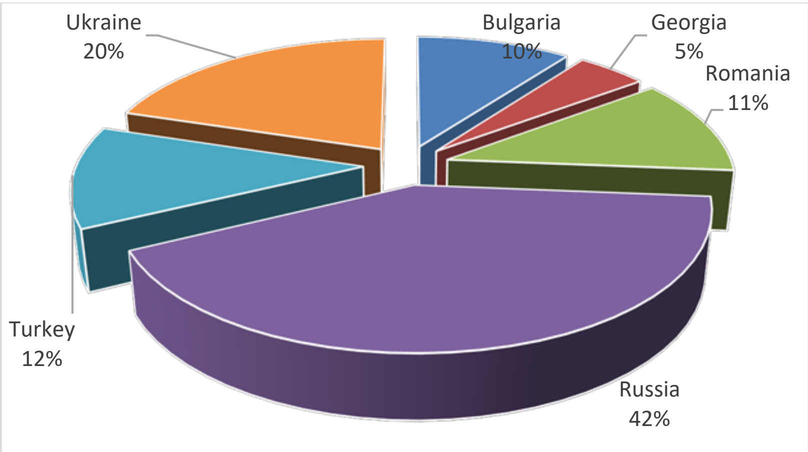

Figure 5. Detention percentages of member Authorities for the period 2010-2014 in the Black Sea MOU

Figure 6 shows inspection rates of member Authorities from 2010 to 2014 [6]. It is seen that Russia and Ukraine have high inspection rates. Ukraine, Russia and Romania have about 2000 calling number of individual ship, Turkey and Bulgaria have number of individual ship about 1000, and Georgia has below 1000 annually.

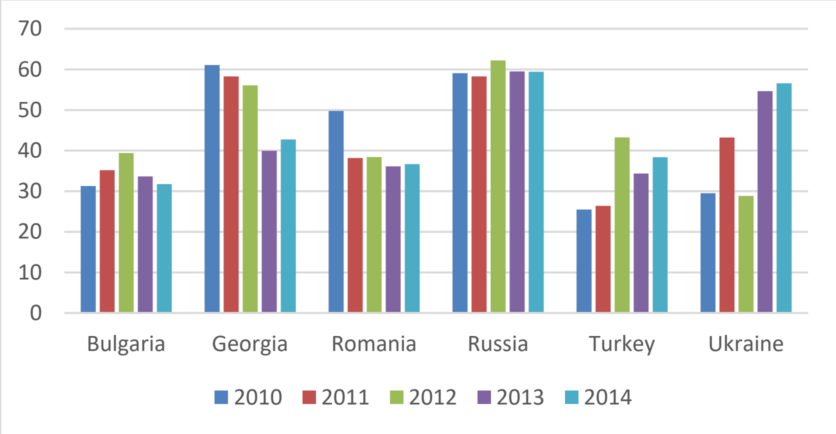

Figure 6. Inspection rates of member Authorities for the period 2010-2014 in the Black Sea MOU (%)

CONCLUSIONS

While the number of inspections in the Black sea MOU has slightly increased since 2010, the number of inspections in the Mediterranean MOU has slightly decreased. In this period, regional detention rates and deficiencies percentages decrease in the both MOUs.

In the period 2010-2013, 28% of all inspections are carried out by Turkey in the Mediterranean MOU. Turkey is one of the members that have the greatest contribution for inspection. Also, it has the greatest detention percentage with % 47.

In the period 2010-2014, 8% of all inspections are carried out by Turkey in the Black Sea MOU. It is seen that Turkey has the lowest contribution for inspection. However, Turkey has the third percentage value according to detention percentages. This result is likely to be the consequence of stringent inspections.

The effectiveness of Black sea MOU and Mediterranean MOU inspections have importance for safety of seas which are around Turkey. Also, port state control performance of Turkey has importance due to enhancing maritime safety in its territorial waters. If regional MOU inspections carry out stringent and effective, ship standards raise and the risks arising from maritime transportation decrease in these region.

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AN INNOVATIVE APPROACH IN INDUSTRIAL MARITIME TECHNOLOGY FOR ENVIRONMENTAL PROTECTION APPLICATIONS: EXHAUST GAS CLEANING FOR MARINE DIESEL ENGINES

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ABSTRACT

One of the advanced topics of maritime strategy is the macro factors influencing seriously the maritime industry, acting on the micro factors in which air pollution is one of them, forcing the shipping companies for Innovative solutions consistently to lower the concentrations of the exhaust flue gas emissions from ships to the acceptable limits specified by the international authorities. The aim of this paper, under the light of Marine Pollution (MARPOL73/78) Annex VI, Marine Environment Protection Committee (MEPC) standards and Energy Efficiency Design Index (EEDI), is to introduce a closed loop, fresh water, slurry circulated, wet type Sulphur Dioxide (SO_2) scrubber system to be applied to the commercial ships at their design and/or construction phase to minimize the fuel consumption, ship building and engineering difficulties and, to minimize the additional costs. Characteristics of the scrubber system to be developed is fist, the use of diesel exhaust gas as energy source to drive the system pumps, which needs less power and consequently less fuel, to circulate the fresh water slurry and sea water in the system to scrub Sulphur Dioxide (SO_2) and particulates in the exhaust flue gas and secondly, the use of closed loop fresh water slurry instead of sea water to avoid the non-treated sea water incidentally discharged back to sea. Optimization of the technical design, investment and operational costs are also taken into account within the frame of system efficiency, reliability, sustainability, regularity and customer satisfaction.

Keywords – SO_2, MARPOL Annex IV, IMO, MEPC, EEDI

INTRODUCTION

Figure 1 and Figure 2 represents global air pollution and excessive fuel oil consumption due to maritime transport that became a major responsibility of international conventions urgently to prepare codes, regulations and standards as well as counter measures in a short term time-schedule before all else.

IMO published desulphurization regulation in 2005 and, encouraging maritime industry to start intensive studies on concepts and theories to evaluate existing ones or develop new techniques and methods reliable to design and manufacture scrubbers efficient enough to keep Sulphur SO_2 and

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Particulate Matters (PMs) within the MARPOL73/78 Annex VI limits as well as to satisfy the customers' demands.

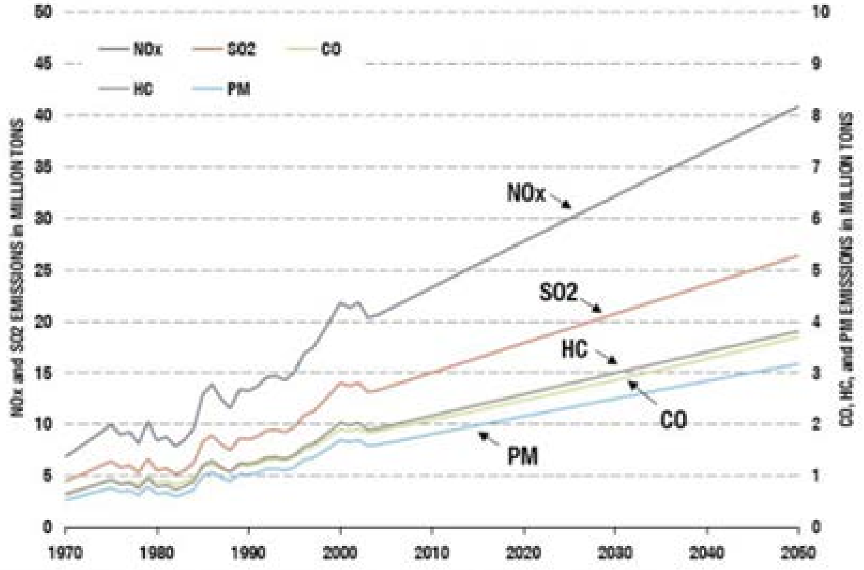

Figure 1. Air Pollution in Maritime Transport
http://www.imo.org/en/OurWork/Environment

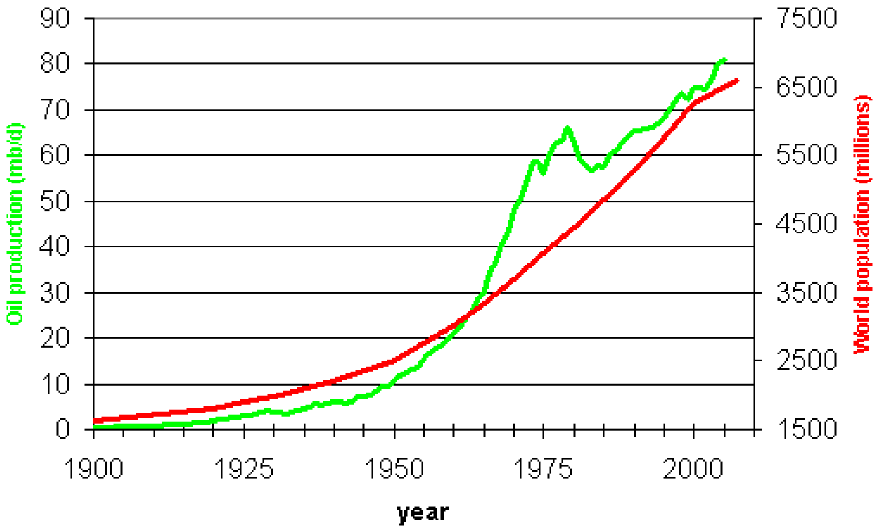

Figure 2. Global Oil Production and Consumption versus to World Population
http://www.imo.org/en/OurWork/Environment

LITERATURE

Researches and investigations of consistent scrubbing techniques and methods still occupy the time schedules of Maritime Conventions, Maritime Law Makers, Marine Industry, Ship Yards, Ship Owners and Maritime Institutes to manage, finance, operate, and control the exhaust flue gas pollutants in the specified limits using various techniques and methods already exsist. Table 1.

Table 1. Various techniques and methods to decrease SO_2

Production of low sulfur fuel in refineries	is an ongoing negotiation in maritime conventions due to the high cost of refining the fuel
Use of Liquid natural gas (LNG) as fuel	is not practical except LNG Tankers and, not as cheap as fuel oil
Internal combustion engine modifications	are actually related to increase the engine efficiency, not applicable for all engines and need long time to develop. It has advantage in long term to develop and apply easily to the ships when compared with the other alternatives.
Scrubber technology	is related with exhaust flue gas treatment and preferred to install on board ships due to high efficiency and low investment cost.

In 2007 a research carried by Massachusetts Institute of Technology, University of Tokyo, Chalmers University of Technology and Swiss Federal Institute of Technology Zurich published that, using the seawater to realize ship SO_2 reduction is a goal due to seawater scrubbing is promising a feasible technology for reducing sulphur oxide emissions from ships but, requires further case studies in order to assess this option.

Our study is focused to the scrubber system optimization related with investment and operational costs, high system efficiency and precise automatic control. We suggested some alterations and developments to decrease fuel oil and chemical consumptions and to increase the influence of exhaust flue gas treatment process to keep SO_2 and PM_S pollutants in standards specified with codes and regulations relevant.

Operating variables, parameters and properties of the suggested closed-loop, freshwater, slurry circulated, wet type scrubber system given with Figure 3, starting from air and fuel supply points of combustion system to the end of treated exhaust flue gas discharge point to the atmosphere, are taken into account to render the research studies scientific, significant and applicable.

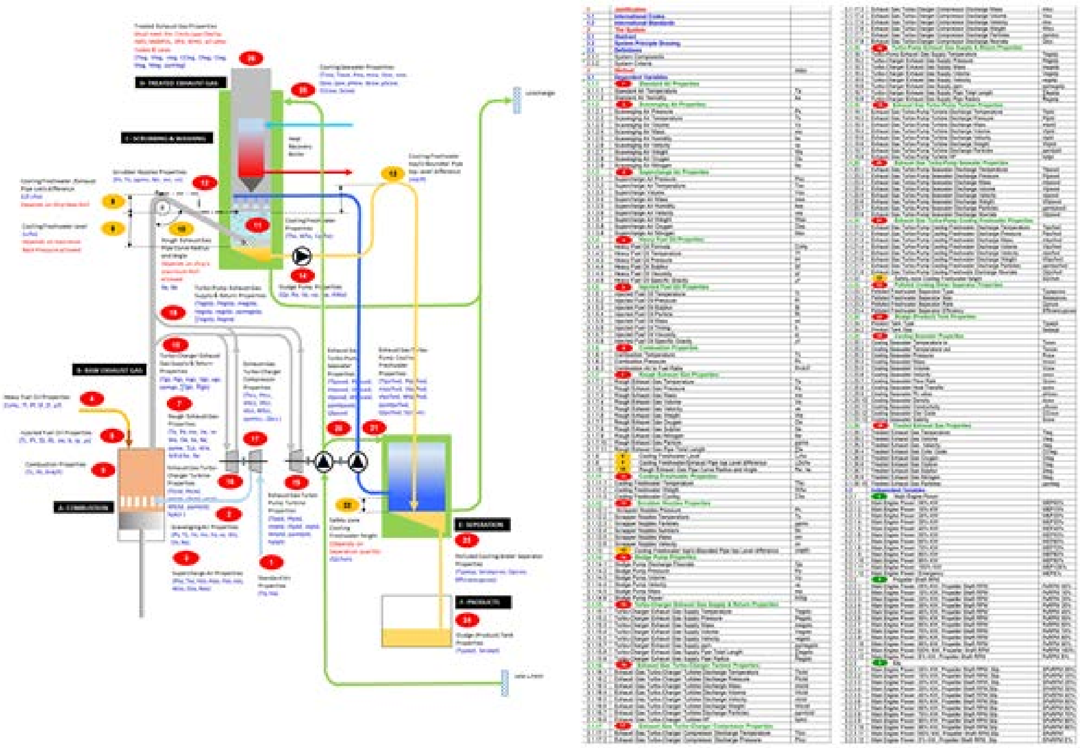

Figure 3. Closed-Loop, Freshwater, Slurry Circulated, Wet-Type Scrubber

In order to achieve the goal, we studied scrubber techniques and methods given with Table 2 and, tried to find the gaps given with Table 3 and, research questions in Table 4 to set the hypothesis to develop and optimize as much as we can the Closed-Loop, Freshwater, Slurry circulated, Wet type scrubber to keep and control SO_2 and PM_S in specified limits; lower fuel oil, chemical and energy consumptions; increase system efficiency; eliminate seawater usage as alkaline; establish precise control and, get by-products by modifying the control basics, system design and mechanics as well as operational concepts.

Table 2. Scrubber techniques and methods

Dry Scrubbers	use granulates with Caustic Lime Ca(OH)2 which reacts with Sulfur Dioxide (SO2) to form Calcium Sulfite (CaSO3).
Hybrid Scrubbers	operate in both Open and Closed Loop using Sea Water to remove SOX from the Exhaust Flue Gas.
Sea Water Scrubbers	absorbe SO2 exists in Sea Water, reacts with Oxygen to form Sulphate Ions Hydrogen Ions.
Freshwater Scrubbers	combines SO2 with a Salt and consequently does not react

Table 3. The Gaps monitored on the existing scrubbers

Emission Treatment Process	to cover whole process, not the scrubber section only	each stage effects consequently the next stage due to unavoidable correlations
Filitration of PMs	to be fully filtered	better filitration with Pipe-Wash system
Freshwater Slurry	instead of sea water	to eliminate sea water treatment and discharge accidently back to sea
Energy saving	Exhaust Gas or Steam Turbo- Pumps instead of Electric motor-pumps	may increase investment cost
System Cooling	Sea Water	better efficiency
Automatic Control	precise and sensitive cascaded control	better system management and efficiency
By-Products	Gypsum, H2SO4, Soot, etc.	early Return of Investment (ROI)
Sludge valuation	raw material for Carbon Nano Tube production	out of our study

Table 4. Research Questions

1	System Variables: Dependent and Independent
2	Operating Parameters and Limitations
3	Operating Conditions and Sea States
4	Type and number of Operating Chemicals
5	System Correlations and consistency
6	System Back Pressures and Limitations
7	System Structural Material
8	System Automatic Control
9	System Instrumentation
10	Cost of Investment
11	Cost of Operation
12	Return of Investment
13	System Efficiency and Sustainability
14	System operational Flexibility
15	Capacities of System Units and Elements

METHODOLOGY

Current Legislations relevant to the scrubber systems to be used on board ships, are first examined to be in line with safety and environment protection standards. Secondly, literature has been reviewed to find acceptable solutions for the suggested developments. Preparing a mathematical model is the third step to specify the effective correlations relevant to the operating parameters, properties and variables for the diesel engines specified with MARPOL 73/78 Annex VI, in Table 5 and, the Fuel Oil given with Table 6 to be consumed, are accepted as the reference sources to research where the suggested scrubber will be adopted. The fourth step is arranged preliminary designing of suggested system which can be applied on various ships specified and according to the owners' requirements.

The closed loop, slurry circulated, wet type scrubber system proposed with this paper is composed of six number of stages each having different chemical and physical properties and variables, Table 7, which need well study and analysis for the solution of technical, financial and legal questions to meet the specifications and standards

Table 5. Diesel engines specified with MARPOL 73/78 Annex VI

Typical size and output of diesel engines						
Bore (mm	45	80	127	280	400	840
Stroke (mm)	37	80	120	300	460	2900
Displacement (liter/cylinder)	0,06	0,402	1,77	18,5	57,82	1607
Number of cylinders	1	4L*	8V↑	6-9L	6-9L	4-12L
Output/cylinder (kW)	0,7	10	40	325	550	3380
Rated speed (rpm)	3600	4800	2100	1000	514-520	55-76
BMEP (atm)	4	7,5	13	22	22,2	16,6

*L designates in-line cylinder arrangement
↑ designates V-Shaped cylinder arrangement

Tab.6 Type of fuel s specified with MARPOL 73/78 Annex VI

Fuel type	Fuel Grades	Common Industry Name
Distillade	DMX, DMA, DMB, DMC	Gas Oil or Marine Gas Oil
Intermediate	IFO 180 380	Marine Diesel Fuel or Intermediate Fuel Oil
Residual	RMA - RML	Fuel Oil or Residual Fuel Oil

SYSTEM BASICS

The system, together with its supplementary units of Pipe-wash, Turbo-Pump and Automatic Control proposed with Figure 3, can be classified as Closed-Loop, Freshwater, Slurry circulated Wet Type Scrubber.

Limestone as alkaline, being the cheapest additive already in the global markets, is projected to blend with fresh water to compose a type of slurry to wash and scrub SO_2, PMs and Soot exists in the exhaust flue gas.

The scrubber proposed with this paper has six numbers of supplementary units cascaded in sequence, each having individual properties, operating parameters and variables to be managed and controlled by properly instrumented automatic control system to solve technical, financial and legal constrains and achieve the MARPOL 73/78, Annex VI. Shame-A rules.

Tab.6 Type of fuel s specified with MARPOL 73/78 Annex VI

Shame-A	is based on initial emission performance unit Certification together with a continuous parameter check of operating parameters and daily exhaust emission monitoring.
Shame-B	is based on continuous exhaust emission monitoring together with a daily parameter check of operating parameters.

Operating variables of the stages possible to expose domino effects may cause time-delays and interfere instant and sustainable adjustments on the automatic control system, Figure 4, which consists of sensors, transducers, control units, data measurement devices and their installation points on the system.

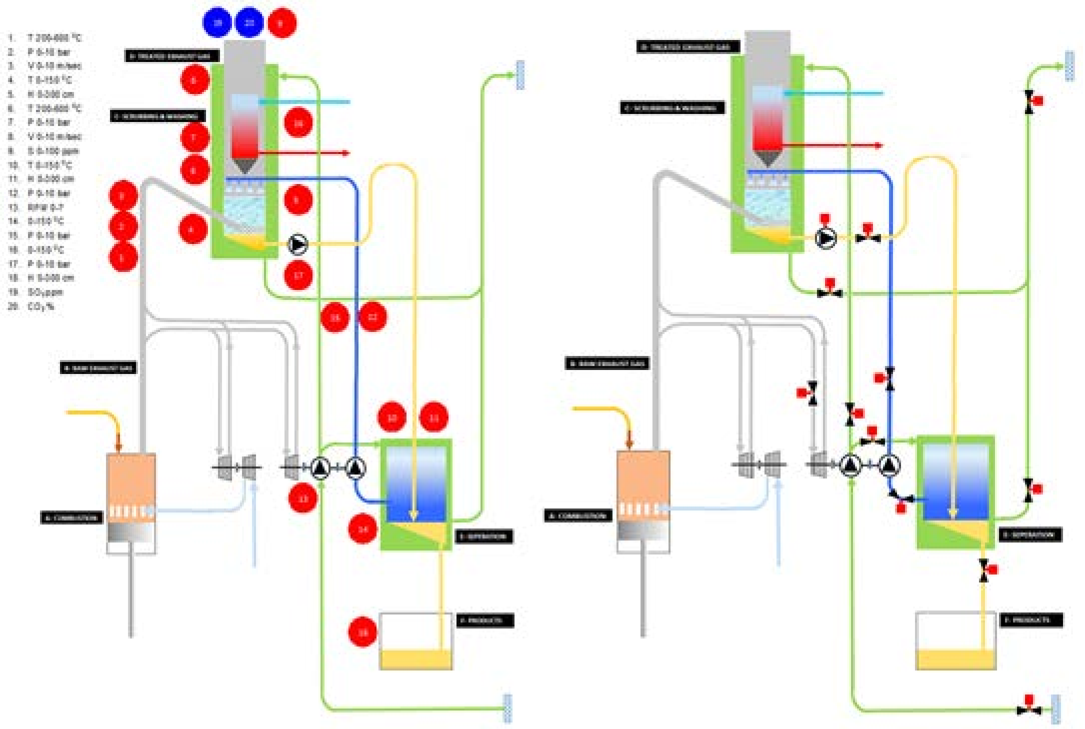

Figure 4. Automatic control elements of the suggested Scrubber system

MODELING

Empirical, deterministic mathematical simulation model for potential routes of building, studying, testing and use is accepted to facilitate computer based data analysis due to the research, suggested to optimize Closed-Loop-Freshwater-Slurry Circulated-Wet type scrubber, is based on mechanical, chemical and physical properties of the system variables' ratios and correlations represented with Figure 5. Shaft speed orders have been accepted as independent variable, while physical and chemical

properties correlated each other in all stages of the process have been accepted as dependent variables to develop a reliable software efficiently and effectively control the scrubbing process.
Air-to-Fuel ratio (R=A/F) keeps the exhaust flue gas temperature within the operation limits, provides the best fuel economy and acts on the scrubber system efficiency and performance to establish a proper and continuous emission control as projected.

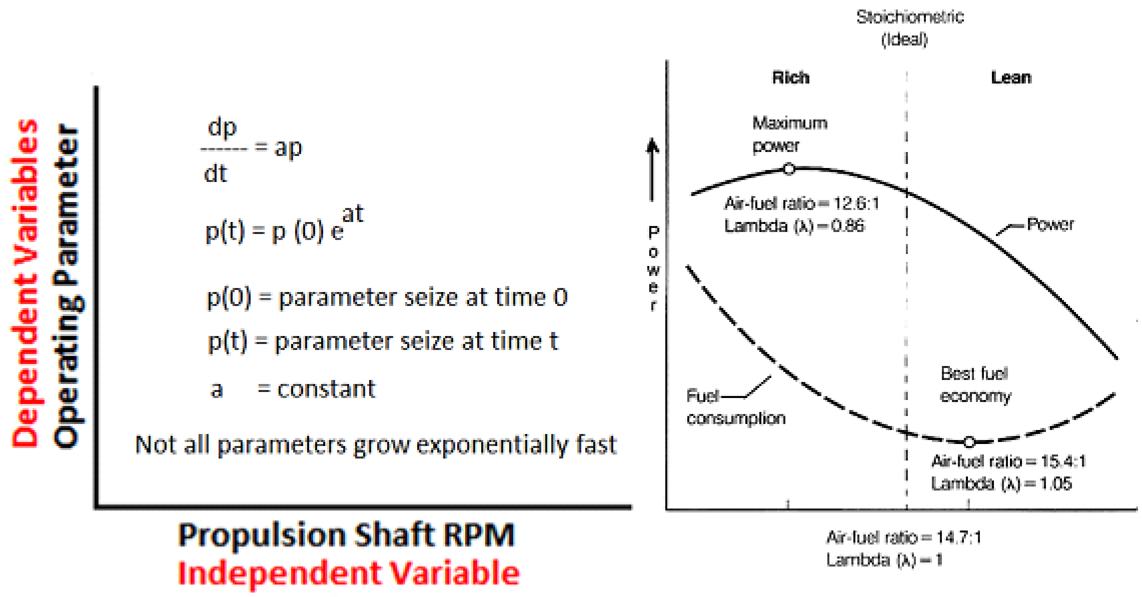

Figure 5. System variables Ratios and Correlations

TESTS, TRAILS AND CERTIFICATES

System approval, survey and certification using parameters, emission checks and proof of the SO_2/CO_2 ratio enables direct monitoring of exhaust gas emissions to verify compliance with emissions limits set out in Section 1.3, Paragraph, 4, Table 1 of the Guideline MEPC.184(59)

INVESTMENT AND OPERATIONAL COSTS

In order to estimate the cost of investment for designing and manufacturing the proposed system, a calculation format needs to be prepared for market analysis to satisfy all demands of the suggested system projected be installed on board commercial ships in various seizes having different application characteristics obliged by the laws and regulations. For ship owners it is not an additional cost to their new ship orders due to the exhaust flue gas scrubbers are actually covered within the bidding documents. From the operational point of view, maintenance of the scrubber system and the chemicals to be consumed for treatment are the expenses depending on the running period of the exhaust flue gas sources, types, quality of the fuel and, proper monitoring and controlling the operating parameters of the installed systems.

To partially offset the cost of suggested scrubber installation, as an option, the ($CaSO_3$) (calcium sulfite) is forced further oxidized to produce marketable ($CaSO_4 \cdot 2H_2O$) (gypsum) which needs additional investment to design, manufacture and arrange additional space in the ship engine room to install.

CONCLUSION

The scrubber, having suggested modifications, may achieve the goals if, full attention is carried out by the operators to manage properly the system components, even if the scrubber functions with high efficiency. This principle has the first priority in this research. Second important issue, for the proposed scrubber, is to have a full automatic control system with precise, correct and reliable data flow. Proposed scrubber system is assumed to add value to the efforts on human health and air pollution control.
Since January 2013, an Energy Efficiency Design Index (EEDI) and a Ship Energy Efficiency Management Plan (SEEMP) are mandatory for all ships of 400 gross tonnages and above.

From 2015, ships operating in Emissions Control Areas will be required to use fuels with 0.1% or less sulphur content (versus 1% now). Therefor a high level of preparedness will be the key of new opportunities emerging.

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EFFECT OF SEA WATER COOLING SYSTEMS TO THE ENERGY EFFICIENY OF SOLAR PANELS ON MARINE VESSELS

Olgun KONUR[1], K. Emrah ERGİNER[2]

ABSTRACT

Sun power becomes a viable power source for marine vessels. Photovoltaic systems provide clean and silent energy production for the service needs and also for the propulsion of small vessels. However, limited usable area for solar panels and high installation costs restrict the sufficient energy production for satisfying the whole needs of vessel.Thus, improving photovoltaic system efficiencies gain importance recently to maintain sustainability.Characteristic properties of solar cells can be utilized to increase the efficiency of photovoltaic systems. Previous studies show that, decreasing the surface temperature of solar cells increases the produced energy from the cells. In this case, cooling the photovoltaic system is needed on hot weather conditions. Studies made on this subject are mainly focused on producing electricity and besides hot water for land use while cooling photovoltaic panels. In this study, cooling solar panels with sea water in an open loop cooling water circuit for small marine vessels is investigated. Energy efficiency and power output changes are observed.

Keywords –Energy efficiency, sea water cooling systems, solar cells.

INTRODUCTION

Photovoltaic systems could not attract enough interest from people by reasons of high installation costs and low efficiency values of commercially available photovoltaic technologies. Silicon solar cells, which are holding the most market share, reach to %25.6 cell efficiency values [1] recently. In laboratory conditions, maximum efficiency values can be reached to %46 values with the help of nanotechnology and multi-junction products with concentrating photovoltaic technology [2].

Photovoltaics are specialized semiconductor diodes in which electrical current is associated with light with the current and electrical energy being driven by radiation energy. Temperature directly affects the cell efficiency and power output accordingly because of the diode law for silicon solar cells. Equation (1) shows the Shockley ideal diode equation or diode law which gives the I–V characteristic of an ideal diode;

$$I = I_S\left(e^{\frac{qV_{OC}}{kT}} - 1\right) \tag{1}$$

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where I is the net current flowing through the diode; I_S is dark saturation current, which is the diode leakage current density in the absence of light; V_{OC} is the voltage across the terminals of the diode; q is absolute value of electron charge; k is Boltzmann's constant and T is absolute temperature in Kelvin.

The dark saturation current, I_S, is not constant for photovoltaic cells, but varies significantly with temperature. Increased temperature narrows the band gap of individual cells. Depending on the voltage-temperature characteristic of cell's p-n junction which is based on q/kT diode factor, open circuit voltage (V_{OC}) decreases linearly by increased temperature as seen in Figure 1. Narrower semiconductor band gap causes to slightly increase I_{CC} because electrons can pass from valance band to conduction band easier [3]. Slightly advanced I_{CC} fail to compensate voltage drop and the cell generates less power with the increasing temperatures [4].

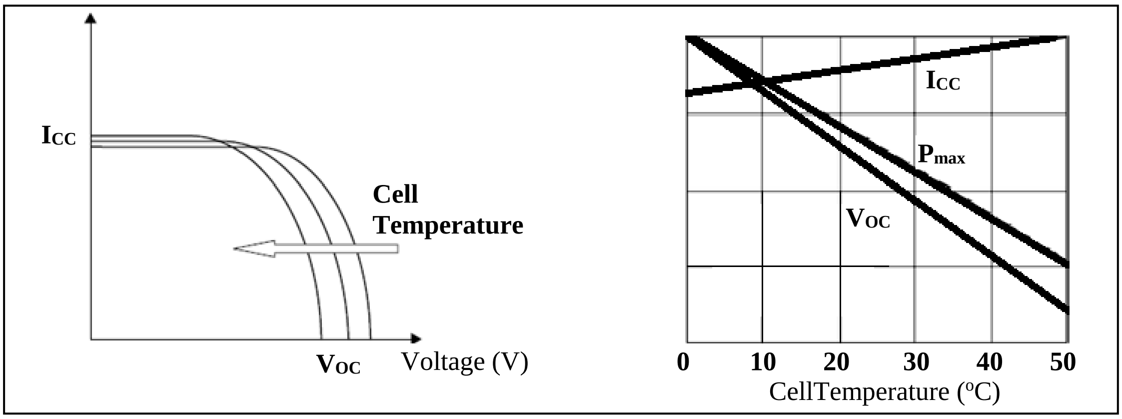

Figure 1. Effect of Cell Temperature to Photovoltaic Cell Characteristics [4], [5]

Photovoltaic modules generate more power, when either active or passive cooling is applied to solar cells in hot climates. Thus, both cold and also sunny weather conditions at the same time are the best environment to get more efficiency from photovoltaic modules.

Experimental researches from literature show that passive cooling can increase the module efficiency by 1.4% [6]. Active cooling systems can provide up to 6% efficiency increases according to the test conditions [7]-[9]. It is revealed that most of the solar modules used for experimental research are laminated with glass. Glass lamination is very common at land applications; but is not suitable for marine vehicles because of non-flexible properties and heaviness problems of glass. Although, it is still possible to see solar panels laminated with glass on marine vehicles, flexible panels which are more suitable considering the sea conditions and lightness in weight as much as quarter of glass laminated panels, become popular increasingly for marine vehicles. Cooling systems are also chosen as photovoltaic thermal systems which use heated fresh water in home applications and typical refrigeration systems which consume too much power. Hence the purpose of the present work is to study the cooling effect of sea water to solar panel efficiency for marine vehicles. Comparison of cooled and uncooled solar panel power output values are measured.

EXPERIMENTAL SETUP

An experimental setup has been developed to study the effect of seawater cooling on the performance of photovoltaic panels of solar powered marine vessels as seen in Figure 2. Studied solar panel is made up of 8 pieces monocrystalline silicon solar cells with FR4 material lamination that makes the panel light and flexible. Overall dimension of photovoltaic panel is 700 x 360 mm and have a thickness of 2 mm. Total silicon cell covering area is 0.1886 m^2. Panel was placed horizontally to the ground while taking the measurements. Plexiglass was used to cover the back of the panel forming the cooling area. 10 x 10 mm rubber gasket was used to provide the sealing of cooling area. Sea water, which is the cooling media that can be found plentiful in environment, was provided from a sea water pump that has 67 W power and 8 l/min at 1.5 bar capacity. Seawater outlet from the panel is discharged to sea with an open loop circuit. Two pieces of thermometers are used to measure the inlet and outlet temperatures of cooler. Temperature of the sea water was varied between 20°C and 22°C during the day as read from the inlet temperature of the cooler. Temperature variations were observed from the front surface of solar panel with an infrared thermometer while voltage and current values were measured from panel output with a multimeter.

Figure 2. Experimental Setup of Seawater Cooling System

ERRORS AND ORDER OF ACCURACY

Errors associated with the experimental measurements and the limits of errors are presented here. The water temperature was measured using probe thermometers with an uncertainty of ±0.5°C. The accuracy of the multimeter for the measurement of DC voltage is ±0.5% and for the measurement of current is ±1%. Data acqusition of solar radiance was made by a handheld solar meter with an accuracy of ±5%.

MATHEMATICAL FORMULATIONS

The output power (P) of the photovoltaic panel is calculated using voltage (V) and current (I) data and is given by the following equation;

$$P_{output} = V.I \tag{2}$$

Using the output power of photovoltaic panel and the incident solar radiation data I, the efficiency of the photovoltaic panel is calculated by the Equation (3) as given below;

$$\eta = \frac{P_{output}}{A.I} \tag{3}$$

where η is the efficiency of solar panel, P_{output} is the power output generated by solar panel, A is the surface area covered by photovoltaic cells and I is the incident solar radiation.

EXPERIMENTAL RESULTS

Experimental measurements of the power output, efficiency and surface temperature of the photovoltaic panel are shown in this section. Measured solar radiation values on the testing day are represented in Figure 3.

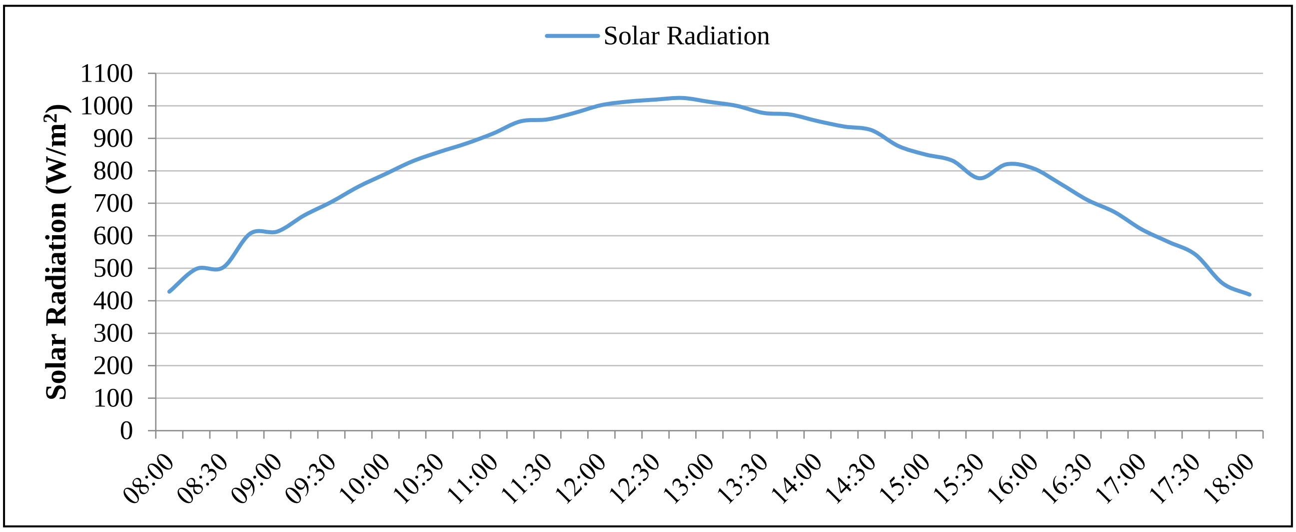

Figure 3. Measured Solar Radiation Values during Test Day in June 2016

Experimental setup of the cooler of the panel is a totally enclosed area. Sea water is also directly in contact with the back surface of the panel. Therefore, temperature measurements were not taken from the back surface, but from the front surface of the photovoltaic panel. Solar panel was firstly generated electricity under uncooled condition. When sufficient heat energy was absorbed by the panel, surface temperature of the panel was recorded and then, sea water pump ran to start cooling. Cooling was applied until the outlet temperature of sea water reaches to steady state. Cooled surface temperature was measured and cooling was stopped until the solar heat energy was absorbed by solar cells once again. Measurements were taken from 08:00 to 18:00 with 15 minutes interval. Figure 4 shows the uncooled and cooled panel surface temperature values and ΔT differences, which reached to 36.5°C during noon time.Uncooled surface temperature was peaked at 13:15 to 60 °C, where the solar radiation was close to the peak radiation value of the day.

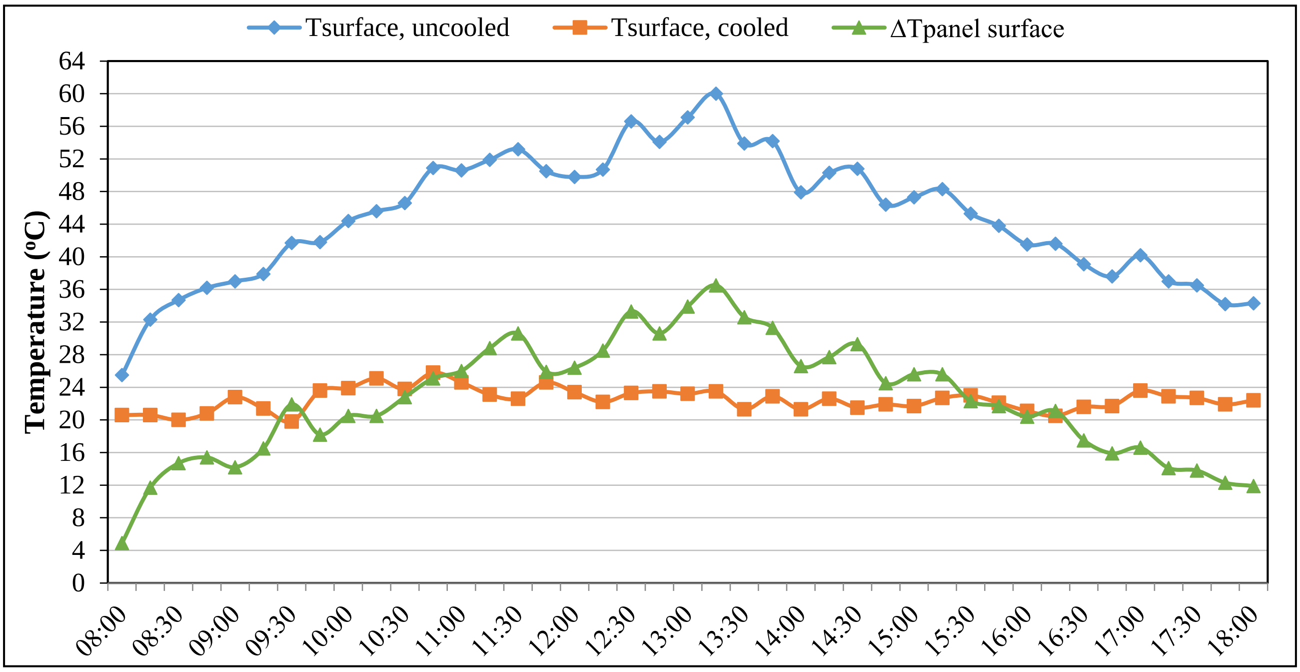

Figure 4. Uncooled and Cooled Panel Front Surface Temperature Measurements and ΔT Difference

Together with the temperature measurements, voltage and current output values were also taken from the solar panel output. These values are multiplied using Equation (2) to find the produced power output (P_{max}) from the photovoltaic panel on uncooled and cooled conditions. Figure 5 represents the power output of uncooled panel in blue line and power output of cooled panel in orange line. The power output differences ΔP are shown as the green line which can also be called as the power gain by using the cooler.

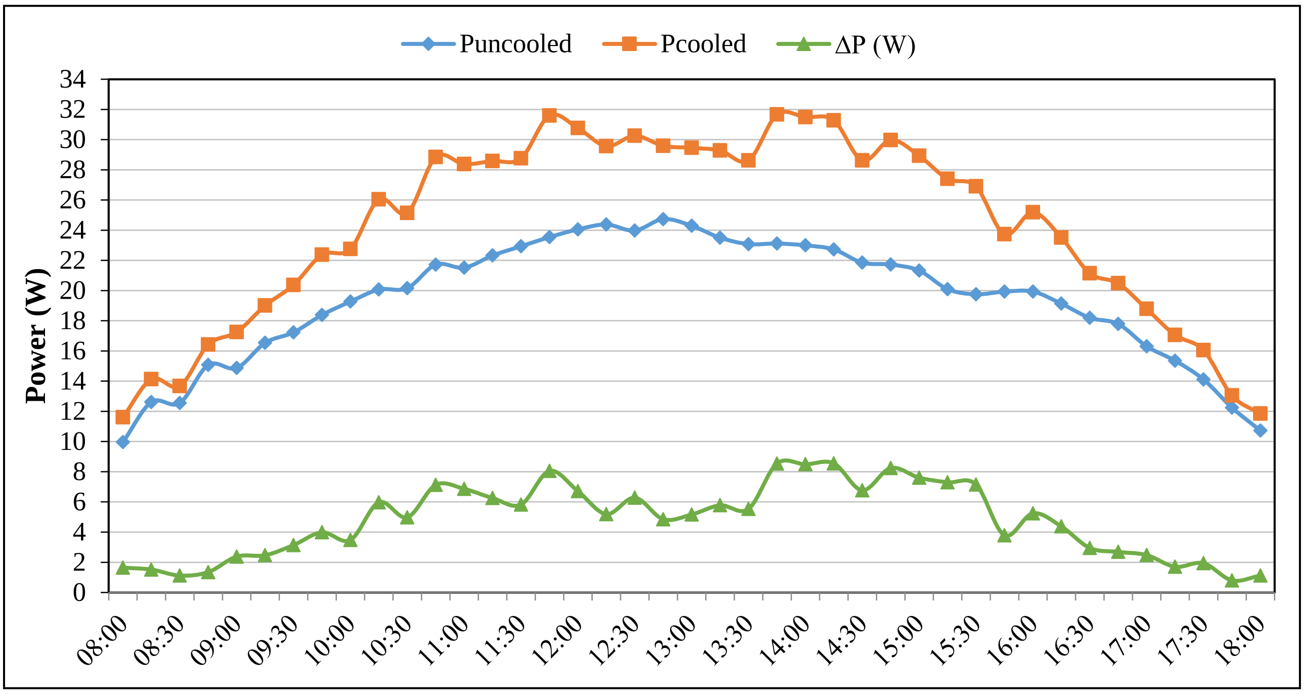

Figure 5. Power Output Measurements of Uncooled and Cooled Panel and ΔP Difference

Figure 6 represents the increase in power output as percentage with the utilization seawater cooling system to the photovoltaic panel. As can be seen on the figure, up to 37% of power output can be generated with cooling system. Power incremention is less during morning and eventide periods; because of the low radiation values produce less heat on the panel.

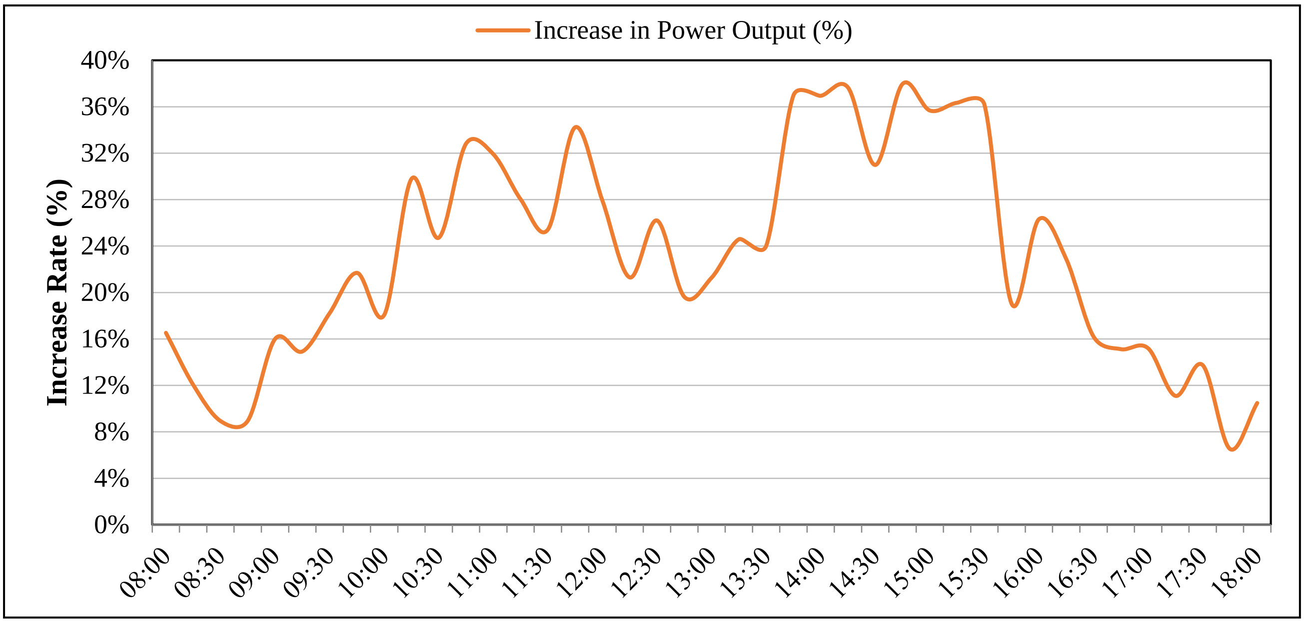

Figure 6. Percentages of Incremention in Power Outputs Provided by the Cooling System

To make a general judgement about the effect of cooling on solar panels, panel efficiency changes need to be observed. Using the Equation (3) in Section 4, photovoltaic panel efficiency values are calculated for uncooled and cooled conditions seperately as shown in Figure 7. Green line represents the efficiency gradient by the sea water cooling effect.

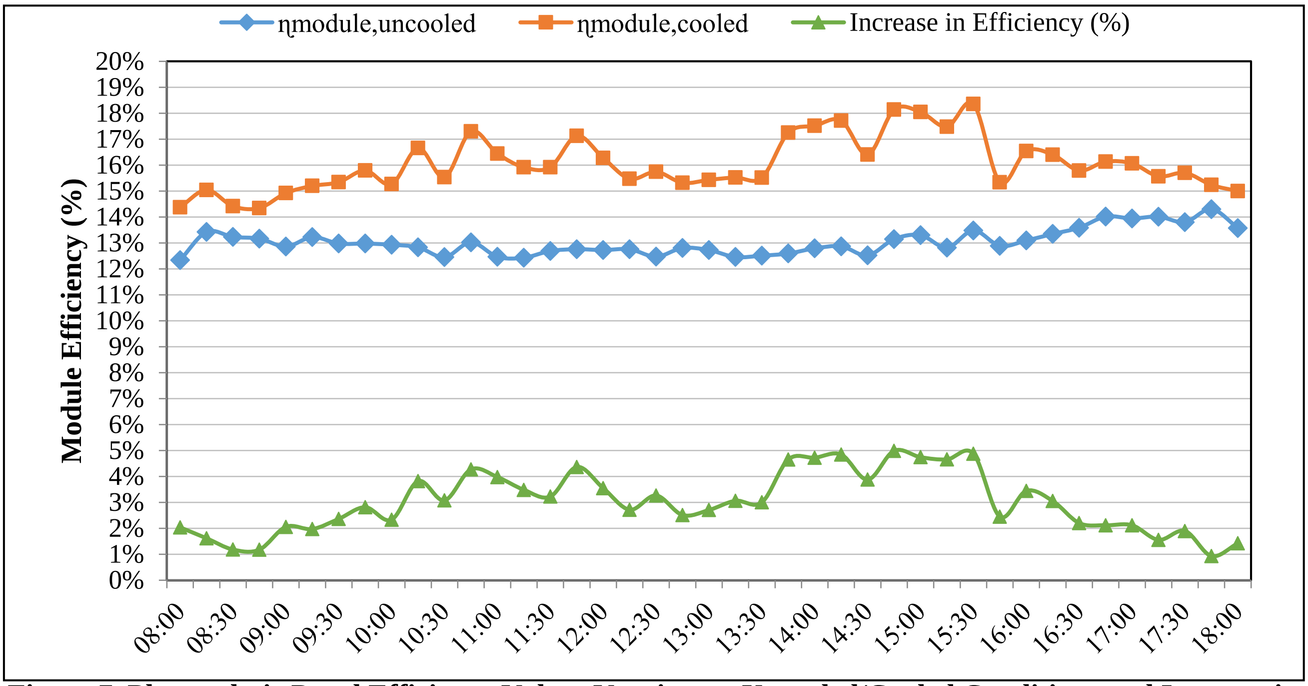

Figure 7. Photovoltaic Panel Efficiency Values Varying on Uncooled/Cooled Conditions and Increase in Efficiency by the Effect of Cooling

Uncooled panel efficiency shows a change between 12.4% and 14.3%. The efficiency values for all of the measurements are boosted with the applied cooling. Seawater cooling system provides a maximum of 5% and a minimum of 1.5% efficiency boost to the solar panel. Minimum increases are seen in the morning and eventide periods because the solar radiation is also at minimum. Noon and afternoon periods show great potential to benefit from the cooling effect of seawater for photovoltaic modules on marine vehicles.

CONCLUSION

The objective of this research is to determine the energy efficiency increases at the solar modules by the cooling effect of seawater. The effect of temperature to the photovoltaic system efficiency is a result of natural characteristics of crystalline silicon cells. If the environment around the marine vehicles is thought, seawater would be a good source to be used for cooling. An experimental study has been carried out to accomplish the objective of this research. A seawater cooling system was designed for a 700 x 360 mm photovoltaic module which has a thickness of 2 mm with FR4 material lamination in which the seawater is directly in contact with the back surface of the panel. The photovoltaic panel efficiency and the power output from the panel are sensitive to panel temperature. As the ΔT difference provided by cooling gets bigger, solar panel efficiency and power output increase accordingly. Seawater cooling system fitted on solar powered marine vehicles would increase the power output by up to 37%. Solar module efficiency can also be boosted by 5%. Cooling effect is more visible between 09:30 and 16:30 in June 2016. Solar radiation drops below 700W/m^2 that results absorbing less heat by solar panel beyond these hours. Consequently, cooling of solar panels on marine vehicles is a very effective way of increasing energy efficiency of the electrical system. It is necessary to increase the range of the marine vehicles with electric propulsion. Charging with solar module durations will also be shorter, if a cooling system is functional on solar modules of the marine vehicle.

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ENERGY EFFICIENCY OPTIMIZATION TECHNIQUES FOR SOLAR POWERED BOATS

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ABSTRACT

Marine vessels require highly efficient, powerful and economic fuel sources and propulsion systems. Internal combustion engines today give the necessary requirements; but extinction of fossil fuels in the near future leads the world to find alternative energy sources. Sun power becomes a potential power source for low power consuming marine vessels; especially for boats and yachts. Due to the restrictions on boat's deck coverage for the solar panel area, power output coming from the solar panels mostly can't provide required propulsive power for the boat. Battery storage capacity is also very limited for the vessels' critical electrical system equipments, so the boat's range with fully charged batteries is inadequate for the boat owners. In this case, energy efficiency optimizations for the electrical propulsion systems of solar powered boats become vitally important to make the electric propulsion system more efficient. In this research, energy efficiency optimization techniques for solar powered boats are examined and discussed. Energy efficiency gaining applications from each component of solar electric propulsion system are elaborated.

Keywords – Electric propulsion systems, energy efficiency, photovoltaic systems.

INTRODUCTION

Solar powered boats can reach significant speeds in our day with the enhancements on electric propulsion system performance and weight reduction technologies of boat hull such as using high technologhy composite materials. Increasing environmental conciousness among people also causes pressure for more improvements on electric propulsion systems to make them widespread. Low maintenance costs and the potential of storing free energy with renewable energy resources make the solar power supported electric propulsion systems favourable.

Figure 1 shows the typical electric propulsion system for solar power boats. Electricity provided as AC power source from shore connection is converted to DC current with the help of a redressor to be stored in battery pack. Energy produced by photovoltaic solar panels is stored directly in battery pack because solar panels are already a DC power source. Maximum power point trackers (MPPT) can be fitted to the system according to the system voltage to send the maximum power output from photovoltaic panels to the batteries. Motor controller adjusts the speed setting of electric motor according to the given signal from control panel. If AC electric motor is equipped onboard to propel the boat, inverter is needed to convert DC current coming from battery pack to AC current. If electric motor's RPM is higher than propeller's designed RPM, reduction gear can also be used in the system.

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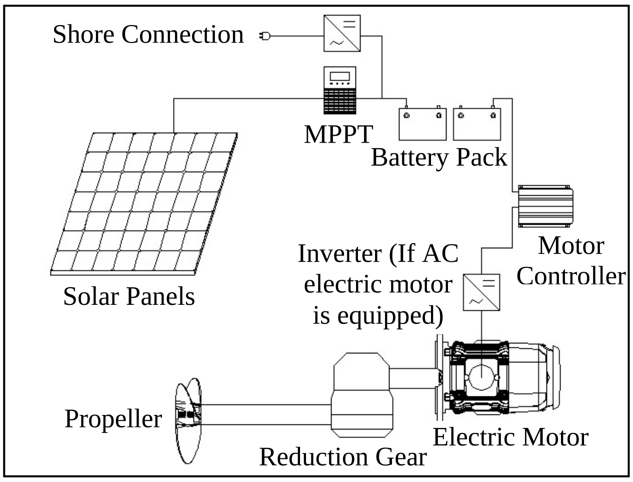

Figure 1. Typical Electric Propulsion System of Solar Powered Boats

The range issue still remains as the main problem for the electric propulsion boats. Although solar power supports the power system for a little more, recent photovoltaic technologies are still inadequate for increasing the endurance to a satisfying level. This situation affects the usefulness of solar powered boats. Battery storage capacity is the most important factor to provide more endurance; but limited spaces to place the batteries and weight restrictions on boats affects the storage capacity to a specific level. Bigger boats with lighter weights are designed to overcome range problems. In addition, efficiency gaining applications from renewable energy sources and electric propulsion system components are studied to maximize solar power boat endurances.

INCREASING ENERGY EFFICIENCY OF SOLAR MODULES

Solar power proves itself as a clean and eco-friendly source of energy with the emergence of photovoltaic and thermal systems. Technological advancements also provide significant cost reductions on solar systems day by day [1]. There have some factors that affect the energy efficiency of solar modules of solar powered boats. Weather and sea conditions, technologies equipped on photovoltaic system and cell temperature can have negative or positive effect on photovoltaic systems.

Effect of Using High Efficiency Solar Cells

Efficiency of solar cells has dramatically improved with the desire of finding alternative energy sources which was geared up with the beginning of 1973 oil crisis. Recent maximum efficiency value of crystalline silicon solar cells is 25.6% [2]. 4-junction solar cell technology breaks the latest efficiency record with the production of 46% efficient solar cells in December 2014 which exceeds the theoretic maximum solar cell efficiency of 29.4% defined by Shockley & Quisser [3].

According to National Renewable Energy Laboratory (NREL) data, Figure 2 shows the maximum efficiency values of solar cell technologies from 1975 to 2016. Blue line on Figure 2 illustrates efficiency improvement of crystalline silicon cells which are the most commonly used cells on photovoltaic market. Purple line indicates the efficiency change of multi-junction cells since 1980s as the new photovoltaic trend. Incremention of solar cell efficiency reduces module and system costs. Multi-junction solar cells, that have a big slop of efficiency change by year, are expected to have a more active market than silicon cells if the solar module efficiency levels can be upgraded to 45% efficiency [4].

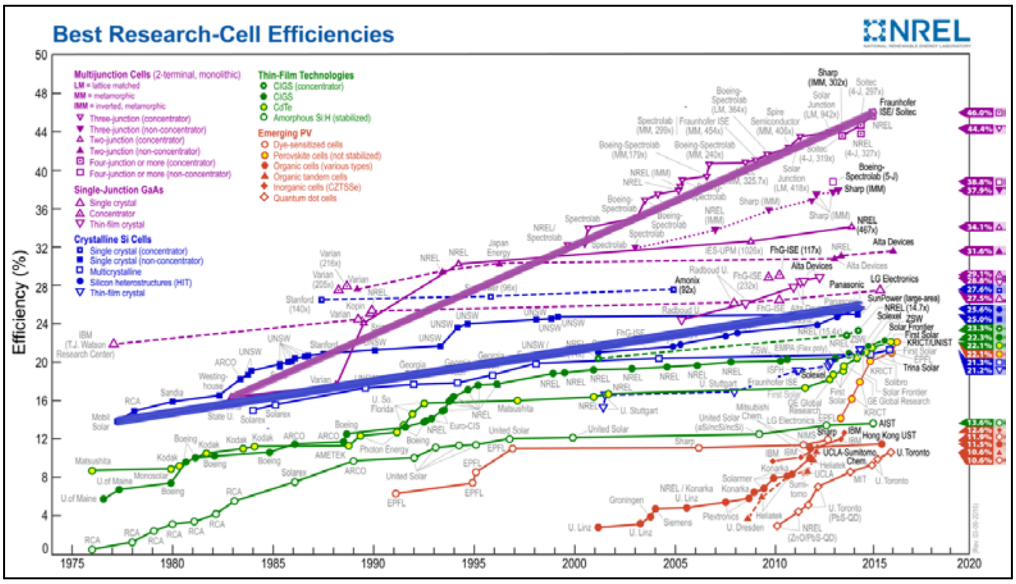

Figure 2. Efficiency Progress of Solar Cells since 1975 [5]

The comparison table shown in Table 2 represents 5 photovoltaic systems with different efficiency values that are suitable to be placed on 22m^2 roof area of a solar powered boat. Total module power difference of 1200W$_P$ can be pointed out between 13.4% and 19.0% efficient modules.

Table 1. Comparison of 5 different photovoltaic modules that can be placed on 22m^2 area of a solar boat

	Used Space (m^2)	Panel Size (mm)	Panel Power (W$_P$)	Panel Needed (pcs)	Panel Efficiency (%)	Total Module Power (W$_P$)	Total Module Weight (kg)
A	21,4816	1005x668x35	90W	32 panel	% 13.4	2880W	256kg
B	21,8114	1580x1062x45	250W	13 panel	% 14.9	3250W	214.5kg
C	21,7146	1196x534x35	100W	34 panel	% 15.7	3400W	272kg
D	21,7985	1109x546x2	102W	36 panel	% 17.0	3672W	50.4kg
E	21,4336	1580x798x35	240W	17 panel	% 19.0	4080W	255kg

Endurance changes of a solar powered boat, which is equipped with 12 pieces 12V, 100Ah batteries and a 10kW continuous power generating electric motor, are calculated for the 5 different solar modules and only with batteries in Figure 3. Calculations are done under the solar radiance of July in İzmir/Çeşme [1] for the varying load conditions of electric motor between 5kW to 10 kW.

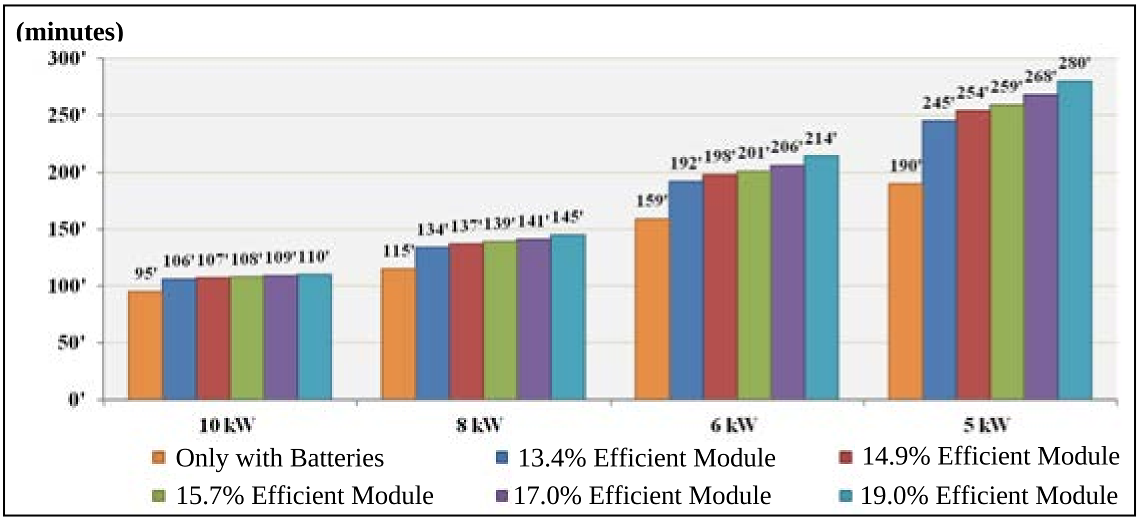

Figure 3. Calculated Endurances of a Reference Boat with 5 Different Modules and only with Batteries

Battery and electric motor system data are taken from all electric and solar powered "Yeşil Eylül" boat propelling with a controllable pitch propeller which belongs to Dokuz Eylül University Maritime Faculty and supported by IZKA (Izmir Development Agency) with the number of TR31/12/YE02/0015. All endurance calculations are assumed as the batteries are full for every test and power consumption of electric motor is continuous. If the motor is run at full performance at 10kW, endurance of the boat doesn't affect much with the change of panel efficiency. For lower speeds, endurance difference becomes visible with 35 minutes between 13.4% and 19.0% efficient modules in the example of 5kW power consumption. Endurance problem of electric boats are a well-known problem for years. Efficient solar panels can boost the endurance of solar powered boats for slow speeds and lower the charging duration of batteries.

Solar Tracking Effect

Solar radiation can most efficiently be converted to energy at the vertical position of solar module according to the radiation. Solar trackers provide efficient solar power generation from solar modules by tracking the sun's position in a day and year.

Solar tracking provide more energy than static system on every position of the sun; but the most energy production difference is seen at morning and sunset periods of day. Experiments made by two axis and active controlled solar trackers show that 82% energy efficiency gain can be provided at morning and sunset periods [6]. Microprocessor controlled sun tracking systems boost the total power output of solar modules by 52% in comparison with horizontally placed static systems. Solar trackers boost the energy gain by 33%, if compared with solar modules that are fixed to the optimum sun power harvesting angle for that specific position [7]. In addition, cost analysis of solar trackers shows that initial costs of photovoltaic systems with solar trackers are less costly than static systems for the same energy production capacity [8].

Active controlled solar trackers can be useful to increase energy efficiency of solar modules on solar powered boats. If the sea is flat enough to track the sun or the course of the boat is straight without too many maneuvers, solar trackers can boost the energy production from solar modules. If the sea is wavy or the boat is maneuvering too much while sailing, power consumption of the tracker will be high, so the solar tracking will not be functional. Sun tracking devices can be used functionally on marinas or ports for solar powered boats.

Effect of Reflectors on Solar Panel Performance

Solar radiation falling to the outward perimeter of solar modules can be directed to module surface with cheap reflectors to increase produced energy from solar modules. Mirrors, aluminuim materials, multi-layered polymer materials and lenses etc. are utilized as reflecting materials.

Photovoltaic systems supported with regularly placed flat mirrors generate up to 1.5 times more energy than conventional systems [9]. Concentrated photovoltaic systems (CPV) are the new trend in photovoltaic systems which are generally using Fresnel lenses, parabolic reflectors and pit mirrors. Main purpose of using concentrating photovoltaic systems is to reduce the photovoltaic cell area significantly and utilizing more economic optical reflectors instead [10]. These systems include single junction solar cells that are only able to absorb photons equal to cells' band gap and also multi-junction cells that are able to absorb lower wave lengths of light than cells' band gap. These systems are more costly; but have very efficient solar cells with the maximum efficiency of 46% by 2016. Photovoltaic cells exposed to intensive radiation may require cooling by convection or an active cooling system. Concentrating photovoltaic/thermal systems gain energy from the waste heat produced on cells. Exergy analysis show that 60% energy incremention can be regained by using cooling systems on concentrated photovoltaic systems [11].

Concentrating photovoltaic systems may require solar tracking devices to absorb lower wave lengths of light. Inaccurate solar tracking can cause significant power output drops on solar modules. For that reason, concentrating photovoltaic systems are not pratical for marine vehicles. These systems can be considered to be used in marinas or ports to supply power to the batteries of solar powered boats.

Shade Effect

Photovoltaic cells work reversely in the case of shading by cloud, trees, buildings or other objects. Cells act as loads, consume I^2xR amount of energy and produce heat. Hot spot problems can occur on solar modules and damage the cells if the system protection is not working well. Photovoltaic cells are connected in series to increase the voltage output to the required usable level. Lowest current amongst all cells is generated from photovoltaic module with series connected cells as the output current. Small portion of shading on solar modules cause significant power drops as can be seen on I-V characteristics of solar modules because of shading in Figure 4.

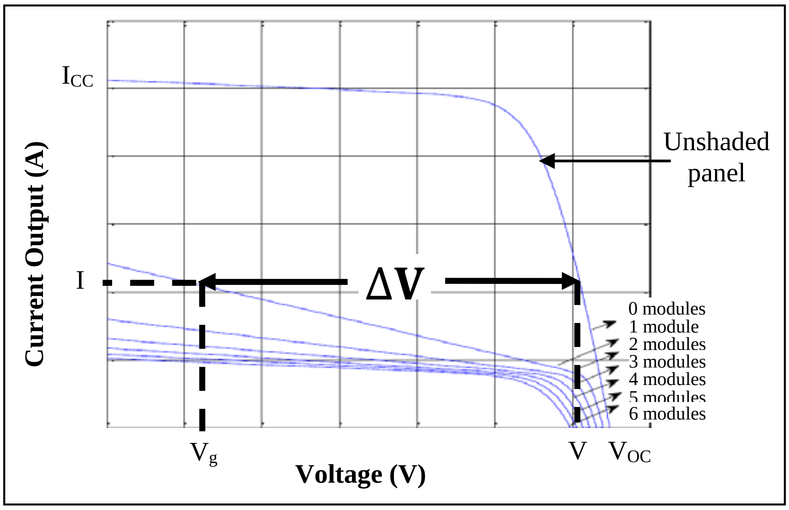

Figure 4. I-V Characteristics of Modules According to the Number of Modules Affected by Shading [12]

Cloudiness is the main factor of shading at sea conditions. Clouds cause unstable and disorganized energy dispersion to the earth according to the geometric properties of the clouds. So, the energy falling to the modules are reduced due to the shading effect of clouds. Blockage diodes fitted among the panels, and also to the outlet of cell groups if required, provide optimum current flow by blocking power losses from shaded cells or panels on the module. Only power losses occur at the shaded cells.

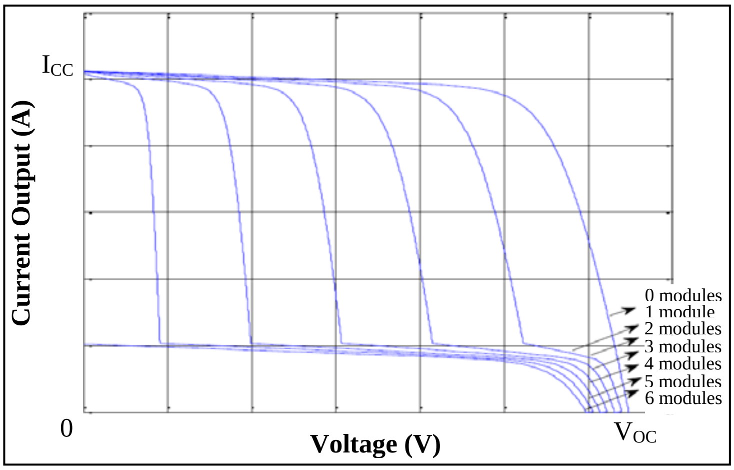

Figure 5. I-V Characteristics of Shaded Modules Equipped with Blockage Diodes [12]

ΔV difference is minimized by using blockage diodes among modules as can be seen on Figure 5. Shaded modules that are connected in parallel consume electric current generated from the unshaded modules. Blockage diodes prevent these consumptions and also provide safety against reverse current flows coming from the batteries. As a result, blockage diodes should be used on solar powered boats as a precaution against shading effect of cloudy days. As many as the blockage diodes are used between cells or panels, system gains advantage of gaining improved efficiency. Also, unwanted heat spots and heat losses are reduced on modules.

Temperature Effect on Solar Cells

Temperature of photovoltaic cells is a significant factor that affects cell efficiencies. In addition, ambient temperature also affects power output of solar modules. As the intensity of light increases, both closed circuit current (I_{CC}) and open circuit voltage (V_{OC}) increase as seen in Figure 6a. Increased temperature narrows the band gap of individual cells. In accordance with the voltage-temperature characteristic of cell's p-n junction, V_{OC} decreases linearly by increased temperature as can be seen in Figure 6b. Narrower semiconductor band gap causes to slightly increase I_{CC} because electrons can pass from valance band to conduction band easier [13]. Slightly advanced I_{CC} fail to compensate voltage drop and power loss occurs on the cell [14].

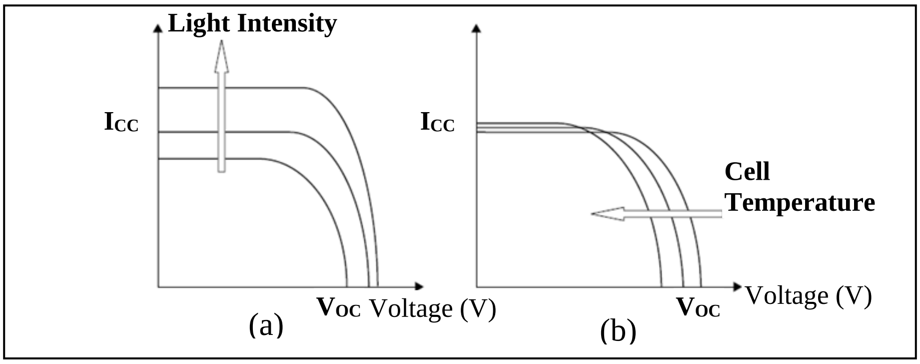

Figure 6. (a) Effect of Light Intensity to Photovoltaic Cell Characteristics; (b) Effect of Cell Temperature to Photovoltaic Cell Characteristics [14]

Temperature reduction at surfaces of photovoltaic modules generates more power output. The best environment for collecting energy from photovoltaic modules is provided in both cold and also sunny weathers at the same time. Energy efficiency is increased by adapting an active or passive cooling system to the module for hot climates. Experimental researches from literature show that passive cooling can increase the module efficiency by 1.4% [15]. Active cooling systems can provide up to 6% efficiency increases according to the test conditions [16]-[18].

The effect of temperature to the system efficiency is a result of natural characteristics of crystalline silicon cells. A cooling system fitted to the solar modules on solar powered boats would increase power output substantially. If the environment around a boat is thought, water and air would be a good source to be used for cooling.

INCREASING ENERGY EFFICIENCY BY USING EFFICIENT BATTERY SYSTEM

Batteries are electrochemical structures that store energy by converting electrical energy to chemical energy and discharge stored energy by converting chemical energy to electrical energy [19]. Electricity can be discharged at stable and continuous currents and voltages. Photovoltaic modules require batteries to store produced energy and be able to discharge it at high currents to the related equipments as needed. Various types of batteries are used in different applications to store energy. Low installation costs, commercially availability at different sizes and being understood of performance characteristic make the lead acid batteries used widespread for photovoltaic applications. Nickel-cadmium batteries are also used at some critical and low temperature requiring applications; but these types of batteries are rarely used because of high installation costs [20]. New advancements in battery technologies offer better performance. However, there still have troubles with cycle life and installation cost issues. Battery characteristics should be analyzed very well in order to understand their advantages against each other.

Table 2.Technical Characteristics of Various Battery Types [21]-[23]

Battery Type	*Specific Energy (Wh/kg)*	*Energy Density (Wh/L)*	*Specific Power (W/kg)*	*Self-discharge Coefficient (%/24h)*	*Cycle Life*	*Operaitng Temperature (°C)*	*Initial Cost (£kWh^{-1})*
Pb-acid	40	70	180	1	500	-15 - 45	105-175
NiCd	60	100	150	5	1350	-40 - 70	200-300
NiMH	70	250	1000	2	1350	-30 - 70	250-350
Li-ion	125	270	1800	1	1000	-20 - 60	250-1000
Li-Poly	200	300	3500	1	1000	-20 - 60	350-750
ZEBRA	125	300	1500	0	1000	275 - 350	70-270

Table 2 shows average technical specifications and initial costs of various types that can be used on electric propulsion boats. More energy density means more range, which is most common problem of solar powered boats [25], varying with the changing electric motor loads.

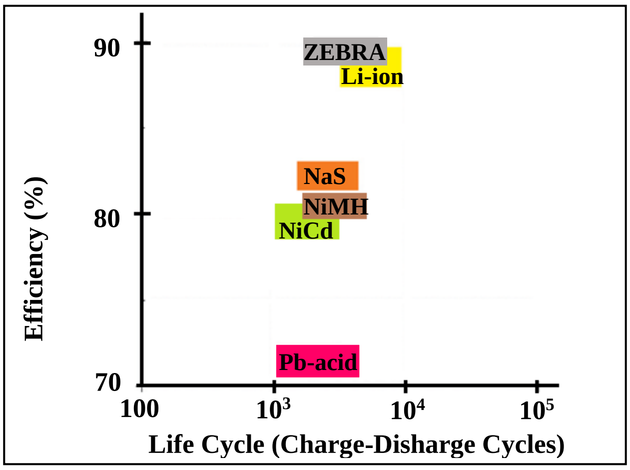

Figure 7. Efficiency/ Life Cycle Graphic for Various Battery Types [23]-[24]

Operation costs of lithium-ion batteries are very low, however initial costs are high. According to the economical analysis made for lithium-ion batteries show that unit energy cost of lithium-ion batteries are competitive with lead-acid batteries [22]. Therefore, it not true to say lithium batteries are expensive. All in all, lighter and more economic products than lead acid batteries are predicted to be invented in the near future owing to the new developing material technologies.

MPPT (MAXIMUM POWER POINT TRACKER) EFFECT

Power output of photovoltaic modules varies with the change in solar radiation and temperature. It is important to track maximum power point (MPP) where the solar module is able to generate maximum power on a specific load while power changes occur. Maximum power point trackers (MPPT) track the maximum power point at all events of meteorological conditions [26]. Integrated

DC-DC converter stabilizes the voltage coming from photovoltaic modules to the charging voltage of batteries.

A set of methods are developed to track maximum power point of the system which are seperated from each other in terms of complexity, sensor necessity, convergence speed, cost, effectiveness range, hardware and popularity. Because of the fact that there are no clear distriction between MPPT methods, decision of providing the most appropriate method for a specific photovoltaic system becomes pretty hard [27]. Comparison of minimum and maximum energy efficiency values of some MPPT methods are shown in Figure 8.

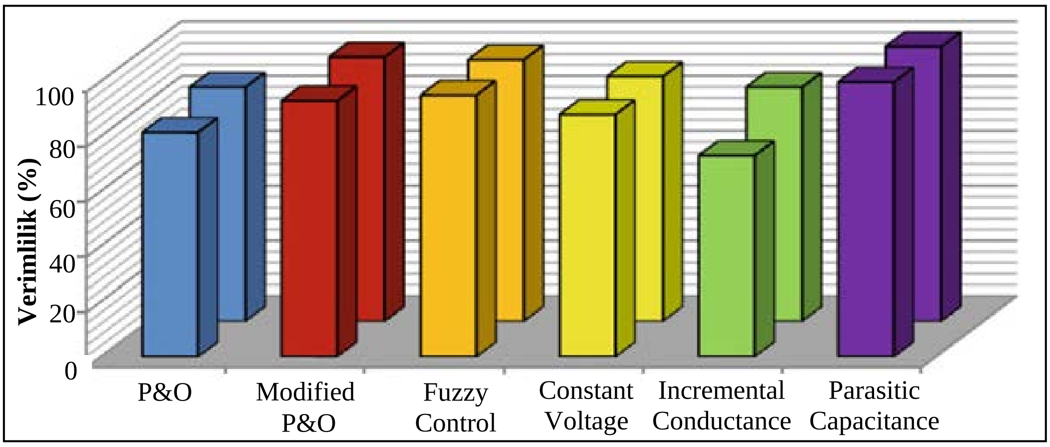

Figure 8. Energy Efficiency Comparison of MPPT Methods [19]

Perturb & Observe (P&O) algorithm proposes reductions in initial costs and application simplicity; although proposed energy efficiency range is low compared to other methods. Modified P&O and parasitic capacitance methods, in which mathematical and numerical calculations are used, and also artificial intelligence based fuzzy controllers are able to provide energy efficiencies up to 98%. Incremental conductance method has the advantage of quick power point tracking. Parasitic capacitance algorithm can ensure interesting amounts of energy efficiency increases especially on large scale photovoltaic applications.

Up to 30% power boost is possible by implementing MPPTs to the photovoltaic modules [28]. Separate MPPT usage at the outlet of each panel forming the solar module provides optimum power generation from solar panels by avoiding voltage drops derived from series and parallel connections between panels.

INCREASING ENERGY EFFICIENCY BY PROVIDING HIGH EFFICIENCY ELECTRIC MOTORS

Electric motors are the main power consuming equipments for propelling electric propulsion boats. A little incremention at the efficiency percentage of electric motor can reduce the power consumption dramatically according to the working hour of the equipment. Decreasing the power consumption means cost reductions and increased range for the solar powered boats.

Investment returns for high efficiency electric motors are generally shorter than standard efficiency electric motors. However, only a few of end-users choose high efficiency electric motors. The reason can be appointed as the lack of awareness about the energy efficiency and cost reduction acquisitions with high efficiency electric motor utilization. Power consumption costs of electric motors constitute

97% of the 20-30 years-long lifetime costs [29]. Installation costs only form 2% of the lifetime costs. Therefore, utilizing high efficiency electric motors instead of low-cost, low efficiency electric motors is an important factor for the systems that have 1000 working hours and above annually.

The graphic shown in Figure 9 state the results of a case study which compares the energy savings provided by choosing high efficiency electric motor against standard efficiency electric motor. Low efficiency electric motor efficiency is chosen 92.7% at IE1 international efficiency standard. 95.3% motor efficiency at IE3 standard is chosen as high efficiency electric motor. Both motors are considered to have 75kW nominal power, 0.91 power factor and 1000 working hours annually.

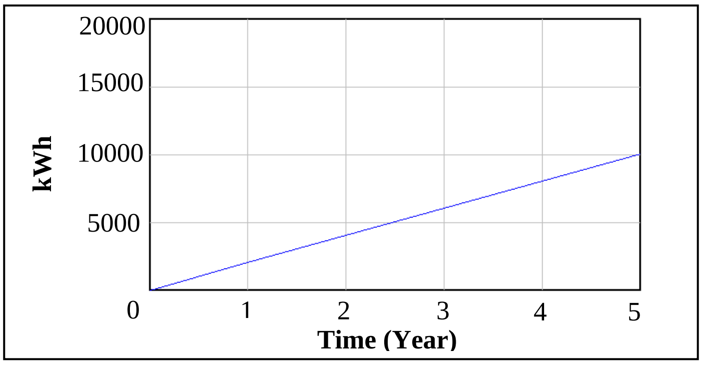

Figure 9. Yearly Energy Savings Obtained by Using IE3 Standard Electric Motors Instead of IE1 Standard Electric Motors According to the Case Study Data

Using the most efficient commercially available electric motors can reduce total power consumption at about 4-5% [30]. High efficiency electric motor utilization can provide slight increases at the endurance of solar powered boats which varies with the load of electric motor. To achieve the goal of a highly efficient solar powered boat, choosing a high efficiency electric motor is a must to increase energy efficiency by reducing energy consumption.

UTILIZING THE MOST EFFICIENT CABLING ON ELECTRICAL SYSTEMS

Electric cables are used to transmit energy among electrical system equipments. These cables produce heat because of the owned self resistance against electric flow. Therefore, heat losses occur during energy transmission from photovoltaic modules to batteries and from batteries to electric motors. Resistance of cables changes depending on length, diameter and self resistance of cable which varies with the cable’s material.

Copper is the most frequently used material to transmit electricity and link connections. Aluminium is also preferred for the reasons of low cost and low self resistance specifications. Silver also has low self resistance value; but is not preferred because of oxidation that causes to increase the self resistance over time. Redundant cable lenghts decrease system efficiency; thus electric system of solar powered boats should be compact and removed from excessive electric cables. Diameter of chosen cables for electrical system should be considered carefully. If smaller cable is used rather than using the diameter required by the system, heat losses occur during high loads of electric motor. Much bigger cable diameters cause to increase the initial costs, even if the resistance is reduced.

Tablo 3. Self Resistance and Temperature Coefficient Values for Various Materials at 20 ºC [31]

Material	ρ_c ($\Omega.\mathrm{m}$)	Tempereture Coefficient (K^{-1})
Carbon (Graphene)	$1,00 \times 10^{-8}$	-0,0005
Silver	$1,59 \times 10^{-8}$	0,0038
Copper	$1,68 \times 10^{-8}$	0,0039
Gold	$2,44 \times 10^{-8}$	0,0034
Aluminium	$2,82 \times 10^{-8}$	0,0039

Another factor affecting the cable resistance is the temperature. Temperature effect on energy efficiency changes is less if compared with cable length and diameter factors. Temperature coeefficient can be either positive or negative for various materials as can be seen in Table 3. Equation (1) introduces effect of temperature to the cable resistance;

$$R_2 = R_1 \ x \ [1 + (\propto x \ \Delta T)] \qquad (1)$$

R_2 : Cable resistance after temperature change
R_1 : Cable resistance at the first state
$\propto$: Temperature Coefficient
ΔT: Temperature Difference

Some materials show superconductant properties with no measurable resistance at extremely low temperatures. These materials haven't developed enough yet to be used in widespread applications. If the main focus of finding superconductors that work at room temperate is achieved, lossless energy transmission will be possible for many applications.

CONCLUSION

Energy efficiency of solar powered boats is increased by improving the system performances of solar electric system components. Using high efficiency solar cells in the solar module can make a very good contribution which is exampled at Section 2.1 with 35 minutes additional endurance to the solar powered boat case study. Solar tracking and concentrating reflector systems also improves the energy efficiency of solar modules significantly; but tracking the sun while sailing creates excessive energy consumption problem from solar tracking devices. Therefore, these systems would only be efficient at marinas, ports or anchorage areas. Shade is the enemy of solar modules which causes extreme power output drops. Using blockage diodes on solar modules, which are placed between cells or panels against shading effect of cloudy days, provides improved energy efficiency to the solar system. A cooling system fitted to the solar modules on solar powered boats would increase power output by 1% to 6% in consequence of the natural characteristics of crystalline silicon solar cells reacting to temperature changes.

Battery system plays an important role for the improving endurance performance. Lightweighted and high energy density lithium batteries propose promising solutions with competitive lifetime costs if compared with heavier lead acid batteries. MPPT utilization to the outlet of the solar module is a must to gain up to 30% power output. Separate MPPTs equipped to each panel forming the solar module ensure optimum power generation by avoiding voltage drops from individual panels. Using high efficiency electric motors instead of standard efficiency electric motors reduce total energy consumption at about 4-5%. Amount of energy savings differ with running hour, nominal power of motor and power factor. Cabling should also be checked at electrical system of solar power boats. Excessive cable lengths should be removed. Diameter of the cables should be chosen carefully to avoid heat losses during high electric motor loads.

All in all, optimizing energy efficiency of solar power boats plays a critical role for seeing carbon-free electric vehicles on our seas in a widespread manner. It is not an easy goal to achieve the range of fossil fuel burning boats can reach with solar power boats. Nevertheless, it would be possible to travel shorter distances without thinking the fuel costs with the optimized handling of boats' solar electrical systems.

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A LITERATURE REVIEW ON GREEN PORT-RELATED STUDIES

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ABSTRACT

Nowadays World trade has established a competitive landscape in global markets. This has improved maritime transportation to the furthest extent, when compared with the other modes of transport. The competitive climate has also enabled ports to become global logistics centres. As the steady sustainability of ports will greatly contribute to the future of maritime transportation, the term "green port" has been of considerable importance. The purpose of this study is to thoroughly review the green port-related literature, observe and scrutinize the relevant advancements, and reveal the incomplete courses. To do this, the articles are available at the "mass browsing of databases" of DokuzEylul University Central Library, all of which have been passed through refereeing steps, have been reviewed. As a result of this review stage, totally 41 articles, which have been published in indexed academic journals, were reached. The articles which have included in their keywords such notions as "port + green" have been focused. Content analysis will be carried out on the articles chosen and eventually the findings will be discussed.

Key Words: Content Analysis, Green Port, Sustainability.

INTRODUCTION

Associated with decreasing world resources, sustainability has become an essential necessity in all spheres. Actually since 21th century, the idea of sustainability has effected all in area of life[1]. Sustainability concept has comprised of three dimensions named as triple bottom line are as follows: economic welfare, environmental management, social commitment [2]. Green port approach has deployed under environmental management leg of sustainability concept. Green port has faced not only environmental demands, but also enhanced economic activities [3]. Green port approach involves usage of electrically operated vehicles, utilization of renewable and alternative energy resources, slow steaming what means decreasing ship speed, taking advantage of waste and sludge, protecting marine animals, in landside and seaward of the port area. These provide economic benefit for ports and create new economic field for market. Currently, green port concept seems as based on voluntariness. In legislative context ports have to carry out green performance criteria to be mentioned green port. Although it is differential by prescriptive organization to organization, thirty two green performance criteria had been collected. These were gathered under five group are as follows: *air pollution management, liquid pollution management, solid waste and the other*

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pollutants management, aesthetic and noise control management, and marine biology preservation [4]. In the following parts of this study, green port literature review has been executed. Moreover some statistical data about studies on green port and these studies' methodologies has been revealed.

LITERATURE REVIEW ON GREEN PORT

Green port-related literature executed by reviewing academic articles issued in academic journals which are available at the "mass browsing of databases" of Dokuz Eylul University Central Library. After detailed reviewing, previously reached 41 articles have been decreased to 18 articles are related mainly green port concept. These articles had been revealed by methodologies different from each other. This methodologies are differential by articles have been collected in **Table 1**. **Table 1** shows that green port-related articles have struggled to create a literature and statistical data is insufficient to establish a model on green port concept.

Table 1: Methodologies of green port-related articles

No	Year	Author	Name of The Article	Subtopic	Methodology
1	2007	Szili, Rofe	Greening Port Misery: Marketing the Green Face of Waterfront Redevelopment in Port Adelaide, South Australia	Aesthetic and Noise Pollution Management	In this article, the marketing of urban regeneration and green washing literatures have been linked via case study of the Port Adelaide revitalization.
2	2008	Morales-Caselles, Rico, Abbondanzi, Campisi, Iacondini, Riba, DelValls	Assessing Sediment Quality in Spanish Ports Using a Green Alga Bioassay	Marine Biology Prevention	Probit Analysis Program has been used in order to determine toxicity of sediments received as sample from 7 Spanish city ports.
3	2010	Esmer, Çetin, Tuna	A Simulation for Optimum Terminal Truck Number in a Turkish Port Based on Lean and Green Concept	Air Pollution Management	A simulation model has been used to determine the optimum number of container handling equipment to increase the lean capabilities of a Turkish port. Arena 12.0 Simulation Software has been used.
4	2011	Ying, Yijun	Discussion on Green Port Construction of Tianjin Port	Air Pollution Management	Literature Review
5	2011	Anastasopoulos, Kolios, Stylios	How will Greek ports become Green ports?	Environmental Economy	This study is based on a bibliography survey, examining two Greek ports as case studies and investigating the integration and adaptation of the environmental legislation, national, international and European.

6	2011	Hou, Guo, Wang, Wei	Joint Port-cost and Power-consumption Savings in Hybrid Hierarchical Optical Networks	Environmental Economy	In this study, Integer Linear Programming(ILP) model and heuristics has been proposed to determine optimum port-cost and power-consumption.
7	2012	Bergqvist, Egels-Zanden	Green Port Dues- The Case of Hinterland Transport	Environmental Economy	Green Port Fees and Marginal Costs have been evaluated in one table.
8	2012	Chang, Wang	Evaluating the Effects of Green Port Policy: Case Study of Kaohsiung Harbor in Taiwan	Air Pollution Management	Calculation related to ship emissions by using equation model of Corbettt et al.
9	2012	Carballo-Penela, Mateo-Mantecon, Domenech, Coto-Millan	From the Motorways of the Sea to the Green Corridors' Carbon Footprint: the Case of a Port in Spain	Air Pollution Management	This paper describes the method which iscomposed of financial accounts (MC3) used to estimate the Carbon Footprint of a port.
10	2012	Fan, Dong, Zhang, Li, Liang	The Research on the Cooperation and Coordination Game in Constructing Low-Carbon Green Oil Port	Air Pollution Management	This paper adopted the static game model under the asymmetric circumstance to research cooperative relations of low-carbon green oil port between the oil port enterprises and other enterprises and achieved good research achievements.
11	2013	Dooms, Haezendonck, Valaert	Dynamic green portfolio analysis for inland ports: An empirical analysis on Western Europe	Environmental Economy	This paper offers a dynamic green portfolio analysis of a range of European inland ports, based on an adapted model of the BCG-matrix and traffic volumes generated in the period 1999–2010. Strategic Positioning Analysis (SPA) has been used while evaluating.
12	2013	Sheu, Hu, Lin	The Key Factors of Green Port in Sustainable Development	Air Pollution Management	This study uses the questionnaire survey procedure for scholars, shipping companies, and port operators. This paper extracted five key factors by principle component analysis. Then, indicating the characteristic of the successful green ports and the gap between four ports in Taiwan and the successful green ports based on five key factors. (Cronbachalfa)
13	2013	Lirn, Wu, Chen	Green Performance Criteria for Sustainable Ports in Asia	Green Performance Criteria	The purpose of this paper is to measure a port's green performance. Analytic Hierarchy

					Process was used for this article.
14	2013	Yang, Chang	Impacts of Electric Rubber-Tyred Gantries on Green Port Performance	Air Pollution Management	This study compared RTGs and E-RTGs from the perspective of energy savings and CO2 reduction. Kaohsiung Port has been selected for being Case Study scope.
15	2014	Pavlic, Cepak, Sucic, Peckaj, Kandus	Sustainable Port Infrastructure, Practical Implementation of The Green Port Concept	Air Pollution Management	This paper presents a methodological approach for the implementation of the green port concept. Presented research work provides a methodological approach for finding realistic solutions to the problem of the future development challenges of seaports. This study has involved case study.
16	2014	Chiu, Lin, Ting	Evaluation of Green Port Factors and Performance: A Fuzzy AHP Analysis	Green Performance Criteria	A Fuzzy AHP Analysis has been used to be forged a greener port operation.
17	2015	Kavakeb, Nguyen, McGinley, Yang, Jenkinson, Murray	Green Vehicle Technology to Enhance the Performance of a European Port: A Simulation Model With a Cost-Benefit Approach	Environmental Economy	In this paper, to identify the most economical fleet size for each type vehicle in order to satisfy the port's performance target, and to compare their impact on the performance of container terminals, a discrete-event simulation model has been developed.
18	2016	Chang, Jhang	Reducing Speed and Fuel Transfer of the Green Flag Incentive Program in Kaohsiung Port Taiwan	Air Pollution Management	This research applied Green Flag Program to investigate benefits of reducing speed and fuel transfer for large vessels entering Kaohsiung Port. For this purpose fuel consumption has been calculated.

On this study, viewed academic articles had been classified by their subtopics are as follows: Aesthetic and Noise Pollution Management, Marine Biology Prevention, Air Pollution Management, Environmental Economy, and Green Performance Criteria. **Figure 1** shows number of article has been involved for each subtopic. Accordingly, 9 articles studied on Air Pollution Management, and this constitutes half of all articles; 5 articles studied on Environmental Economy, this constitutes %28 of all articles; 2 articles studied on Green Performance Criteria, this constitutes %11 of all articles; subtopics are Aesthetic and Noise Pollution Management and Marine Biology Prevention are handled in one for each article, these constitute %11 of all articles.

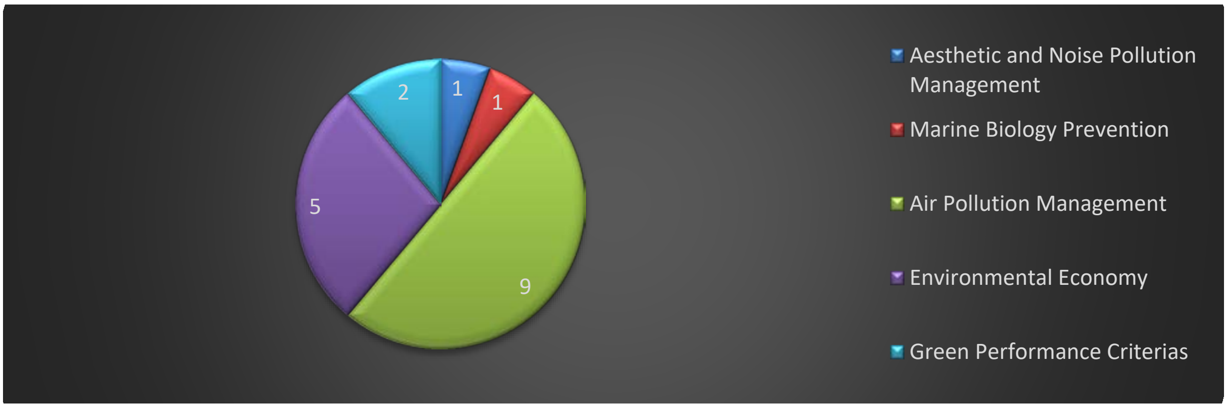

Figure 1: Number of article by their subtopic

Besides, distribution by years of the articles has been determined and shown in **Figure 2** and **Figure 3**. Accordingly, in Figure 2, number of article has been shown between the years of 2007-2011 per year by publication date; in Figure 3, between the years of 2012-2016 has been shown.

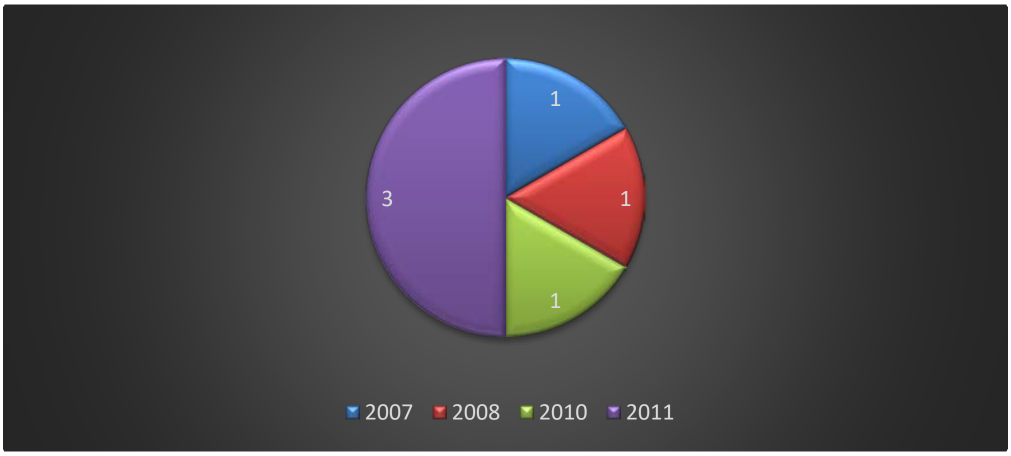

Figure 2: Number of article by publication date (between the years of 2007-2011)

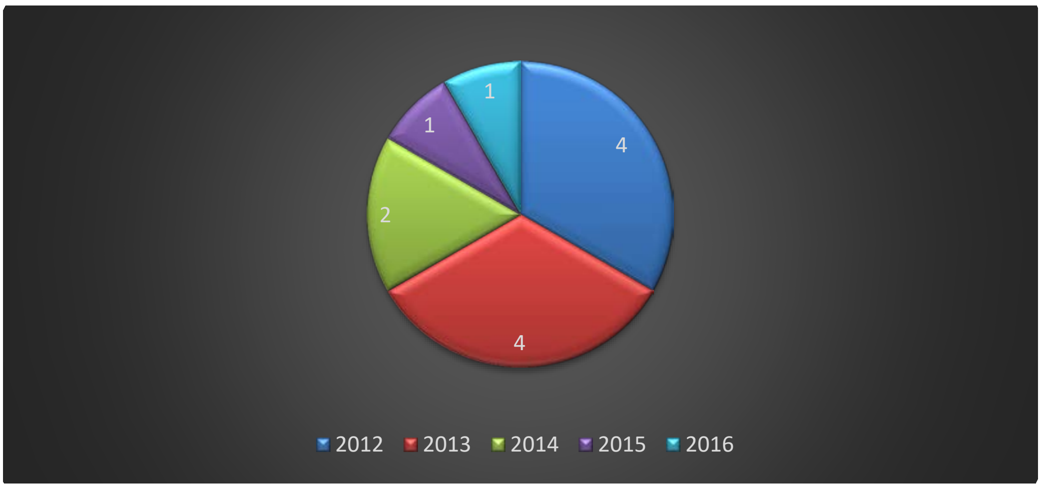

Figure 3: Number of article by publication date (between the years of 2012-2016)

Until the year 2012, six green port-related articles have been determined; since the year 2012, 12 articles have been specified. Most of the articles had been studied in between the years of 2012-2013 which involve eight articles, and this constitutes nearly %44 of all years studied. In order that green port-related articles have struggled to create a literature, keywords of the articles are different from each other and had been regulated immethodically. Academic journals which published these articles differ from each other. Hardly, academic journals are “*Transportation Research*” and “*Research in Transportation Business and Management*” had published three for each green port-related article; both of them have published nearly %33 articles of all.

In the following parts of this study, articles have been evaluated under their subtopic. Articles’ aims, methodologies and findings have been evaluated by their subjects.

Air Pollution Management

Maritime transportation has seemed as one of the major producer of the carbon footprint. Green port concept has tried to work out this problem. Esmer et al., in their study, has aimed to evaluate Turkish container terminals as dimensions of lean capability and green concept. A simulation model has been created to specify optimum number of container terminal handling equipment, in order to increase Turkish ports’ lean capabilities by taking into consideration of green care. In this study optimum number of atmosphere pollutant MTT(Terminal Truck) has been found as 2, when 1 SSG and 2 RTG are has been used in operations. Authors have been considered not to exceed optimum number of MTT significant for green port concept [5]. Ying and Yijun aimed to realize Tianjin Port’s green port planning and development thereby executing their constructions’ actualities and problems [6]. According to Chang and Wang reducing ship speed to 12 knots, cold ironing, constituting reduced speed zone close at hand 20 nautical miles to shore, are effective strategies in order to compose green port policy and increase air quality [7]. Carballo-Penela et al., in their study, have executed that building materials, materials and electricity in ports are leading composing parts of corporate carbon footprint in the port of Gijon [8].Fan et al. have analyzed the relationship of cooperation and coordination between the oil port enterprise and other enterprises. And oil port and related enterprise’s cooperation coordination game model which has been retained to be beneficial, has been fictionalized [9].In the study of Sheu et al. green port factors had been collected from literature and implemented to Taiwan Ports by means of questionnaire and this ports compared with the successful green ports are port of Los Angeles and port of Long Beach. Consequently, Taiwan ports have focused on energy efficiency and Taiwan ports’ biggest gap between successful green ports is tax incentives and rewards [10]. On the study of Yang and Chang, a comparison between rubber-tired gantries (RTGs) and electric rubber-tired gantries (E-RTGs) by the vista of energy saving and CO_2 emission reduction, has been evaluated. And these are detected: E-RTGs can save %86.60 energy and reduce % 67.79 CO_2 emissions in comparison to RTGs; and also investment return of E-RTGs is starting after 2.2 years [11]. According to Pavlic et al. trainings about environmental care are helpful to boost the confidence of employees and management vane; and establishing environmental and energy management departments and developing environmental and energy management system or adapting implemented system are helpful to constitute corporate environmental culture. This research has aimed to present approach accords port infrastructures to green port concept thereby not jeopardizing economic benefits [12]. Chang and Jhang had fictionalised on scenarios that decreasing vessel speed to 12 knots 20 nautical miles away from port and decreasing vessel speed to 12 knots and transferring fuel 20 nautical miles away from port. According to scenario one, about %41 and %14 more CO_2 emission had been supplied; and in scenario two, SO_2 emission had reduced about

%48 and %43 in proportion of current applications. And also according to this research, large vessels are more environmentally friendly than small vessels and container carriers gain more economic and environmental favour than bulk carriers from the policy of Green Flag Program [13].

Environmental Economy

Although, environmental care is an approach has seemed as based on voluntariness for profit making companies, usage of environmentally friendly equipment is cost efficient and green performance criteria for ports provides added value. Anastasopoulos et al., in their study, two Greek ports have been compared vis-à-vis Green view of International legislation, European policies and Greece national policies. In consequence of comparison fundamental standards of Green Port which are prevent air pollution, reduce soil and sediment pollution, improve water quality, improve wildlife – marine life, reduce energy consumption, reduce noise pollution, improve weather monitoring, has been executed [3]. Hou et al. have offered a new routing method and built a port-cost and power-consumption minimization model. This developed algorithm supplies an option to prefer optimum waveband merging strategy [14]. Bergqvist and Egels-Zanden have highlighted green port due system for decreasing ports' external costs which involve pollution, congestion, noise, land use in port area in order to raise efficiency of ports [15]. Dooms et al. executed that there is no relationship between environmental and economic performance on the individual inland port level, in their green portfolio analysis by the help of BCG-matrix and traffic volumes. And also industry supported inland ports show greater economic and environmental performance in comparison to metropolitan supported inland ports [16]. On the study of Kavakeb et al., a discrete-event simulation model has been developed to identify impacts of new technology vehicles which are IAVs (Intelligent Autonomous Vehicles) decreases carbon footprint in port area on ports performance by Kavakeb et al. And they have executed that IAVs are more efficient than trucks for now, in other respects this efficiency difference can be enhanced thereby increasing IAVs' speed [17].

Green Performance Criteria

Ports have to fulfil some green performance criteria in order to become green ports. These criteria involve environmentally friendly approaches while ports are operating. Lirn et al., in their study, constituted green performance criteria by the help of literature. And "air pollution management" was found out as the most important dimension effecting ports' green performance, followed by "liquid pollution management", under favour of AHP technique used for prioritizing these indicators [4]. In the study of Chiu et al. green port factors' priority in itself and green performance comparison of sample ports have been evaluated by means of FAHP(Fuzzy Analytic Hierarchy Process) algorithm. Accordingly hazardous waste handling, air pollution and port greenery were determined as more prior factors than others. And port of Taichung was ranked the first, the second is Keelung, the third is Kaohsiung [18].

Aesthetic and Noise Pollution Management

Ports have effect on social environment and urban aesthetic. Control of noise is produced by port operations and aesthetic protection has ranked among green port concept. Authors Szili and Rofe had worked on Port Adelaide's redevelopment while urban development had been occurring by the help of the analyses of various promotional materials and interviews conducted with key stakeholders.

Authors had established that in spite of environmentally friendly claims of Port managers, implementations in Port Adelaide had seemed as ‘window dressing’ [19].

Marine Biology Prevention

Marine biology has a vital role for sustaining ecosystem of seas. In this manner directly social and environmental benefit have been provided, indirectly economic benefit has been materialized. Morales-Caselleset al. had revealed that the metals (Cd, Cr, Hg, and Zn) and organic contaminants (PAHs and PCBs) are involved in the sediments that reduces green alga’s normal growth, therefore contamination level of ports are higher than normal environmental level according to study which has been implemented in Spanish ports [20].

CONCLUSION

During the recent years green port concept has been a trend for ports especially located in North America and Central Europe. Although green port concept has seemed as based on voluntariness, it is also cost efficient approach and it has contributed to urban aesthetic. In terms of academic, studies on green port policy have remained incapable despite academic articles have been increased on this subject especially after 2012.In reason to this, increasing environmental care to use scarce resources effectively and regulative applications for maritime transport to ensure environmental awareness in recent years can be seen.Articles viewed in this study initially dwelled on Air Pollution Management as recent reports published by IMO (International Maritime Organization), ESPO (European Sea Ports Organization), AAPA (American Association of Port Authorities) had done. Articles also had studied on some subtopics are as follows: Environmental Economy, Green Performance Criteria, Aesthetic and Noise Pollution Management, and Marine Biology Prevention. However certain subtopics have an important role in green port concept, for instance Avoiding Liquid Pollution and Solid Waste Management, are deficit in these studies.

In this study, articles studied on green port concept have been investigated, and deficiencies have been established in the fields of conceptualisation, model building, and developing methods. In order to overcome these deficiencies, varying cases can be helpful.

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MEASUREMENTS OF PARTICULATE EMISSIONS FROM A FERRY

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ABSTRACT

Particulate emissions have been shown to be related with lung cancer and cardiopulmonary diseases. Estimation of exposure to Particulate Matter (PM) at Marmara Sea is important matter due to ecological conditions and specific location of the region. In this paper, particulate matter and gaseous emissions were measured on-board of a ferry sailing at Marmara Sea. The main engine of the ferry is four-stroke medium speed diesel using the ultra-low sulfur diesel fuel. The experiments were carried out in accordance with the regulations of MARPOL Annex VI and for different engine loads. The study is concentrated on the formation of particles. The size of particles determines the potential impact to the environment and health. Therefore, mass size distributions of particulate matter were investigated as PM ≥ PM10, PM ≤PM2.5 and PM2.5 < PM < PM10. Along with PM emissions, NOx, SOx, CO_2, CO, O_2, HC emissions including shaft power measurements are presented and discussed. The weighted total PM emissions are found to be 0.079 g/kWh for the main engine. This low value is due to using the ultra-low sulfur diesel fuel during the experimental investigation.

Keywords – *Air pollution, emission measurements, exhaust emission, marine environment, particulate matter*

INTRODUCTION

The total emissions from the transportation sector are mainly contributed by the ship emissions. According to the marine activity data, about 70–80 percent of all ship emissions emitted within 400 km of land [1-3]. Carbon dioxide (CO2), carbon monoxide (CO), sulphur oxides (SOx), nitrogen oxides (NOx), hydrocarbons (HC) and particulate matters (PM) are the key emission compounds from marine diesel engines. CO_2, SOx, heavy metals and sulphur compounds become from fuel property whereas CO, NOx and PM originated from engine technology [4]. The global estimates show that shipping emits between 0.9 and 1.7 million tons of particulate matter annually [5]. Particulate emissions in the exhaust gas derive from deposition of very small particles of partially burned fuel, partly burned lube oil, the ash contents of cylinder lube oil and fuel oil, sulfates, and water [6]. The exhaust particles emitted from ships consist of organic, elemental and inorganic

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carbon, ash, sulphate and nitrates [7, 8]. Diesel particles are usually classified into three categories such as nucleation mode (10–100 nm), accumulation mode (0.1–1 µm) and coarse mode (1–10 µm).

The nucleation mode is generally composed of volatile compounds, such as sulfate and unburnt hydrocarbon as well as ash and soot particles. On the other hand, most soot particles agglomerate and are usually found in the accumulation mode, although the larger particles can be a break-up of larger soot particles from the engine. Furthermore, many particles grow with adsorbed soot particles that they lead to a complex mixture of PM [9].

Ship based emissions have become a great concern in many recent studies [10-15]. This is due to the essential contribution of sea transport to global air pollution. Winnes and Fridell [16] carrried out emission measurements on board of a product tanker by using two different fuels (HFO and MGO) with varying engine loads. The effects of different fuels on exhaust gas composition and emission factors were investigated.

Exhaust gases emitted from ships to atmosphere are rarefied after they are interacting with air. While exhaust gases are diluting in the atmosphere, they are partially reverted and then some chemical compounds drop on land and sea. As a result of this, emissions from ships cause many adverse environmental effects such as acidification, climate change and air pollution, to name the most important. In port and coastal cities, ship emissions are a dominant source of urban pollution in many cases. Furthermore, ship emissions may be transported in the atmosphere over several hundreds of kilometers, hence, this can contribute to significant air pollution problems on land, even if they are emitted at sea [17]. This air emission on land directly affect the acidification or eutrophication of natural ecosystems and biodiversity of freshwater bodies concerning of sulfur and nitrogen compounds deposition. Thus, the control of particle emissions, NOx and SO_2 has positive effects on air quality, eutrophication and acidification [18, 19]. In addition, global impacts of emissions, regional and local air pollution problems in coastal areas and ports with heavy traffic are very important [20]. Particles have also negative impacts on environment such as reduced visibility [21], light scattering [19], global warming [22], accumulation on vegetation, change of ecosystem and damage on buildings [23] and etc.

The principle reason for limitation of particulate matter emission is the strong relation with the adverse health effects to human [24-27]. Corbett et al. [28] presented that the particle emissions from ocean-going vessels could cause approximately 60000 premature mortalities annually from lung cancer and cardiopulmonary disease. Also, this study stated additional health impacts of emissions like respiratory illnesses as bronchitis, asthma, and pneumonia. In the future, using low sulfur fuels may improve air quality and prevent negative health impacts due to ship emissions [29]. Cohen et al. [30] estimated that there are approximately 0.8 million deaths per year worldwide from outdoor urban PM2.5 air pollution and 1.2% of global premature mortalities each year. Fine particles are of great concern from health effects, furthermore they are responsible for most of the light scattering [19]. Pope et al. [31] show that the fine particulate and sulfur oxide emissions may cause lung cancer, and cardiopulmonary mortality. However, coarse particles and suspended particles emissions are not consistently associated with mortality.

Several pollutants, including NOx from newly built ships, and SOx are regulated by the IMO MARPOL Annex VI convention. According to this convention, there are certain maritime regions on the world designated as emission control areas (ECAs). In these areas, the regulated emission levels are lower than in the rest of the ocean. The regulations will become tighter step by step and additionally, the number of emission control areas will increase [32]. EU has also specific measures for the reduction of ship air pollution in harbour areas [4]. In 2014, Turkey also became a party of MARPOL Annex VI.

The shipping activity in the Marmara Sea, Turkey has increased substantially over the last fifty years, and now it has a significant contribution to the global shipping emissions. The Marmara Sea has both national and international marine traffic which covers transit, non-transit and domestic ships. More than 2.5 million people are daily crossing from one side to another in Istanbul by using city ferries, sea busses and other shuttle boats.The number of vessels transits the Istanbul and the Çanakkale Straits are respectively, 50871 and 46686 in 2010 [33]. As seen also from Figure 1, the local ship traffic is intensive in Marmara Sea. Therefore, there are some studies on the ship based emissions at Marmara Sea. Ergin [33] estimated exhaust emissions from ships at Marmara Sea and Turkish Straits using 2010 AIS data and national statistics. The results of the calculations are 56.49 tonnes/year of NOx emissions, 18.57 tonnes/year of SO2 emissions, 18.57 tonnes/year of PM emissions and 2518.2 tonnes/year of CO2 emissions. In the study, the cost and benefit analysis were also carried out for several scenarios including if the Marmara Sea and the Turkish Straits were designated as an Emission Control Area. Similar study was also carried out by Viana et al. [34]. According to their results, implementing an ECA for the Marmara Sea and Turkish straits would reduce ship sourced PM10 and PM2.5 ambient concentrations in İstanbul by 67 %, and SO_2 by 90 %. Previous emission inventories of Marmara Sea and Turkish straits are presented in the studies of Kesgin et al. [35] and Deniz et al. [36].

Figure 1. Shipping Traffic at Marmara Sea

This study aims onboard measurements of particle emissions (PM) from a ferry to investigate the particle characteristics with varying engine loads. Size distributions of particles named PM2.5, PM2.5-PM10 and PM10 are obtained experimentally. They are essential to find out health risks of PM emissions from ships. Size of particles and chemical composition of particles are a major parameter for indication of how harmful they are. The NOx, SOx, CO, CO_2 and HC emissions, shaft power, exhaust temperature, exhaust humidity, exhaust velocity, and ambient conditions were also measured. Experimental investigation was carried out on the main engine exhaust of the ferry sailing at Marmara Sea. The main engine is a four-stroke medium speed diesel using ultra-low sulfur diesel fuel. The weighted total PM emissions from the main engine are obtained to be 0.079 g/kWh. PM and SO2 emissions are quite low due to the fuel type used in the main engine. Furthermore, the results show that NOx emissions of the ferry are under the IMO limits set by MARPOL Annex VI.

EXPERIMENTAL STUDY

Particle emission measurements were performed on a ferry running with the ultra-low sulfur diesel fuel (ULSD). The ferry was built in 2000. It is 81 m long and has a tonnage of 1600 GRT. She has two four-stroke medium speed main engines, each with 883 kW at rated speed of 750 rpm. Table 1 shows the main engine specifications. During the experiments, the ferry was sailing at Marmara Sea.

Table 1. Main Engine Specifications

Main Engine	
Type	4-stroke, turbocharged, intercooled
Power, kW	883
Speed, rpm	750
SFC,g/kWh	198
Compression ratio	12,06:1
Bore, mm	242
Swept volume, liters	117,8
Stroke, mm	320
Injection	Direct, mechanical, one pump per cylinder

Table 2 presents the properties of the low sulfur diesel fuel used in the main engine during the experiments.

Table 2. Fuel Properties

Properties	
Density, kg/m3	831,1
Sulfur, mg/kg	4,4
Water content, mg/kg	48
Cetan Index	58,6

The emission sampling was carried out in the exhaust stack of the main engine in the engine room. During the measurements, the varying engine loads, 25%, 50 %, 75% and 100% were considered. According to IMO MARPOL Annex VI, E2 test cycle for the main engine was employed [32]. Sampling points were placed after the turbochargers. The sampling port and sampling line for the measurements are shown in Figure 2, schematically.

During the emission measurements, shaft power measurement system was monitored continuously and the engine brake power was measured by fixing strain gauges on the shaft. Reduction gear losses were considered as 5 %. The measurements also include the exhaust temperature, exhaust humidity, differential pressure, ambient pressure, ambient temperature and ambient humidity.

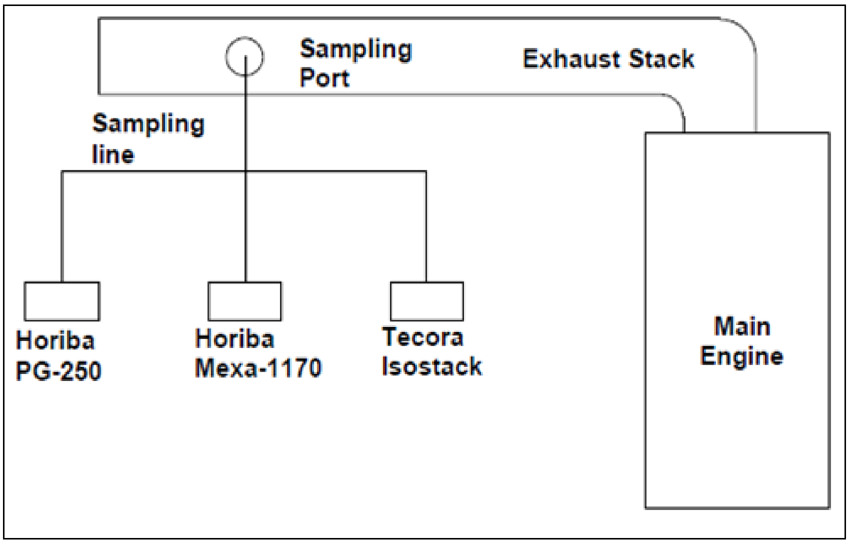

Figure 2. Experimental Rig

Horiba PG-250 gas analyser was employed to measure the concentrations of NOx, SO_2, CO, CO_2 and O_2 in the raw exhaust gas at varying engine loads, namely 25 %, 50 % 75 %, and 100 %. On the other hand, Horiba Mexa 1170 was used to measure the unburned HC emissions. The particles were collected by using Tecora Isostack Basic Equipment considering their size distribution as lower than diameter of 2.5µm, diameter between 2.5µm and 10µm and higher than diameter of 10µm. Particle mass was firstly collected by using 47 mm glass-micro fibre filters and then these filters were analyzed gravimetrically, weighed before and after sampling using a micro balance in the laboratory. Samplings have been carried out in about 30 minutes at nearly steady state and isokinetic conditions according to ISO 9096 standard [37]. In measurements, isokinetic deviation was less than 10 %. Samplings at different loads were taken at the exhaust gas temperatures between 250 °C and 350 °C. The methodology given in IMO NOx Technical Code was used to calculate the weighted emission factors for gas pollutants and particulate matters.

RESULTS AND DISCUSSION

Figures 3-5 show the measured emission factors for the main engine and different engine loads. The gaseous emission factors of nitrogen oxides (NOx), sulfur dioxide (SO_2), carbon monoxide (CO), carbon dioxide (CO_2) and hydracorbons (HC) are presented in Figure 3. The values of NOx emission factors are obtained between 11 and 17 g/kWh. Since the NOx emissions mainly depend on the combustion temperature, the NOx emission values increase with increasing engine load. However, NOx emissions have the highest value at 25 % engine load. This is due to lean mixture of air/fuel ratio [38]. The fuel properties generally play a role in the formation of the CO_2 and SO_2 emissions [4]. As can be seen from Figure 3, there are some discrepancies in the distributions of these emissions with this behavior. The reason for this is the poor performance of the engine at partial loads due to cold start up, low combustion temperature, inadequate atomization, heat losses from combustion chamber and etc. CO emissions generally related with incomplete combustion of fuel. Mostly they increase with increasing engine load due to the lack of oxygen. Figure 3 shows that the highest value of CO emission is at 25 % engine load. This can be attributed to the low temperatures in the combustion chamber which affect the fuel atomization [39]. The HC emissions in the exhaust gases generally result from the incomplete combustion of the hydrocarbon fuel [6]. The results in

Figure 3 show that unburned HC emissions increase at partial loads. The uncertainties of measurements for the gaseous emissions are obtained in the range of 10-12 % as seen in Figure 3.

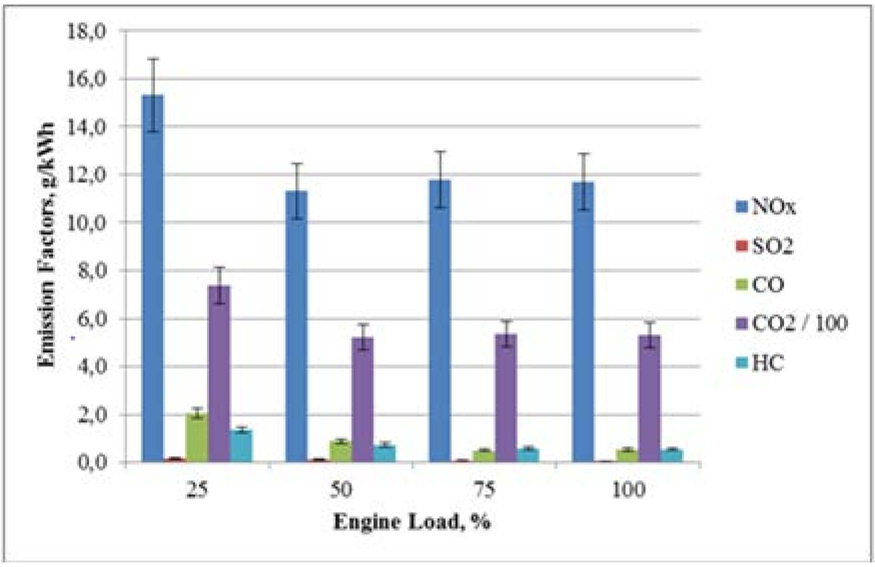

Figure 3. Gaseous Emission Factors for the Main Engine and Different Loads

Particulate emissions are obtained considering their size distribution as diameter lower than 2.5 µm, diameter between 2.5 µm and 10 µm, and diameter higher than 10 µm as seen in Figure 4. The previous studies show that particulate matter emissions mostly depend on sulfur content in the fuel, see, for example, [11, 40, 41]. In this study, ultra-low sulfur diesel fuel is used. Therefore, the particulate emissions are quite low. As can be seen from Figure 4, the highest PM emissions were found at the engine load of 25 %. In this case, the low combustion efficiency may influence the particle formation. Size distributions of the particles are related to temperature losses. Particles are formed during cooling and the decrease of exhaust gas temperature, so, some particles will develop due to the condensation of hydrocarbons [9]. Sampling was done at the exhaust gas temperatures between 250 °C and 350 °C, therefore, coarse particles may not formed duly regarding to high temperatures. On the other hand, nuclei (PM2.5) mode particles have highest values at each engine load. It can be seen from Figure 4 that the uncertainties in PM measurements are less than 13%.

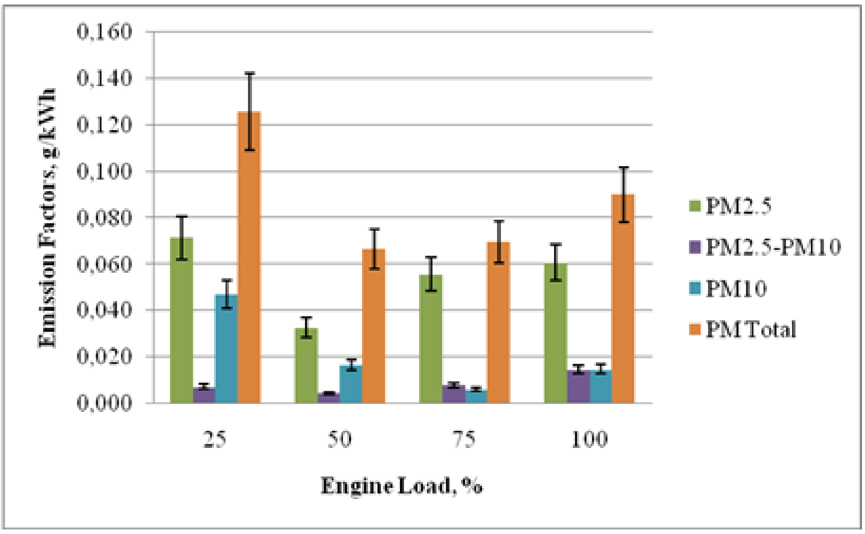

Figure 4. PM Emission Factors for the Main Engine and Different Loads

The overall weighted emission factors for the main engine are presented in Figure 5. The emission factors for NOx, SOx, CO, CO2, HC and PM emissions are obtained as 11.91 g/kWh, 0.10 g/kWh, 0.67 g/kWh, 611.14 g/kWh, 0.62 g/kWh and 0.079 g/kWh, respectively. The overall weighted NOx emission value is obtained just under the IMO limit value 11.97 g/kWh.

The results of the study indicate that ship emissions in the Marmara Sea may substantially degrade local air quality and affect human health adversely.

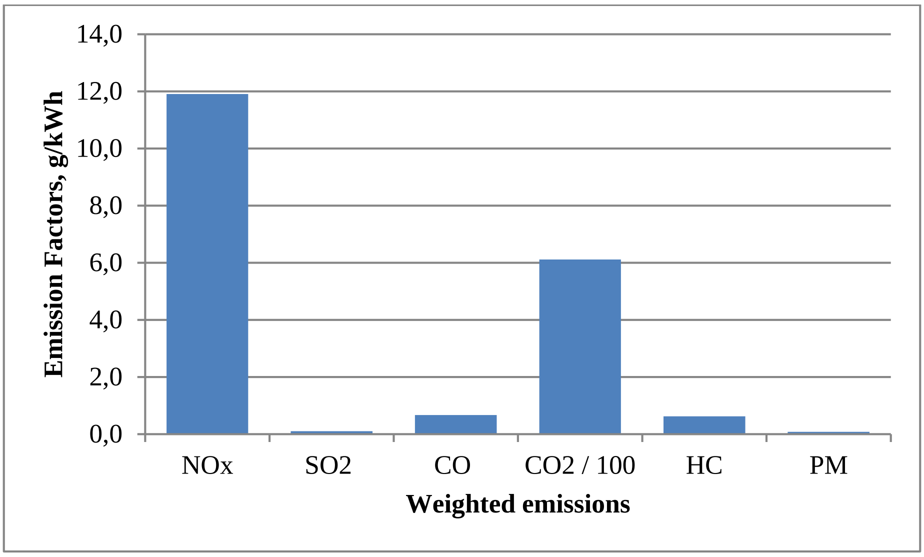

Figure 5. Overall Weighted Emission Factors for the Main Engine

CONCLUSIONS

The experimental investigation on the formation and size distribution of the particulate matter was carried out on board a ferry cruising at Marmara Sea. The low sulfur diesel fuel is used for the main engine during the measurements. It is found that the nuclei mode (PM2.5) particles have highest values at each engine loads, namely, 25%, 50%, 75% and 100% engine loads. This size of particles may cause lung cancer and cardiopulmonary diseases. The overall weighted emission factor of total PM is obtained as 0.079 g/kWh. This low value is due to using ultra-low sulfur diesel fuel as expected.

The shipping activity is increasing in the last 50 years in the Marmara Sea. Therefore, ship emissions are becoming dominant source of air pollution for this region. It should be reduced for adverse environmental and health effects. The measurements of the ship emissions are required and important to reduce the impacts of marine traffic on the air pollution. On the other hand, it will also help to develop new regulations, new mathematical models and innovative emission reduction technologies.

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DETERMINING THE POLLUTION CARRIED BY THE RIVA STREAM (ISTANBUL, TURKEY) TO THE SEA OF MARMARA

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ABSTRACT

This study dwells on physico-chemical parameters of Riva Stream between March 2006-February 2007. Hence, the pollution it carries to The Sea Of Marmara was tried to be determined. Samples were collected from 4 different stations once a month. Physico-chemical data were given as maximum, minumum and average: Water temperature 16.08±8.29 °C (4.0-26.5); dissolved oxygen 2.9±1.54 mgL^{-1} (1.0-6.1); electrical conductivity 1202.83±47.85 µScm^{-1} (310-1680); pH 7.33±0.30 (6.7-7.82); salinity 2.25±2.13 ‰S (0.5-6.6); chemical oxygen demand (COD) 123.84±22.18 mgL^{-1} (23.0-462); biological oxygen demand (BOD_5) 48.10±35.07 mgL^{-1} (13-136); ammonia nitrogen (NH_4-N) 3.92±3.02 mgL^{-1} (0.2-6.12); nitrate nitrogen (NO_3-N) 12.32±0.27 mgL^{-1} (11.58-12.46); orthophosphate (PO_4-P) 1.81±0,73 mgL^{-1} (1.18-3.33); suspended solids 2.29±1.28 mgL^{-1} (0.5-4.53); total hardness 35.63±23.11 mgL^{-1} $CaCO_3$ (11.8-80.58). The physico-chemical parameters under the analysis indicated that Riva Stream is eutrophic and polluted The Sea Of Marmara intensely.

Keywords: *Marine Environment, Physico-Chemical Parameters, Pollution, Riva Stream,The Sea Of Marmara.*

INTRODUCTION

The increase in population and industrial development of Istanbul has caused pollution in air, soil and water, and Istanbul's rivers and lakes were placed on outskirts of residential areas up until 1970's. However, a fast increase in population in recent years has expanded the city bringing those aquatic areas into the residential areas.

The waterways studied are the Riva Stream, also known as the Çayağazı Stream, beginning at the small city of Kocaeli which is placed in the north of the Marmara region, goes through the towns of Pendik, Çekmeköy and Beykoz, running into the Black Sea, with a length of 70 km. This stream also creates the Ömerli Water Reservoir's lake. However, after the construction of Ömerli Water Reservoir this stream slowly lost its main water supplies, causing it to turn into more of a trickle of water. In addition to this, there is Biological Water Treatment Center collecting used water from Ümraniye, Sarıgazi and Sultanbeyli residential areas, disposing its residue into Riva Stream.

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Effluence flows into the stream from residences with inadequate sewage systems, along with rubbish thrown by the residents into the stream. Locals residing in these areas are mainly known to be farmers and herdsmen. Furthermore, the Anatolian side of Istanbul has picnic areas and seaside resorts within the region, which increases its population during the summer months.

There are limited studies made of the Riva Stream, but most of these studies are preliminary researches, which are important in observing changes in phytoplankton specimens found in the Riva Stream. Previous studies made during October 1989-August 1990, April/July 1993, August 2002 and August 2003 are displaying Riva Stream's periodic conditions, but with no comparisons [1]; [2]; [3].

The purpose of this study is to reveal with extended and detailed scientific research of its physical and chemical with the data shown by the previous studies made at least 15 years ago.

MATERIAL AND METHODS

Water samples algae of Riva Stream; periodically, every month water samples are collected from 4 different stations from Riva Stream, from March 2006 to February 2007. The sample of the quality of the water to be able to fully represented in the selection of sampling locations; proximity to residential areas, before and after the merger of the agricultural activity and its tributaries such factors are taken into account. The coordinates for those stations are; Station 1 (Riva); 41° 13′ 23" N, 29° 12′ 59" E, Station 2 (Paşamandıra); 41° 11′ 74" N, 29° 14′ 19" E, Station 3 (Bozhane); 41° 16′ 42" N, 29° 27′ 22" E, Station 4 (Cumhuriyet); 41° 08′ 29" N, 29° 26′ 89" E (Figure 1.).section that you want to designate with a certain style, then select the appropriate name on the Styles menu.

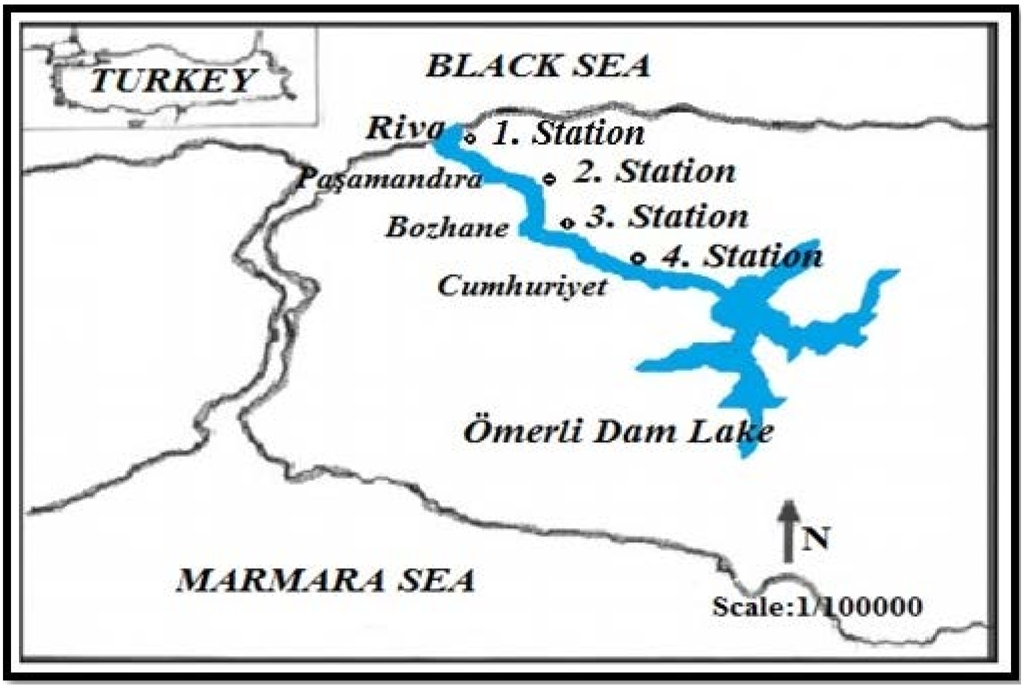


Figure 1. Research Area and Sample Collecting Stations.

In the present study carried out between March 2006 - February 2007, water samples were collected from the sampling points determined on Riva Stream, on certain days and at certain times in each month; the samples were taken to a laboratory on the same day in order to carry out analyses using standard methods [4]; [5]; [6]. The temperature (°C); and dissolved oxygen (mgL^{-1}) were measured using WTW Oxi 320 Meter; pH was measured using WTW pH 330-i pH Meter; electrical conductivity (25°C µS/cm) and salinity (ppt) were measured using YSI 30 SCT Meter, in the field of study. Biological Oxygen Demand (BOD_5 mgL^{-1}) was determined by oven-drying the water samples (Nüve ES 500) at 20°C for 5 days using WTW ONTOP IS 6 BOD_5 measurement set. Chemical Oxygen Demand (COD) level was determined using strong chemical oxidants, through titration with iron ammonium sulphate which is based on specifying the amount of oxygen used in decomposing natural and organic pollution loads. Ammonium nitrogen (NH_4-N mgL^{-1}) was measured colorimetrically using the phenate method; nitrate nitrogen ($NO^-{}_3$-N mgL^{-1}) was measured through the UV spectrophotometric method. As for measuring the orthophosphate phosphor ($PO^{-3}{}_4$-P mgL^{-1}) colorimetrically, spectrophotometer was used. Suspended Solid Analysis was carried out taking advantage of the difference in the weight that occurred after passing the water through Whatman-brand membrane filters no 42 size 0.45 µm and then leaving filter papers at 105°C for 24 hours. Total hardness ($CaCO_3$ mgL^{-1}) and calcium (Ca^{+2} mgL^{-1}) were titrated with EDTA and magnesium level (Mg^{+2} mgL^{-1}) was determined based on total hardness and calcium results. In spectrophotometric measurements, Shimadzu UV-1800 spectrophotometer was used. All aforementioned analyses were carried out using standard methods [4].

RESULTS

Minimum, maximum physico-chemical measurements of water samples were taken monthly, with their average results and observation dates are shown in Table 1. The temperatures in Riva Stream changed according to the sampling point and time. The lowest temperature was 4.0°C (January, 2007), the highest was 26.7°C (July 2006) and the average temperature was 16.08±1.543°C (Figure 2). The lowest dissolved oxygen amount was 0.6 mgL^{-1} (September 2006), the highest was 7.8 mgL^{-1} (March 2006) and the average amount was 2.97±1.535 mgL^{-1} (Figure 3). As for electrical conductivity, it changed according to the sampling points and months - the highest electricity conductivity was at Riva Station with 1725 µS/cm (September 2006), the lowest was at *Cumhuriyet* station with 292 µS/cm (March 2006) while the average electricity conductivity level was 1202.83±47.855 µS/cm (Figure 4). The average pH levels of the stream was above 6 in all sampling points; the lowest level was 6.7 (March 2006), the highest was 8.54 (May, 2006) and the average level was 7.35±0.305 (Figure 5). Salinity changed according to seasons and the highest salinity was 12.0 ppt (August 2006) and the lowest was 0.3 ppt (March 2006) (Figure 6).

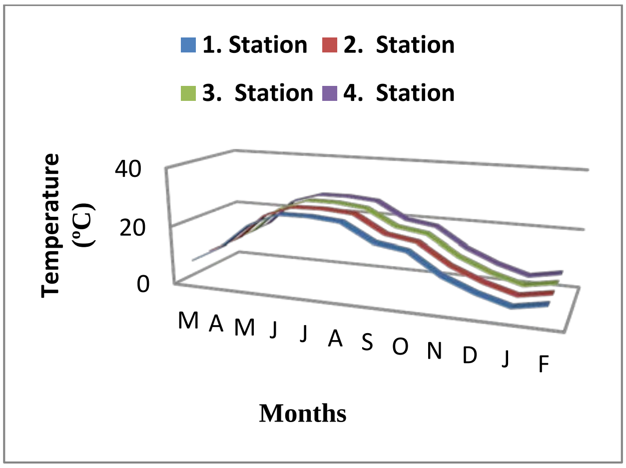
There were changes in Chemical Oxygen Demand through the year - the lowest level recorded was 20.8 mgL^{-1} (February 2007), the highest was 940 mgL^{-1} (July 2006) and the average level was 123.847±22.186 mgL^{-1} (Figure 7). Similarly, the Biological Oxygen Demand changed throughout the study - the highest level was 145 mgL^{-1} (July 2006) at Riva Station while the lowest was 8 mgL^{-1} (February 2007) at the same station. The average level across all stations was 48.1±35.073 mgL^{-1} (Figure 8).

The highest ammonium nitrogen level was 14.25 mgL^{-1} (November 2006), the lowest was 0.09 mgL^{-1} (March 2006) and the average level across all sampling points was 3.92±3.023 mgL^{-1} (Figure 9). As for the nitrate nitrogen sat sampling points, they changed throughout the year - the average levels across all stations was 12.14±0.272 mgL^{-1} while the highest level was 12.50 mgL^{-1} (November 2006) and the lowest level was 11.52 mgL^{-1} (Figure 10).

The highest orthophosphate level was 3.54 mgL^{-1} (April 2006), the lowest was 1.06 mgL^{-1} (February 2007) and the average level was 1.813±0.735 mgL^{-1} across all stations (Figure 11). The highest suspended solid amount was 7.27 mgL^{-1} (May 2006), the lowest was 0.16 mgL^{-1} (June 2006) and the average suspended solid amount was measured as 2.229±1.283 mgL^{-1} (Figure 12). Total hardness, calcium and magnesium levels changed during the study period, but it was determined that the levels were higher in the areas flowing into the sea in comparison to the other sampling points. The highest total hardness level was 136.2 mgL^{-1} (July 2006), the lowest was 7.6 mgL^{-1} (March 2006) and the average level was 35.633±23.116 mgL^{-1} (Figure 13).

Table 1. Observed Physico-Chemical Parameters in The Riva Stream

	STATIONS			
PARAMETERS	**1. Station**	**2. Station**	**3. Station**	**4. Station**
	Ort.±SE **Min.-Max.** **Observed Dates**	**Ort.±SE** **Min.-Max.** **Observed Dates**	**Ort.±SE** **Min.-Max.** **Observed Dates**	**Ort.±SE** **Min.-Max.** **Observed Dates**
Temperature (ºC)	16.6±1.839 4.0-26.4 Jan.2007-July 2006	15.8±1.441 4.1-26.6 Jan.2007-July 2006	15.9±1.407 4.1-26.6 Jan.2007-July 2006	16.05±1.486 4.1-26.7 Jan.2007-July 2006
Dissolved Oxygen (mgL^{-1})	3.7±1,809 1.6-7.8 Sept.2006-Mar. 2006	3.2±1,880 0.9-7.7 Sept.2006-Mar.2006	2.5±1.260 0.9-4.8 Sept.2006-Mar.2006	2.2±1.233 0.6-4.3 Sept.2006-Mar.2006
Electrical Conductivity (µS/cm)	1227.25±48.862 322-1725 Mar.2006-Sept. 2006	1219.41±47.703 319-1698 Mar.2006-Sept.2006	1189.75±47.293 308-1642 Mar.2006-Sept.2006	1174.91±47.565 292-1656 Mar.2006-Sept.2006
pH	7.47±0.538 6.8-8.54 Mar.2006-May 2006	7.32±0.284 6.8-7.75 Mar.2006-May 2006	7.26±0.193 6.7-7.46 Mar.2006-Oct.2006	7.29±0.206 6.7-7.53 Mar.2006-Aug.2006
Salinity (‰S)	3.975±4.247 0.8-12.0 Mar.2006-Aug. 2006	2.533±2.592 0.6-8.3 Mar.2006-May 2006	1.483±1.096 0.5-4.0 Mar.2006-July 2006	1.017±0.598 0.3-2.2 Mar.2006-Apr.2006
Chemical Oxygen Demand (COD) (mgL^{-1})	189.668±25.215 20.8-940 Feb.2007-July 2006	121.761±12.794 25.6-478 Mar.2006-July 2006	79.839±37.872 24.7-160 Mar.2006-July 2006	104.120±12.865 20.9-270 Mar.2006-July 2006
Biological Oxygen Demand (BOD_5) (mgL^{-1})	49.91±41.148 8-145 Feb.2007-July 2006	46.25±34.235 10-128 Feb.2007-June 2006	43.58±32.047 16-135 Feb.2007-June 2006	52.66±32.864 19-135 Feb.2007-June 2006
Ammonia Nitrogen NH_4-N (mgL^{-1})	2.31±2.114 0.09-5.20 Mar.2006-Dec. 2006	2.89±2.160 0.1-5.88 Mar.2006-Nov.2006	4.64±3.345 0.2-10.25 Mar.2006-Nov.2006	5.86±4.474 0.4-14.25 Mar.2006-Nov.2006
Nitrate Nitrogen NO_3-N (mgL^{-1})	12.08±0.309 11.52-12.40 Mar.2006-Oct. 2006	12.15±0.264 11.58-12.48 Jan.2007-Sept.2006	12.16±0.278 11.56-12.47 Jan.2007-Sept.2006	12.20±0.240 11.68-12.50 Feb.2007-Nov. 2006
Orthophosphate PO_4-P (mgL^{-1})	1.716±0.723 1.06-3.28 Feb.2007-Apr. 2006	1.778±0.695 1.12-3.14 Feb.2007-May 2006	1.874±0.804 1.18-3.54 Feb.2007-Apr.2006	1.887±0.737 1.36-3.36 Feb.2007-Apr. 2006
Suspended Solids (mgL^{-1})	3.012±1.809 0.9-7.27 Mar.2006-May 2006	2.271±1.139 0.8-4.0 Mar.2006-Aug.2006	1.899±1.091 0.2-3.35 June 2006-Nov.2006	1.737±1.095 0.16-3.50 June 2006-Apr. 2006
Total Hardness (mgL^{-1} CaCO3)	51.183±36.332 15.3-136.2 Feb.2007-July 2006	36.729±21.359 13.5-75.0 Mar.2006-July 2006	30.333±18.946 10.8-60.9 Mar.2006-July 2006	24.288±15.837 7.6-50.25 Mar. 2006-July 2006



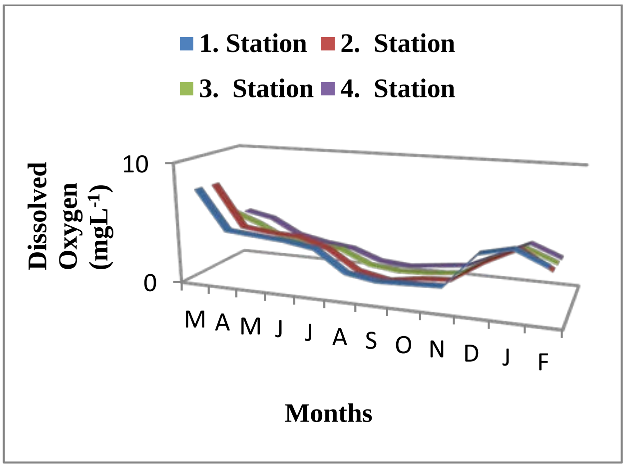
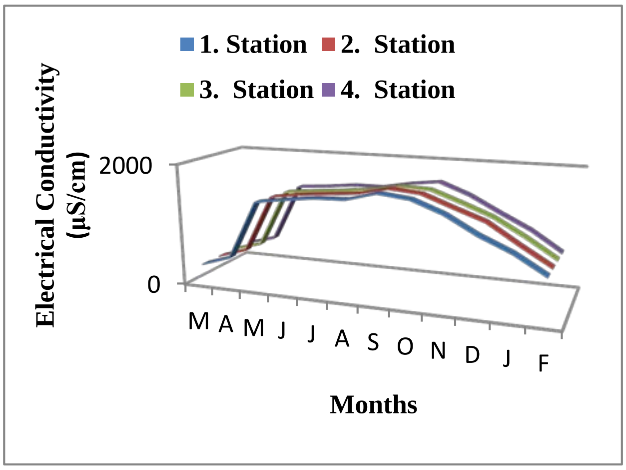


Figure 2. Monthly change of temperature at stations

Figure 3. Monthly change of dissolved oxygen at stations



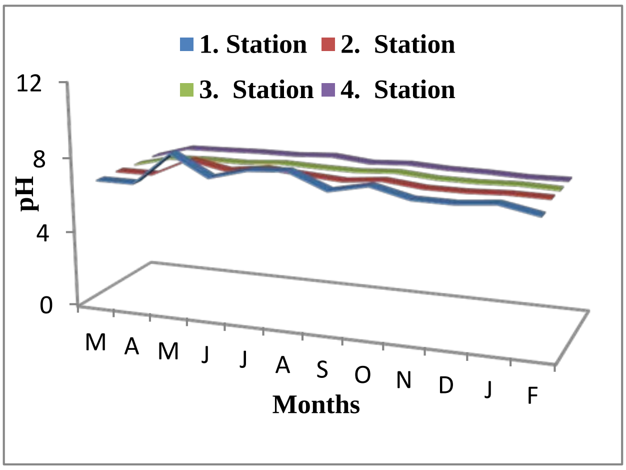
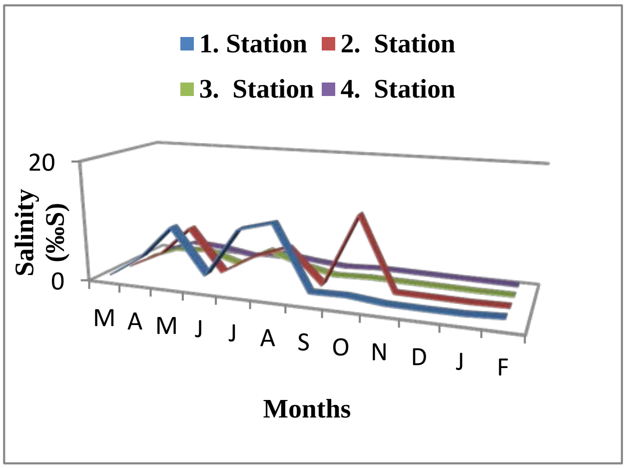


Figure 4. Monthly change of E.C. at stations

Figure 5. Monthly change of pH at stations



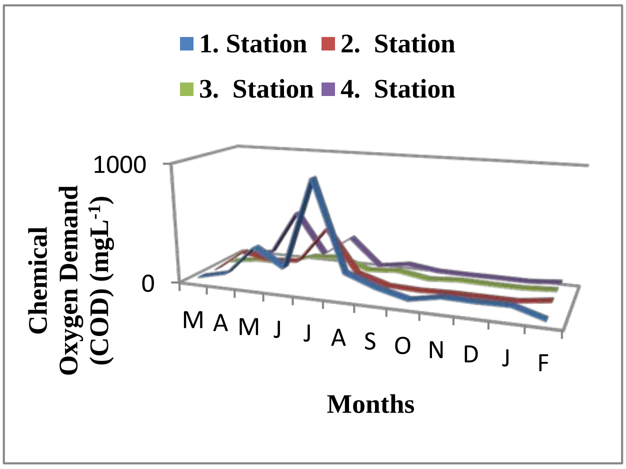


Figure 6. Monthly change of Salinity at stations

Figure 7. Monthly change of COD at stations

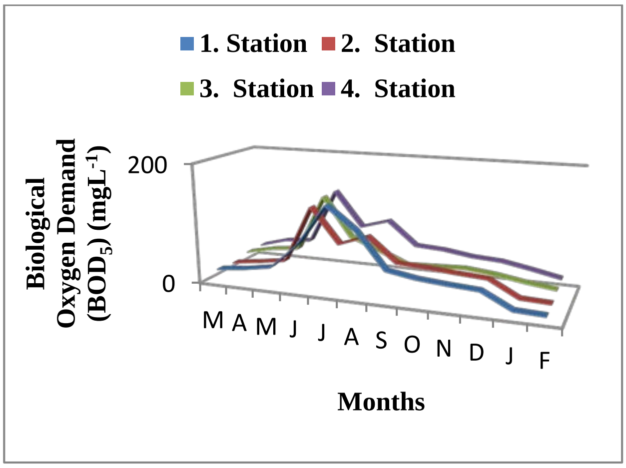


Figure 8. Monthly change of BOD_5 at stations

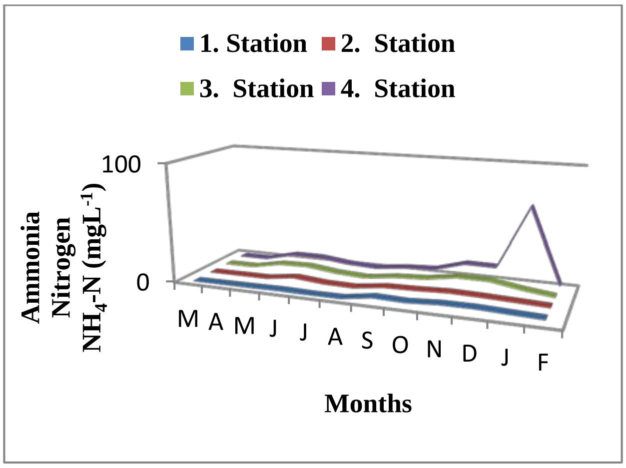


Figure 9. Monthly change of ammonium nitrogen at stations

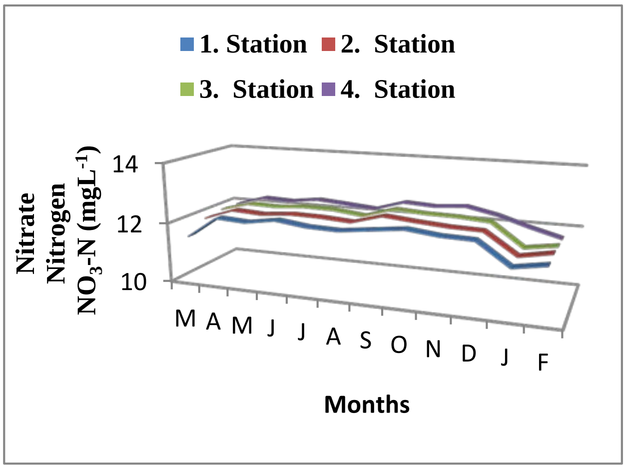


Figure 10. Monthly change of nitrate nitrogen at stations

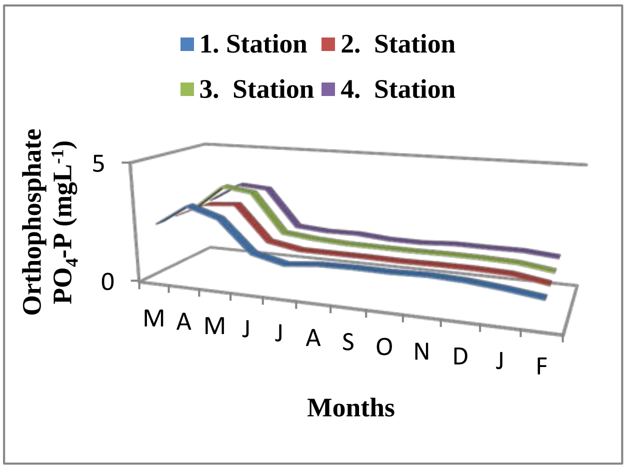


Figure 11. Monthly change of orthophosphate phosphor at stations .

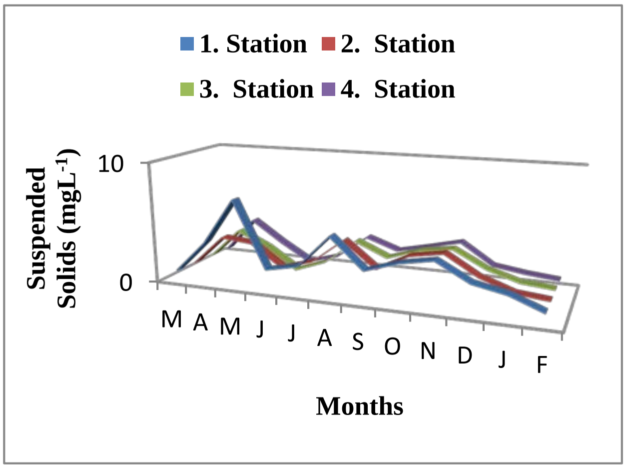


Figure 12. Monthly change of suspended solids at stations

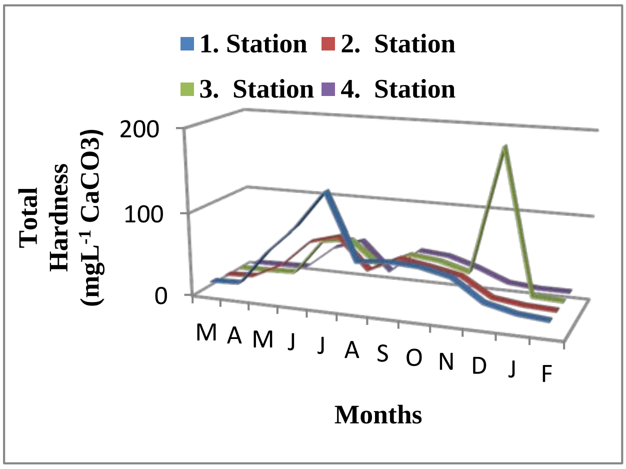


Figure 13. Monthly change of total hardness at stations

DISCUSSION

This research has studied 12 physico-chemical parameters where only 6 of them had been previously worked upon [2]; [3]; [4]. Temperature is the most important factor which affects the vital activities of living. Water temperature 4-26.7 °C, which was recorded in this research, and coincides with the studies made by Selçuk during 1989-1990, indicated water temperature was 5-28 °C and Temel's April-July 1993; 2002-2003 August periods where water temperatures were 11-25 °C, and 4-26 °C respectively. The highest temperatures recorded in 4 stations in the summer period can be associated with the fact that the stream bed gradually became narrower; the depth decreased and the weather conditions other than water had an effect.

It is known that dissolved oxygen limits the life of organisms in the aquatic environment by regulating and the amount of dissolved oxygen depends on the temperature of the water at that moment, on the dissolved salt concentration, on the partial pressure of gas in the atmosphere in touch with water surface, and on the depth of water; and flow speed, increase of wind speed, decrease in the temperature increases the dissolved oxygen concentration. Station one has shown higher levels of dissolved oxygen measures when compared to the other 3 stations. The stream's level of dissolved oxygen rapidly decreased throughout the years as seen in the studies of 1989-1990 14.5 mgL^{-1}, April-July 1993; 13.43 mgL^{-1} and 2002-2003 August; 9.41 mgL^{-1} with respect to this study measurement level was made 2007 with 7.8 mgL^{-1} [2]; [3]; [4].

Although pH is an important factor affecting the water quality in natural waters; determining the direct or indirect effect of pH is very difficult [6]; [7]. However, it has close relationship with dissolved CO_2. Through determining the presence of free CO_2 in water by measuring its pH, it may be decided if the water has an alkaline or acidic structure. All live in the aquatic environment is tolerant to a certain pH range, however, live can show better growth at the limit values of pH 6.4-8.6 [6]; [8]. The average pH values measured in this study remained between 7.26 to 7.47 which was an indication that the slightly basic structure of the river. The alkali characteristics resulted from the streambed, which contained approximately 200 m calcium oxide and schist layers [2]. This study indicates that the pH levels coincide with previous studies that were registered between 6.7-8.54, and the stream water illustrates alkali characteristics [2]; [3]; [4].

Electrical conductivity, a measure for ionic capacity of the water, vary according to the concentration of dissolved inorganic material and salinity. Electrical conductivity is very important in terms of water quality and conductivity exceeds 1000 μS/cm as the water pollution increases [6]; [9]; [10]. Riva Stream, especially in the spring and summer has been found to exceed this value. The highest electrical conductivity was observed at the station No. 1 in September 2006 with 1725 μS/cm. Solmaz observed the highest electrical conductivity again at the Station 1 in August 1990 with 1950 mho/cm. In addition, while the highest salinity during this study was observed by 12.0 ‰ (August 2006), Solmaz had made this observation in the study conducted in 1990 as ‰ 10.98 (July 1990). Again, the total hardness which was measured as 136.2 mgL^{-1} $CaCO_3$ during the research, had been mentioned as 144.16 mgL^{-1} $CaCO_3$ in the study of Temel which included the months of August 2002-2003. Station 1 was located at the end of the Riva stream, where it meets the Black Sea, with the vaporization in summer months resulting increase of ionic concentration levels are thought to be the causes of high level of conductivity, salinity and total hardness.

Biological oxygen demand is the oxygen abundance which bacteria needs to decompose organic substances in oxygenic environment. In terms of water quality, BOD_5 measurement is a measure of organic pollution [6]; [11]. The registered level of COD, BOD_5 was a maximum of 940 mgL^{-1} - and min. 145 mgL^{-1} was an indication of aquatic pollution, which causes aquatic life to become distorted, that results in eutrophication. Similar studies performed in Izmir, Turkey, bird sanctuary and Gediz stream was registered at high levels of COD, BOD_5 was also thought to be caused by the similar environmental settings [12]. Residences surrounding the stream with inadequate sewage systems, residential and industrial waste dumping in to the stream are thought to be reasons for this eutrophication.

Presence of high levels of phosphorus in surface waters which is transferred to the structures of living with assimilation by plants causes eutrophication. It is known that main source of phosphorus is originated from agricultural areas by 91% while the rest consisting of detergents and sewage in municipal waste. The amount of phosphorus in the water varies between 0.05-0.3 mgL^{-1} [5]; [6]; [8]; [11]; [13]. Third station's highest level of orthophosphate was registered in April 2006 at 3.54 mgL^{-1}, but Temel registered it at 0.86 mgL^{-1} in April-July 1993 and 4.58 mgL^{-1} during 2002-2003 August. Besides the residential and industrial waste, plus chemical fertilizer used by the farmers, and is thought to result in orthophosphate levels increasing. The high level of orthophosphate is an indication of organic pollution which known as eutrophic water. High level of orthophosphate that found in similar studies was also thought to be an indication of eutrophication [14]; [15].

The highest level of ammonium (NH_4-N) and Nitrate (NO_3-N) was registered in November 2006 at 4th station with 14.25 and 12.50 mgL^{-1} respectively. During the previous studies made in the Riva Stream, nitrate (NO_3-N) levels registered as 5.58 mgL^{-1} and 13.66 mgL-1 [2]; [3]. Latest measurements indicating that the level of nitrate (NO_3-N) has increased. This is also thought to be the result of a lack of sewage systems in the region. Due to increased algae and aquatic plants in the summer months the level of nitrate (NO_3-N) measures less than in spring and autumn levels. In addition, nitrogen was reported in previous studies as a major nutrient affecting the productivity of aquatic ecosystems.

The present study is the only study demonstrating the current situation of Riva Stream. As a result of physico-chemical investigations, it was found out that Riva Stream showing meso-oligotrophic characteristics in the nearly 15-year period between 1993 - 2007 has now eutrophic characteristics. Considering that this stream brings along the pollutions that it carries to Black Sea and Marmara Sea to which it is connected, it was considered essential to launch re-creation works on the stream immediately so that the marine environment is not affect any more.

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APPLYING THE QUALITY FUNCTION DEPLOYMENT (QFD) METHOD TO MARINE DIESEL ENGINES

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ABSTRACT

Marine diesel engine selection is a crucial issue for the maritime industry. Choosing the suitable power plant for the ship has positive economical and operational effects thus, it is beneficial for both manager and operator. In this study, Quality function deployment (QFD) method is carried out and the extended house of the quality is constructed to find out which criterions are the most important for marine engineers. QFD is a customer-oriented method aiming an agreement in enhancing a novel or developed output for higher buyer satisfaction. The house of quality (HOQ) is the first step of QFD that is a formed matrix turning the customer demands into quantifiable product technical requirements (PTRs). In consequence, we divided customer demands five header which are technical, physical, economic, maintenance and environmental and formed two matrixes for operator and management. After that, customer needs and technical requirements are designated and correlation matrix is obtained.

Keywords- Engine selection, House of quality, Marine diesel engines, Quality function deployment

INTRODUCTION

Nowadays, customers' expectations are the key factor for industrial innovations. Buyers need various types of products so they prefer companies which have wide product and service range. Therefore, corporations have to pay attention to customers' needs and satisfaction if they do not want to lose their buyers. Furthermore, a lot of companies investigate market demands and they try to increase their product range and quality in order to obtain higher market share. For these reasons, quality increasing methods are widespread in the entire business world [1].

Moreover, the quality concept is also soaring in the maritime sector for better service. Lots of shipyards, ship management firms and marine products manufacturers implemented various quality methods in order to qualify the marine sector's requirements [2]. These requirements are consist of, financial savings, applying various regulations about environment and of course customer satisfaction [3].

Marine diesel engines are the most significant equipment at ships. As a matter of fact that we say 'The main engine is the heart of the ship'. Besides, the main engine's cost is markedly higher than

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most of the other components. Operating and maintenance costs are high-priced for ship owners and managers [4]. At the management side, spare parts of the main power plant are markedly expensive compared to the other equipment. Besides, there are lots of auxiliary machines, which regulate intakes and uptakes. These machineries have also some expenses. Moreover, fuel cost is the crucial spending thus, the right main engine type can be helpful to reduce this cost. Furthermore manufacturing of the diesel engine has complex and expensive processes. On the other hand, environmental limitations are significant factor in the maritime sector. A lot of regulations about fuel emissions are in force for ships. At the operator side, marine power plants are the most time-consuming machineries. Working with a maintainable engine would ease their work load.

Consequently, selecting the marine power plant for a ship is a substantial subject for managers and marine engineers. Seeing that, ship owners select generally the main engine according to required speed which varies correspondingly ship type and size, low fuel consumption, easier overhaul, low vibration and noise etc. By reason of these criterions, producers manufacture different types, sizes and models of marine diesel engines.

METHODOLOGY

In this paper, quality function deployment is used as the method for prioritizing marine diesel engine choosing criterions. "*Quality function deployment (QFD) is ''an overall concept that provides a means of translating customer requirements into the appropriate technical requirements for each stage of product development and production (i.e., marketing strategies, planning, product design and engineering, prototype evaluation, production process development, production, sales)''*[5]. QFD strives to adapt the quality concept familiarized in the design process and to reassess quality matters along the product's whole life cycle. In the most QFD application, many matrices are used to determine correlation between customer requests, product specialties, and the manufacturing process [6].

QFD was constituted in Japan in the late 1960s during an era Japanese market was in an economic depression from their post-World War II type of product improvement which was depending on imitation and proceeded to product improvement based on originality [7]. Its first implementation was in 1972 at the Kobe Shipyards of Mitsubishi Heavy Industries in Japan.[8]-[9]. The American Supplier Institute (ASI) and Growth Opportunity Alliance of Lawrence, Massachusetts/Quality Productivity Center (GOAL/QPC) [10]-[11] have made widely known the QFD in the United States. The first recorded case studies in QFD were in 1986 (King, 1989). Kelsey Hayes used QFD to improve a coolant sensor, which ensured crucial customer demands like "easy coolant filling, easy unit identifying and provide cap removal instructions." Many corporations have experienced QFD including Ford, General Motors, Hewlett-Packard, Toyota etc. and they have realized significant profits [12].

The extended house of quality (EHOQ) is generated for QFD application. EHOQ comes into existence eight areas all of them is not essential. Figure 1 identifies each area which gives a glimpse of EHOQ's full potential [12]. Moreover, explanations of areas are given below.

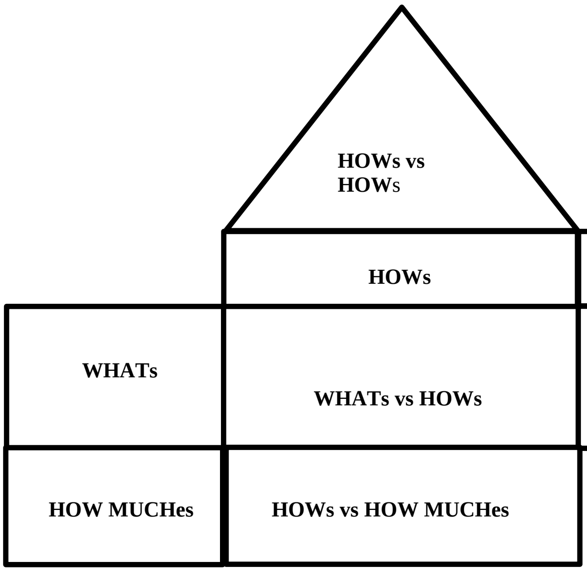

Figure 1.The extended house of quality (EHOQ) [12].

- ***WHATs*** are list of customer demands or customer requirements.
- ***HOWs:*** are a set of quality characteristics used to fulfill customer demands
- ***HOW MUCHes:*** contain a vector list which defines convenience of HOWs.
- ***WHYs:*** are names of competitor and market segments that define current market conditions
- ***WHATs vs HOWs:*** to get relationship between market requirements and quality characteristics
- ***HOWs vs HOW MUCHes:*** this matrix measures how much each HOW can be varied to meet customer demands.
- ***WHATs vs WHYs:*** This is a matrix of coefficients that prioritizes the WHATs based on market segments
- ***HOWs vs HOWs:*** identifies the qualitative correlation between quality characteristics [12].

The matrix relationship parameters are shown in Table 1

Table 1.Standard Relationship Conventions (Weight and Symbols)[12]

Grade	Weight	Symbols
Strong relationship	9	Double or Solid Circle and/or •
Moderate relationship	3	Circle (o)
Weak relationship	1	Triangle (Δ)
None	0	Blank

CRITERIONS DEFINITION

The ship design period has complex and iterative processes since selection process is affected by many factors directly or indirectly. It involves definition of constraints, selecting convenient equipment for providing customer and regulation demands, and application of selected design parameters in order to ensure whole related requirements. Thus it requires solving a multidisciplinary and multi criterion optimization problem. The ship design spiral iterations must be repeated until optimum efficiency point for technical, economical and regulative criterions [13].

For ships, main engine selection is one of the most significant phases of the design period because; it is selected in the early design phase. When the engine type has been decided, there is little chance to re-design the propulsion system. The optimum solution of each component must match constraints and requirements [13].

There have been many improvements on marine propulsion systems. This system has three major components which contains main engine, transmission and propeller. Main engine improvements are generally based on cost and performance characteristics. Transmission and propeller type definition is the second step of propulsion system design [13].

In this study, the main issue is to determine customer requirements which corresponds operational and managerial requests. Furthermore, these two main sub-headings have separately five groups which have related items for operation and management. Our selected criterions are drawn from three sources;

- "An Evaluation of Marine Propulsion Engines for Several Navy Ships" Master Thesis of Mark Thomas Stanko, MIT, 1992
- "Practical Ship Design", David G.M. Watson, 2002
- "A Methodology for Multidisciplinary Decision Making for A Surface Combatant Main Engine Selection Problem" Master Thesis of Mustafa G. Tosun, Naval Postgraduate School, California, 2014

We have aimed illustration of the strategical requirement differences between management and operation departments. Management requests mostly on economic operational conditions since the balance between income and expenditure is the key factor of any business organization. These requirements and their aims have been defined at table 2 below. Each criterion has been specified by taking into consideration of literature.

On the other hand, any on board ship worker wishes easy startup, simple maintenance processes and trouble-free conditions. Operational requirements and aims is listed table 3 below again.

Managerial requirements:

Table 2.Managerial requirements and aims

Requirements	Aims
Technical	
Continuous HP conformity for ship	to satisfy expected service speed
Max. continuous HP conformity for ship	to documentation of main engine situation for regulations
Low max. effective horse power consumption	to reduce fuel costs
Maximum engine RPM convenience with gear	to require efficient usage
Minimum engine RPM convenience with gear	to require efficient usage
Providing ship’s require electrical power and heat	to supply needed energy for operations
High efficient components	to ensure reliable working conditions
Physical	
Low weight of engine	not to carry extra tonnage
Low space of engine	to increase working spaces and load
Low weight of intakes	not to carry extra tonnage
Low volume of intakes	to increase working spaces and load
Low weight of uptakes	not to carry extra tonnage
Low volume of uptakes	to increase working spaces and load
Not to cause accidents	to ensure safety at working areas
Economical	
Low capital cost	to decrease total cost
Low manning	to decrease staff payments
Low costed spare part expenditures	to minimize maintenance expenditures
High durable spare parts	to avoid frequent part changing
Low fuel consumption	to decrease fuel spending
Operational	
High reliability and maintainability	to ensure reliable working conditions
The parts that have similar life cycles should be near	to complete maintenance short periods
Fasteners and joints should not be corroded	not to cause redundant expenditures
High durability	to have long life cycle and reduce maintenance costs
Easy initial installation	to complete installation short periods
Fasteners and joints should be reused	not to cause redundant expenditures
The surfaces of parts should not be damaged during cleaning	to use parts after cleaning
The parts disassembled should not be damaged	to reuse parts after maintenance
Not damage the other parts and itself while disassembling	to reuse parts after maintenance
Accessing to the parts that come to their end of life quickly should be easy	to fulfill rapid maintenance durations
Rapid delivery of spare parts	to fulfill rapid maintenance durations
Environmental	
Low vibration value	to ensure regulations
Low noise level	to ensure regulations
Low emission value	to ensure regulations

Operational requirements:

Table 3.Operational requirements and aims

Requirements	Aims
Technical	
Continuous HP conformity for ship	to reach expected service speed
Max. continuous HP conformity for ship	to documentation of main engine situation for regulations
Maximum engine RPM convenience with gear	to reach expected service speed
Minimum engine RPM convenience with gear	to reach expected service speed
Providing ship's require electrical power and heat	to supply needed energy for operations
Physical	
Low space of engine	to increase working spaces
Low volume of intakes	to increase working spaces
Low volume of uptakes	to increase working spaces
Not to cause accidents	to work in safety areas
Economical	
High durable spare parts	to avoid frequent part changing
Operational	
High reliability and maintainability	to ensure reliable working conditions
The parts that have similar life cycles should be near	to complete maintenance short periods
Fasteners and joints should not be corroded	to make proper maintenance
High durability	to have long maintenance periods
Fasteners and joints should be reused	to avoid fitting problems
Easy start	to decrease starting process
Determining the outworn parts and the conditions of the parts should be easy	to complete maintenance short periods
Accessing the parts to be cleaned should be easy	to complete maintenance short periods
The surfaces of parts should not be damaged during cleaning	to use parts after cleaning
The marks on the parts should be durable for cleaning	to fulfill maintenance correctly
The parts disassembled should not be damaged	to reuse parts after maintenance
The number of the fasteners and joints should be low	to fulfill maintenance easily
Accessing test points and fasteners should be easy	to reach target points directly
Operations should require minimum labor force	to fulfill easy maintenance operations
Not damage the other parts and itself while disassembling	to reuse parts
Not require different tools for disassembling	to use standard tools
The parts disassembled should be handled easily	to easy carry
Accessing to the parts that come to their end of life quickly should be easy	to fulfill rapid maintenance durations
Rapid delivery of spare parts	to fulfill rapid maintenance durations
Practical assemble tolerances	to fulfill easy maintenance operations
Environmental	
Low vibration value	to ensure part and worker safety
Low noise level	to work in safety areas

APPLICATION

In this study, we build WHATs and HOWs matrixes to clarify the main engine selection criterions for ships. In the previous section, criterions' selection, definition and technical requirements have been explained. In order to determine the relationship between these requirements and customer demands, interviews with experts were organized. We made commentaries with technical managers, operational managers and oceangoing marine engineers. According to these interviews, grades shown in Table 1 were given to create correlation matrix. The house of quality is shown Table 4.

Table 4. The House of Quality

			TECHNICAL REQUIREMENTS (HOWS)																														
MANAGERIAL REQUIREMENTS (WHATS)	OPERATIONAL REQUIREMENTS (WHATS)	CUSTOMER REQUIREMENTS (WHATS)	Estimating power calculation	Transmission type selection	Propeller type decision	Propeller RPM calculation	Main engine power/weight ratio decision	Main engine power/volume ratio decision	Low specific fuel consumption (SFC) engine selection	Engine's fuel type selection	Engine's lubricating oil type decision	Annual maintenance cost calculation	Automation system adding	Using equipments which in accordance with standards	Minimisation of attached auxiliary equipments	Proper engine shock mount type selection	Minimisation of out-of-service time	Optimum service speed determination	Selecting wide RPM scaled engine	Technical manual and drawing ensuring	Convenient spare part list preparation	Making life cycle cost analysis	Consideration of voyage range	Enabling maximum propulsion system efficiency	Considering of design draft	Selecting high durable components for the specific shock loads	Selection of easy maintainable machinery parts	Low corrosive equipment selection	Work with a global supplier	Increasing of personnel skill levels	**Total score of each WHATs**	**Order of importance in each groups**	**Order of importance in total**
		Technical																															
x	x	Continuous HP conformity for ship	●	●	○	○	Δ											○	●					●	●						55	2	4
x	x	Max. continuous HP conformity for ship	●	●	○	○	Δ											○	●					●	●						55	2	4
x		Low max. effective horse power consumption		●	●	●			●	●			○	Δ				●	○				Δ	●	○						74	1	1
x	x	Maximum engine RPM convenience with gear		●		○								Δ				Δ	●					●							32	5	15
x	x	Minimum engine RPM convenience with gear		●		○								Δ				Δ						●							23	6	21
x	x	Providing ship's require electrical power and heat		Δ						○			○	○	●			○	●					○							34	4	13
x		High efficient components		●	●	○					Δ		Δ	●				Δ	Δ					●		Δ				○	47	3	7
		Physical																															
x		Low weight of engine					●	○							○																15	4	24
x	x	Low space of engine						●		○	Δ				●																22	3	22
x		Low weight of intakes							○	●	○		○		●								●	○							39	1	9
x	x	Low volume of intakes							○	●	○		○		●								●	○							39	1	9
x		Low weight of uptakes								○	○				○								○	Δ							13	5	25
x	x	Low volume of uptakes								○	○				○								○	Δ							13	5	25
x	x	Not to cause accidents									Δ									○	○					●	●	Δ		●	35	2	12
		Economical																															
x		Low capital cost							●	●	●	○	●		●			○				●									60	2	3
x		Low manning								Δ		●	●	Δ	Δ		●			Δ	○	○				Δ	○			○	44	4	8
x		Low costed spare part expenditures										●		○	○					○	○	○				●	●	○		●	54	3	5
x	x	High durable spare parts												○								●				●	Δ	●			31	5	16
x		Low fuel consumption	○	○	○	Δ			●	○		●		Δ	○			●	○			●	Δ	●	Δ						67	1	2
		Operational																															
x	x	High reliability and maintainability												●						○	○					●	●	Δ			34	2	13
x	x	The parts that have similar life cycles should be near																		○	○						●				15	11	24
x	x	Fasteners and joints should not be corroded																								Δ		●			10	13	27
x	x	High durability												○	Δ											●	○	●		○	28	6	18
x		Easy initial installation												○	●					●										●	30	5	17
x	x	The fasteners and joints should be reused																		○	Δ					○	○	●		●	28	6	18
	x	Easy start		Δ						○			●	○	○					○										●	31	4	16
	x	Determining the outworn parts and the conditions of the parts											●	○						●	Δ					●	○	Δ		○	38	1	10
	x	Accessing the parts to be cleaned should be easy																		●	○									○	15	11	24
x	x	The surfaces of parts should not be damaged during cleaning												●												●	○	Δ		●	31	4	16
	x	The marks on the parts should be durable for cleaning												●						●	○									○	24	8	20
x	x	The parts disassembled should not be damaged												●						○						●	●			○	33	3	14
	x	The number of the fasteners and joints should be low												○	○												●				15	11	24
	x	Accessing test points and fasteners should be easy											Δ	○						●							●				22	9	22
	x	Operations should require minimum labour force												○	○												●	Δ		○	19	10	23
x	x	Not damage the other parts and itself while disassembling												○						●						○	○			●	27	7	19
	x	Not require different tools for disassembling												●													○				12	12	26
	x	The parts disassembled should be handled easily												○													●				12	12	26
x	x	Accessing to the parts that come to their end of life quickly												○						○							●				15	11	24
x	x	Rapid delivery of spare parts																											●		9	14	28
	x	Practical assemble tolerances																									●				9	14	28
		Environmental																															
x	x	Low vibration value	Δ	○	●	○					Δ			○		●			○					Δ		○					36	2	11
x	x	Low noise level	○	Δ	○	○					Δ			○		○			Δ					Δ		○	Δ				23	3	21
x		Low emission value	Δ	Δ	○	○			●	●					○			●	○				Δ	●							51	1	6
		Total score of each HOWs	26	64	42	34	11	12	42	64	26	30	50	104	83	12	9	42	50	79	23	33	27	85	22	87	122	44	9	87			
		Order of importance	15	7	10	11	19	18	10	7	15	13	8	2	5	18	20	10	8	6	16	12	14	4	17	3	1	9	20	3			

CONCLUSION

With the end of WHATs and HOWs correlation matrix, a number of inferences have been reached. The importance order of WHATs shows us customer demands with respect to their wishes list top to bottom. We have obtained 20-stepped significance list. Top five of them are respectively; "low maximum effective horse power consumption", "low fuel consumption", "low capital cost", "continuous and maximum continuous horse power conformity for ship", "low costed spare part expenditures". These five items prove that fuel costs and maintenance expenditures are the most significant issues for a marine shipping company. On the other hand, "low emission values", "high efficient components" and "low manning" are very near demands to top five. If we want to express this situation with a few words, we can say that "low fuel consumption, low purchase cost and low manning expense" are needed more work on.

Second order is HOWs importance list. HOWs are directly related to work for meeting the demands. These top five are; "selection of easy maintainable machinery parts", "using equipment which in accordance with standards", "increasing of personnel skill levels", "enabling maximum propulsion system efficiency" and "minimization of attached auxiliary equipment". In addition to these, "technical manual and drawing ensuring, "engine's fuel type selection", "transmission type selection" and "selecting wide RPM scaled engine" are mostly used techniques for ensuring the customer demands.

In the final of this study, we have demonstrated some significant issues to select the main engine for a ship. The importance order of WHATs sheds light on who works to meet the client demands. These imply a routine process to select main engine.

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CONTAINER INSPECTION AND REPAIR STANDARDS

Ozan Altunlu[1], Güldem Elmas[2]

ABSTRACT

The maintenance and repair standards have always been a problem in the container industry. Due to different preferences of criterias of different parties caused many conflicts. This paper examines the different types of criterias and standards for general purpose containers, and different areas of use of these criterias. The main reason of this paper is to be an explanatory element to define the differences of these criterias. The fundamental structural dimensional basis for an intermodal container is ISO container standards which defines the main structural features. Although it presents dimensional tolerances to a certain degree, it is nearly impossible to use these criterias for the operators and owners in day to day operations. As a result there have been various published maintenance and repair criterias, used by different parties partaking in the container industry. The different organizations and associations published standards suiting their own needs. Although there are lesser implemented criterias like Wind and Water Tight and Cargo Worth, the most known and most implemented criterias around the world are Unified Container Inspection and Repair Criteria, Common Interchange Criteria and IICL publications. While the Wind and Water Tight criteria is generally used for containers which are used as storage, the Cargo Worthy is used for the containers meet the minimum requirements for transport. The Unified Container Inspection Criteria is preferred by the shipping lines and operators, and the Common Interchange Criteria and IICL – 6 are preferred by lessors.

Keywords – container, criteria, inspection, repair, standards

INTRODUCTION

An intermodal container's main purpose is transporting the cargo safe and effectively in an intermodal transport system. These containers should be seaworthy and withstand the challenges caused by different transport modes, variant temperatures and weather conditions. Also should endure all handling operations at depots and ports.

To keep their structural integrity in certain dimensional tolerances is vital for functionality of intermodal transport system. Although containers are made of durable materials they are not invincible to damages degenerating effects of nature. Especially a container which visit a country does not implement these criterias can be damaged heavily and generally it is impossible to trace back to the root of the damage. Therefore it becomes a financial loss and a problem for the container operators. For this reasons, container inspection criterias and applications are used for bringing out unsafe structural conditions, serviceability of the container or factors causing decrease on the lifespan of the containers both at interchange and in - service .

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CONTAINER STRUCTURE

In general containers are Closed steel box structures which have doors on one end, plywood floors, corrugated steel panels which is known as CorTen and a steel frame. The reason the steel is widely known as Corten in the industry is the inventor company US Steel Corporation registered it as a trademark. High durability and resistance against corrosion is the most important features of this steel, so it is widely used in the maritime and especially in container industry. Corrugated panels are used to improve the rigidity and strength of the container. This structural designs can also be seen at cardboard boxes which endure the hardships of shipping, handling, stacking, etc.. These corrugated panels can withstand much more powerful forces than plain steel sheets.

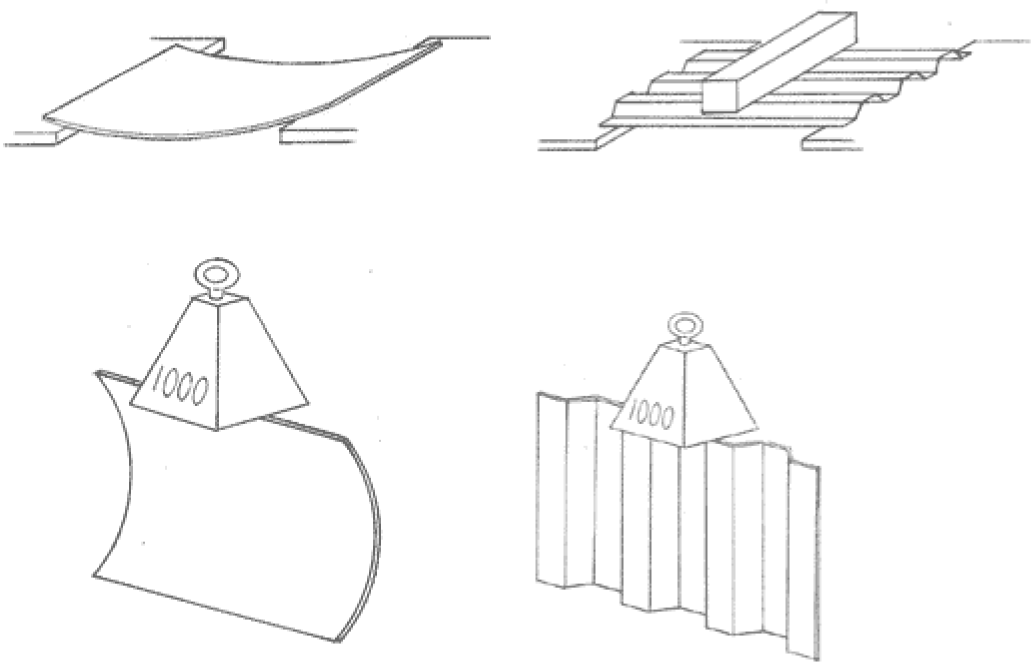

Figure 1. Rigidity of Corrugated Steel Plates [8]

The Figure 2 shows some examples about the rigidity of the plain steel sheet and corrugated steel. The top images compare the plain steel sheet with corrugated sheet resting on supports. The plain steel sheet bent under it's own weight in contrast to the corrugated sheet which is even capable to carry more weight. The bottom figures compares the vertical durability of the both types. Once more the corrugated sheet is being shown more durable. Although the corrugated panels on a container have significant advantages on it's durability, they increase fuel consumption levels at road and rail transportations about %10 due to higher aerodynamic drag [10].

Intermodal containers have eight corner fittings on each corner which are basically twist lock housings. As to twist locks, they are twisting locks which have flanges and used for securing the container. The main purpose of these components are anchoring the containers to the decks of ships, trailers and trains and also let handled by cranes and stackers.

The most important component of a container is it’s steel framework. The framework is the structure which carries the load and weight of the container and it consits two top and two bottom side rails, two bottom front and end side rails, a door header and a top end rail. The crossmembers which positioned between two side bottom rails all along the container are the supporting components for the floor of the container.

The floor is generally coated with plywood in containers. The wood is an expensive material but it is rather practical due to it’s easy to handle feature in repairs and durable enough to carry most detrimental cargoes. Also it offers a good enough rate of friction.

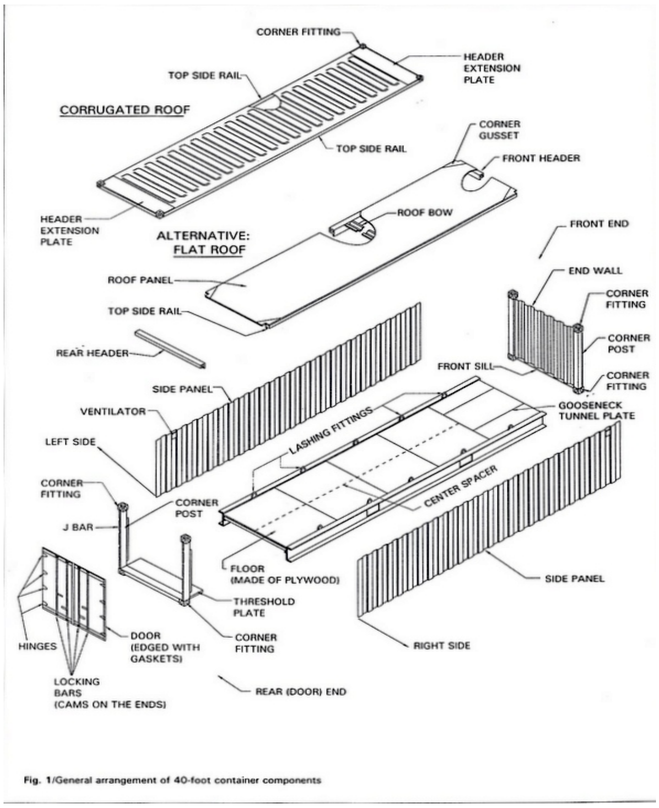

Figure 2. Container Components [11]

The doors of a container, espacially on general purpose containers are one of the most important part of a container. The doors should be able to open a 180º at least and should fit it’s place properly. Also the hinges and other door assemblies must be adjusted decently enough to let the moving parts operate. On the left hand door there must be a CSC (Container Safety Convention) plate. This plate shows all essential technical and owner data. Also it consists of ACEP (Approved Continuous Examination Programme) information which is the container examination programme every freight container must comply. According to CSC and ACEP every container being used for intermodal transport must be examined every thirty months or less. Figure 3. Below shows two examples of CSC plate which presents informations like customs seal approval number, manufacturer’s number, timber component treatment, manufacturer, owner, CSC number, container number and maximum gross weight.

Figure 3. CSC Plate [5]

RELEVANT INTERNATIONAL REGULATIONS

Containers are allowed to be operated under variable conventions, regulations and standards. These kind of international sanctions have an influencing effect on structural features on containers also. The containers built in conformin features with ISO standards and they should have a structural harmony with the allowances that is defined by relevant criterias.

Customs Convention on Containers, 1972

CSC is an international convention which makes transporting containers in an international environment easier. As a consequence of the rules and regulations of CSC presents, there are enforcements about structures of containers. The most basic one may be the structural feature of container doors and handles which allows the container to be sealed safely and securely under one customs seal. The most important enforcement about containers is the necessity of a CSC plate. By this plate the operators, enforcers or the inspectors can gain all relevant information about the referred container and also having a CSC plate on a container means that container is in conformity with CSC and it is inspected for structural integrity regularly. As mentioned before, the inspection period programme referred in the CSC plate as ACEP. The owners or lines can implement their own ACEP but it must not exceed thity months period.

The 1972 Convention for Safe Containers

The 1972 Convention for Safe Containers is developed by IMO in co-operation with Economic Comission for Europe. The Convention has two goals which are explained in the official site of IMO as;" one is to maintain a high level of safety of human life in the transport and handling of containers by providing generally acceptable test procedures and related strength requirements, and the other reason is to facilitate the international transport of containers by providing uniform international safety regulations, equally applicable to all modes of surface transport. In this way, proliferation of divergent national safety regulations can be avoided" [12]. The CSC has two technical annexes which provides rules and technical informations to be applied to the containers. Annex 1 sets out procedures to be applied to the containers being used in international transport which expected to be enforced by an Administration of a Contracting State or by an organization acting on its behalf and Annex 2 provides structural safety requirements and tests and details of test procedures[12].

The International Standards

The structural specifications of containers are established by International Organization and Standardization's relevant standards. Up to date there have been published more than thirty standards regarding freight containers. These standards refers to all types of containers existing in the fleet in the world. The most important standards for general purpose containers are; ISO 1496- 1:1990, Series 1 freight containers – Specification and testing – Part 1 : General cargo containers for general purposes and ISO 668:1995, Series 1 freight containers – Classification, dimensions and ratings which determines all other standards [13]. The containers being used in international trade should be built in conformity with these standards and the structural features and dimensions which standards compel. The Figures 4. and 5. Shows the ISO container dimensions and maximum allowable dimensional tolerances.

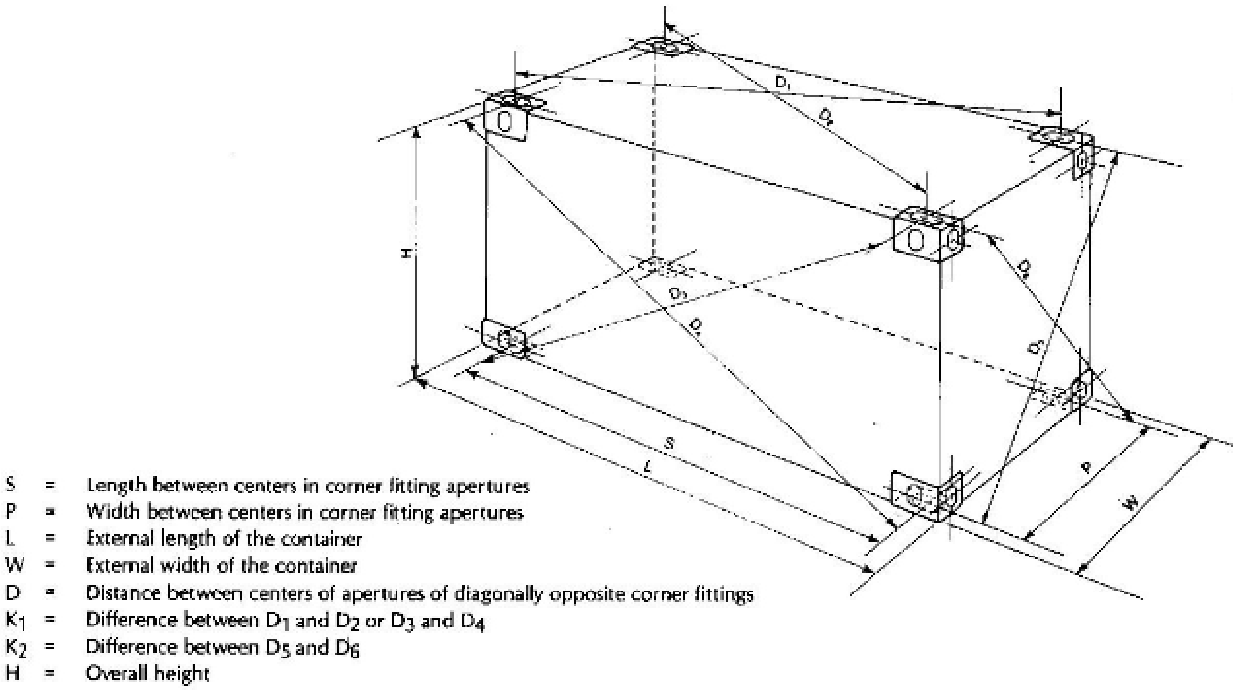

Figure 4. ISO Dimensions and Tolerances 1 [1]

EXTERNAL DIMENSIONS AND TOLERANCES IN MILLIMETERS AND IN FEET AND INCHES

Height - 8 ft. high: 2 438 $^{+0}_{-5}$ mm (8 ft 0 in. $^{+0}_{-3/16}$ in.)   Height - 8 1/2 ft. high: 2 591 $^{+0}_{-5}$ mm (8 ft 6 in. $^{+0}_{-3/16}$ in.)

Height (external) - 9½ ft. high: 2 896 $^{+0}_{-5}$ mm (9 ft 6 in. $^{+0}_{-3/16}$ in.)   Width - All containers: 2 438 $^{+0}_{-5}$ mm (8 ft 0 in. $^{+0}_{-3/16}$ in.)

Freight container designation	Length (external)			S			P			K_1 max.		K_2 max.	
	mm	ft	in	mm	ft	in	mm	ft	in	mm	in	mm	in
40′	12 192 $^{+0}_{-10}$	40	0 $^{+0}_{-3/8}$	11 985	39	3-7/8	2 259	7	4-31/32	19	3/4	10	3/8
30′	9 125 $^{+0}_{-10}$	29	11-1/4 $^{+0}_{-3/8}$	8 918	29	3-1/8	2 259	7	4-31/32	16	5/8	10	3/8
20′	6 058 $^{+0}_{-6}$	19	10-1/2 $^{+0}_{-1/4}$	5 853	19	2-7/16	2 259	7	4-31/32	13	1/2	10	3/8

MINIMUM INTERNAL DIMENSIONS

Freight container designation	Minimum height	Minimum width		Minimum length		
		mm	in	mm	ft	in
20'	Nominal container external height minus 241 mm (9-1/2 in)	2,330	91-3/4	5,867	19	3
30'				8,931	29	3-5/8
40'				11,998	39	4-3/8

Figure 5. ISO Dimensions and Tolerances 2 [1]

CONTAINER REPAIR AND INSPECTION CRITERIAS

The ISO tolerances are actually too strict to be functional at shipping industry. As a result, there are variable repair and inspection criterias created and published by container industry associations, chambers, organizations and/or companies. These criterias generally measure damage tolerances as “ISO dimensions + Relevant criteria tolerances”. In this section, widely used criterias will be examined.

Wind and Water Tight Criteria

The Wind and Water Tight Criteria (WWT) is the criteria that indicates the regarding container is simply water and weatherproof. When the container is shut tight, the observer inside the container should not be able to see any light. This criteria does not pay attention to the integrity of any important understructure or structural feature of the container. This means a WWT should not be considered safe for being used in transportations. Unless it is inspected and given a CSC certificate and plate. This criteria generally used for containers that do not comply with CSC.

WWT containers can be serviceable in transportation again with temporary repair methods. Generally they have full operable doors and minimum level of damage or repair costs. This criteria is widely used to inspect the storage containers.

Cargo Worthy Criteria

Cargo Worth (CW) indicates that the container meets all the standards of it's original specifications and suitable for transportation and generally the container has a valid CSC [6]. CW is in compliance with ISO. CW containers must meet WWT standards and minimum structural requirements. CW containers with CSC certificates are suitable for overseas transportations. The inspectors examine the container if it is WWT and surveys the structural strength of the container. The containers get exposed to many physical and corrosive effects and damages during transportation. If the damages they suffered do not prevent them to carry the cargo safely, the container is considered CW.

New built containers have five years of exemption from inspection for CW. Containers older than five years must be inspected by a licensed surveyor regularly. After the inspection the surveyor prepares a certificate regarding the condition of the container and estimates when the next inspection should occur.

Unified Container Inspection and Repair Criteria

The Unified Container Inspection and Repair Criteria (UCIRC) is a criteria especially designed by International Chamber of Shipping for the specific needs of the shipping lines which are preventing unnecessary repairs and movements and by doing so reducing the repair costs for shipping lines, lessors, and repair depots. In contrast to IICL-6, UCIRC is more practical for the container operating parties. It suits with the basic needs of the shipping lines, operators and etc. about daily maintenance and repairing their own fleets. This criteria allows users a faster response chance in spite of CIC and IICL - 6. Although container operators mainly use the UCIRC, while off-hire procedures they prefer to repair existing damages according to CIC or most commonly IICL - 6. The damage types in UCIRC is defined broadly as below;

- Acceptable Damage
- Non-Acceptable Damage
- Wear & Tear
- Manufacturing Defects

Common Interchange Criteria

The Common Interchange Criteria (CIC) is the criteria prepared and published by Container Owners Association (COA). It is designed to reduce the repair and maintenance costs and bring a more environmentally friendly approach. In recent years, CIC has gained acceptance by the lessors managing nearly %50 of world dry van container fleet [14]. CIC and IICL-6 both are criterias mainly appealing to lessors. Due to complications caused by two different criterias in the industry, COA accepted a new interchange standard, uniforming the CIC with IICL-6. The new standard entered into force in August 1st 2016. Although the new standard does not have major changes, it is considered that it will bring ease to the industry.

CIC is generally based on UCIRC and IICL-6. By harmonizing these two criterias, it is predicted that the efficiency of the repair depots will increase and the repair costs will be reduced. This criteria is generally used for On-Hire and Off-Hire operations. By using this criteria the lessee can be comfortable about the condition of the container while hiring one. Also whan off-hiring one, the lessee would be able to know which condition level the container must be delivered and can estimate how much repair cost will be reflected.

IICL – 6

As a trade association, Institute of International Container Lessors (IICL) mainly looks for safeguarding lessors' interests in the industry. The institute is active in fields like educational, technological, safety, environment, governmental, regulatory, customs and tax. IICL – 6 publications are container inspection and repair criterias published by IICL.

IICL – 6 is the sixth edition of the widely known criteria and it is implemented on August 1 2016. IICL - 6 is the highest quality repair criteria in the industry. This criteria is the most strict and prepared by the world's leading lessors which explains the strictness of the criteria. IICL – 6 is a widely – used criteria at on-hire and off-hires. The operators and lessors generally accept to use CIC during interchanges to define and measure the damages, although the lessors use IICL – 6 for the repair procedures. The main purpose of the standard is reducing operating and repair costs especially for the lessors. The Figure 6. compares UCIRC, CIC and IICL – 6 criterias' differences. Although IICL – 5 and CIC updated, the figure is a good representation of different preferences of the container lessees and lessors. The figure only shows criteria that differ.

	COMPONENT	*CIC*	*UCIRC*
1	Fork-lift pocket sides and gooseneck tunnel rails	No cuts allowed	Cuts up to 500 mm
2	Side panels--cube intrusion	35 mm	50 mm
3	Side panels--outward	ISO + 20 mm	ISO + 40 mm
4	Roof panel--inward	50 mm	70 mm
5	Roof panels--outward	ISO + 20 mm	Corner casting + 40 mm
6	Front panel--outward	Corner casting + 5 mm	Corner casting + 40 mm
7	Crossmember web	50 mm	75 mm

	COMPONENT	*CIC*	*IICL-5*
1	Flat bar top side rail	30 mm	25 mm
2	Front headers	40 mm	25 mm
3	Rear headers	40 mm	35 mm
4	Front & rear corner posts	20 mm Any number of dents	25 mm single dent Maximum 2 dents of 15 mm
5	All side & front panels	35 mm internal cube intrusion	35 mm dents
6	Door Panels	35 mm internal cube intrusion	35 mm dents
7	All roof panels	50 mm internal cube intrusion	35 mm dent
8	Flooring height difference	10 mm	5 mm
9	End frame components (corner posts, front panel, doors, headers, sills, corner castings) ISO tolerance	ISO + 5 mm on end faces ISO + 10 mm on side faces	ISO + 5 mm all faces
10	Entire container, EXCEPT end frame components ISO tolerance	As per below	ISO + 10 mm
	Side panels--outward	ISO + 20 mm	ISO + 10 mm
	Corner posts--end face outward	ISO + 5 mm	ISO + 5 mm
	Corner posts--side face outward	ISO + 10 mm	ISO + 5 mm
	Roof panels--upward	ISO + 20 mm	ISO + 10 mm

Figure 6. A Comparison of CIC, UCIRC and IICL – 5 on Dry Van Inspection Criterias [15]

CONCLUSION

The need for cost effective operations and the difference of prefferances are the main reasons of the different types of inspection and repair criterias. While some parties may prefer to use one type of criteria others may choose to use another. The benefits of having more than one type of criteria seems to be more advantageous. For a person looking for a storage a wind and water tight container would be enough. The container operators' and shipping lines' main consideration is to carry the cargo most cost effective way and safely enough from one location to another. While the lessors' main consideration is receiving and delivering the containers with the least cost and highest possible quality. Nevertheless, these criterias can be applied in harmony with each other. The already proven advantages of these criterias by the leading companies shows the critical importance of them.

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A STUDY ON ROLE OF GREEN PORT IMPLEMENTATION AND ‘‘GREEN-COLLAR’’ WORKERS IN PORT FACILITIES

Birsen KOLDEMIR[1], Murat YAPICI[2]

ABSTRACT

Ports are the commercial areas, where the loading-unloading operations and freight services are given. Global trade and developing technology made ports places where the not only load-unload area, it has become an industrial center. In recent years, international trade has led to an increase in freight transport by sea. Environmental awareness is increasing as well as in all areas at maritime transport. Port facilities are passed to environmentally friendly practices to reduce damage to the environment to a minimum by starting the process of becoming a green port. This aspect also has to perform world's largest port operators can encourage environmental awareness in the communities in which they do business and maintain a change, have undertaken joint industrial ventures. Green port applications are based on a voluntary basis. In this respect, the implementation of green applications and the role of maintaining the port workers come to the fore. In recent years, the result of 'green' jobs, and to raise awareness of 'green-collar' concept were occurred by global climate change and the production of environmentally friendly low-carbon life. In this study, green port management of our ports and applications have been investigated. Trained green-collar manpower potential and work areas were examined.

Keywords – *Green Collar, Port Management, Green Port*

INTRODUCTION

The effect of globalization has led to an increase in world trade. Demand for goods and services have increased with the increase of world population. Approximately 12 billion tons of freight are transported by sea every year through sea transport which makes it ‘‘the key to the realization of world trade’’[1].

Increasing population and industrialization have facilitated human life and have negative effects on the environment. Sea transport causes sea pollution, noise and air pollution. In recent years, marine pollution has been reduced due to measures taken and innovations in ship technology. Marine accidents was reduced by safe navigation rules.

Another negative impact of maritime transport is exhausting harmful emissions to atmosphere. These emissions are affected by the ozone depletion, global warming and agriculture. No concrete results have been obtained with international conferences on global warming.

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However, the Paris climate summit made serious decisions. Particularly until 2100, acceptance of the global temperature increase of + 2 C^0 (even acceptance of the global temperature increase of + 1.5 C^0) has become serious.

In 2023, it will be the result of the first assessment that the countries have kept their promises in good faith. Each 5 years, evaluation performance of the countries will be declared. Positive and negative declarations will be made regarding the green activities of the global recreational plants and facilities.

According these developments, prestige will be provided by both quality standards of public-private organizations and the least harmful production to the environment. It is unforeseeable for companies to see such a loss of prestige. For this reason, there is a need for a specialist in environmental issues to ensure that the products.

The environment has brought innovation to the definition of business and profession by turning to renewable energy sources instead of conscious and fossil fuels. Especially in the energy sector, it is defined as green jobs that are spreading in many engineering and business areas which expert workers of the green collar sectors. The employment of green-collar employees are increasing for environment-friendly, sustainable production by this reason.

Green port applications are increasing rapidly in port operations in our country. These practices based on volunteerism are taking measures to reduce the cost of the port. On the other hand, it is also increasing the preference of the port to be a green port. In recent years, 'green jobs', which include environmentally friendly low-carbon life and production as a result of the global climate change, are defined by the concept of 'green collars' who works in these jobs and are environmentally conscious.

THE CONCEPT OF GREEN COLLAR JOBS

Green professions are jobs that maintain environmental quality, sustainability and sustainability. Examples of green jobs include the installation of solar panels on a port management building, where the operating crews are operated with electricity generated from renewable energy sources instead of fossil fuels [2].

The six main sectors are divided into green jobs as energy, construction, transportation, industry and recycling, food and forestry [3].

Technological developments, economic conditions and energy politics have been influential in the development of green-collar occupations. [4].

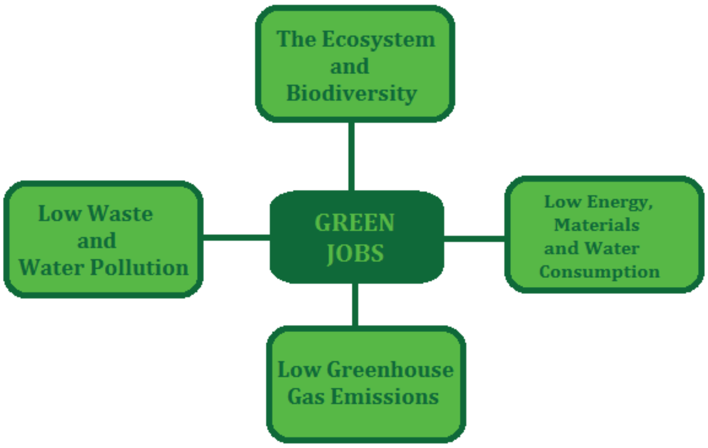

Figure 1. Green Basics Jobs
Source: UNEP and others, 2008.

The countries that provide the most green-collar employment in the world are China, USA, Brazil and Germany, respectively. It is estimated that 12 million new green jobs will be created by 2030. It is expected that the current 500,000 green-collar workers in Turkey will soon find 100,000 [5]. Basic characteristics of green jobs, as shown in Figure 1; conservation of ecosystem and biological diversity, low waste and water pollution, low energy and water consumption, low greenhouse gas emissions. [6].

One of the most important factors in the development of green jobs and clean energy technologies of developed countries is investment in R & D. It is seen that R & D investment is not done as much as developed countries in Turkey as state and private sector. This suggests that R & D work should be developed in the direction of green technologies.

The application of green port based on volunteerism at world ports may become a necessity in the near future. In this case, ports with renewable energy technologies, which are engaged in green works, green collar workers, will be preferred by port users.

GREEN COLLAR WORKERS IN WORLD AND TURKEY

Green Jobs are defined as people working in the green collar. The benefits of green collar can be listed as;

- raw materials and reduce energy consumption,
- to restrict greenhouse gas emissions,
- waste and reduce pollution,
- to protect and improve the ecosystem,
- Businesses can be listed as to increase efficiency.

As seen in Table 1, green-collar engineering linked to TMMOB is defined in 2009. There are no marine engineering branches in the green collar.

When the employees in port operations are examined, engineers who have trained in different disciplines are employed as well as Environmental Engineer, Electrical Engineer, Mechanical Engineer. All kinds of managers, engineers, technicians and workers working in their fields are named as green-collar workers.

Table 1. According to TMMOB Green Collars and Other Engineerings;

Green Collars	Engineers
Environmental Engineer	Surveying Engineering
Electrical Engineer	Geophysical Engineering
Interior Architects	Geological Engineering
Civil Engineering	Chemical Engineering
Meteorological Engineering	Mining Engineering
Architects	Mechanical Engineering
Forestry Engineering	Metallurgical Engineering
Landscape Architects	
City Planners	
Textile Engineering	
Agriculure Engineer	

GREEN PORTS

Port; It is the artificial place where the buildings, warehouses and facilities are located, especially the boundaries, the vessels can safely load and pass by the passengers, the pavilions, the docks and the pier.

The green port is an area where voluntary environmental awareness is consistently provided by all businesspeople and services provided. Advanced ports are places where paperwork is reduced by using information technology and provided by innovations in loading-unloading technologies.

Achieving all operations with low carbon emissions is a major feature of green ports. By green port application;

• establishment of an integrated quality management system approach to the port facility.

• improving the quality of sea water environment of the port facility, protection.

• reduction of environmental pollution from ships or port operations.

• the maximum extent to ensure the highest level of energy saving and keeping the energy efficiency in port operations,

• arising from activities within the port limits and the reduction of harmful greenhouse gas emissions,

• to develop and implement renewable energy projects.

• reducing the amount of waste arising from port operations by providing recycling.

• take the necessary measures on occupational health and safety and is intended to ensure continuity of operations in the port [7].

Green port application is implemented by a number of ports in the world. This embodiment is regarded as a prestige element. The port operators will have the criteria to be considered as green port;

• Bulk Cargo Wharf / Pier / Terminal

• Bulk Liquid Cargo Wharf / Pier / Terminal

• Cruise Pier / Dock / Terminal

• Container Wharf / Pier / Terminal

• General Cargo Wharf / Pier / Terminal

• Ro-Ro / Tools Wharf / Pier / Terminal, can be listed.

Port businesses serving according to the load types listed above, they demand service according to load ships. The use of energy produced by renewable energy sources in terms of energy efficiency in the port area of 'Green Port' and served aboard reduces carbon emissions. [8].

CONCLUSION

The fact that Turkish ports are still heavily using traditional energy sources and the inadequate number of green ports means that the number of green-collar employees working in green ports is low. International agreements and generally accepted practices for reducing carbon emissions will become voluntary. In order to be prepared for this situation it is necessary to train specialist green collar workers.

Operational and theoretical environmental information is required at vocational education levels. Definite definitions of new and emerging green jobs and green collar concepts must be made in terms of green ports. Details of their duties and responsibilities should be given.

Various engineering related to green-fired professions have been defined in Turkey. Trained green-collar workers will be needed by the increase of 'Green Ports'. For this reason, it would be useful to define maritime engineering as a green-collar worker.

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SHIPBREAKING IN TURKEY AND IN THE WORLD

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ABSTRACT

Ship dismantling is a process in which the ships on the scrap heap and out of condition are decomposed and disassembled for regaining. It is quite important for some countries to dismantle ships because it has an important commercial part. For some countries, sector supplies opulent quantity of rerollable scrap steel to be used in metal and steel industries. The ship breaking and recycling industry creates numerous direct and indirect occupations in certain developing countries. For ocean-going ships, India, Bangladesh and Pakistan alone hold almost 70 to 80% of the recycling market, with Turkey and China covering a big part of the other market. Global scrapping volume other than these five countries are only 5%.

Keywords- Ship breaking, recycling industry, ship breaking statistics

INTRODUCTION

Ship breaking is the process of removing the vessel's structure for the purposes of scrapping. It includes certain activities from dismantling all gears and equipment to catting down the ship's main construction [1]. On average, after a ship has concluded its lifespan of approximately 30 years and it has begun to fail to meet the safety prerequisites, it is meant for breaking. Recycling is an environmental and sustainable way of scrapping of old vessels, with every single section of the hull and complex machinery getting reproduced and recycled as junk metal [2]. Vessel dismantling sector holds an important economic part in certain countries. In ship-breaking industry, due to the recycling in which the steel is recovered from the ship, it is expected for steel to constitute 90% in terms of value. Machines and equipment, furniture and fittings, asbestos, wood panels, oil, chemicals, electrical fittings, etc. stands for the remaining 10% [3]. A disused vessel may be consisted of several kinds of products such as solid, gaseous and liquid wastes. Vessel dismantling can be considered as a complicated procedure that requires several consequences such as labor safety, health and environment. Slowly by slowly, this sector is starting to be known as the most hazardous industry in the world [4]. The dismantling of vessel is a dangerous task. Recently, discussion about ship dismantling has primarily focused on health hazard and safety of the workers in this industry. Therefore, main factors such as compliance to environmental standards, hazardousness of the task and the technological costs has been the consequences that caused the relocation of this sector from the developed to the developing countries [2].

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The overall objective of the study is to provide information about the ship breaking in Turkey and in the world.

SHIP BREAKING ACTIVITIES

Ship dismantling were started in the USA and Europe in 1945 and proceeded until 1980. And, it drastically shifted through the continent of Asia during the early 1980s. Taiwan was one of the major locations for breaking during the 1980s, but nowadays they have mostly ended the activity of scrapping. China, India, Pakistan, Bangladesh and some other developing countries continued to be involved in the ship dismantling sector [4]. In the process, from capital-intensive to a labor intensive, a transformation of the ship-dismantling industry has occurred. Beside the sector is promising for the economic growth, over 100 000 people are working at ship dismantling sites in the world [5].

Ship Breaking in Turkey

Turkey started ship-dismantling in 1976. In 1984, due to liberalization measures of that time, official ship-breaking has started when the imported vessels were permitted for scrapping. Being the major ship dismantling site of Turkey, Aliaga is located approximately 50 km north of Izmir. Every ship breaker in Turkey are positioned in connection with the Aliaga waterside. Even though Turkey is an OECD country, neither environmental nor working conditions are not very different than other ship dismantling countries in Asia. In Aliaga, if dry docking is not a requirement, the sites are only considered as safe recycling facilities. Landing on the beach, pulling the ship and disconnecting it from the bow may require refining the methodology. It may be possible using pontoon bridges or barges along the vessel to accommodate the use of heavy machinery alongside the ship and by lowering the wave action on the grounded vessel. Approximately 100 vessels are recycled yearly and the recovered steel from the Aliaga is a significant part of the supply. Due to regulation to Control Hazardous wastes in 1995, Turkey no longer permits the import hazardous waste [5]-[8]. The number and tonnage of dismantled ships in Turkey are given in Table 1.

Table 1. Ship dismantled between 2005-2015 in Turkey [9].

Year	LDT	No of vessels
2005	111 000	83
2006	115 000	94
2007	128 000	73
2008	153 000	73
2009	298 000	127
2010	423 000	238
2011	653 000	341
2012	927 000	281
2013	802 000	232
2014	587 000	203
2015	602 000	113

Ship Breaking in the World

In industrialized countries such as Germany, United Kingdom, USA and Italy, ship dismantling was considered as a mechanized process. In 60s, the industry shifted towards semi-industrialized countries like Spain, Taiwan and Turkey. From the beginning of 80s, in order to minimize the costs, ship owners have began choosing the dismantling sites such as China, India, the Philippines and Vietnam, where labor standards were minimal and people were desperate for jobs. For ocean-going ships, India, Bangladesh and Pakistan alone hold almost 70 to 80% of the recycling market, with Turkey and China covering a big part of the other market [8]. There is only a little ship dismantling activity in Europe and the volume of Germany, Canada, UK, France and other "costly" OECD countries have not been investigated because of the lack of record of ship-dismantling. In the same way, USA was not in the industry. However, the authorities that own fusty naval vessels have licensed four American corporations for ship dismantling. The Mexican shipbreaking industry has downscaled over the last ten years. In the course of this paper, a corporation that has an admissible grade of compliance to environmental standards, opted to end its activities in the ship-dismantling sector [5]. Annual ship breaking volume of the largest ship recycling countries and global ship dismantling activity are shown in Table 2 and 3.

Table 2. Annual ship recycling volume of the largest ship recycling countries (GT) [10].

Country	2006	2007	2008	2009	2010	2011
Bangladesh	2 882 503	1 837 988	4 176 026	6 608 531	3 927 297	5 837 137
China	254 146	340 738	927 762	7 737 730	4 723 151	5 968 520
India	852 990	1 332 492	2 458 113	7 561 258	6 533 954	8 504 517
Pakistan	186 987	379 601	273 937	2 100 637	2 443 304	3 013 926
Turkey	148 448	117 817	141 351	557 251	658 473	1 067 425
Others	266 571	144 211	302 598	393 113	387 853	624 448
World Total	4 591 645	4 152 847	8 279 787	24 958 520	18 674 032	25 016 373

Table 3. Global ship dismantling activity [11].

Country	No of Vessels	Sum of LTD	% of all Vessels	% of LTD
India	2 245	16 135 949	58	45
Bangladesh	529	7 737 562	14	22
China	379	4 794 533	10	13
Pakistan	192	3 521 888	5	10
Vietnam	29	372 882	1	1
Mexico	18	75 746	0	0
Turkey	109	379 641	3	1
Spain	18	54 439	0	0
Unknown	241	1 255 762	6	4
Total	3 760	3 333 402	100	100

CONCLUSION

Ship dismantling have a potential due to its economical occasions for several laborers and promote to the economical development of certain countries, which requires private sector ventures. Actually, almost all countries in the world are somehow involved in vessel dismantling operations such as disposing smaller vessels which might otherwise be abandoned at ports, or sunk. But, the dismantling is carried out in an economically sustainable way and on a sectorial scale in certain countries. The communities around the world could help recycling countries to improve their ship dismantling yards and regulations to put an end to the competition, which compromises workers' safety and the environment. Consequently, if environmental protection and workers' safety continues to become a sub-standard, the community could dissuade the ship breaking.

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OIL SPILL CONTROL AND CLEANUP: ENVIRONMENTAL IMPACTS

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ABSTRACT

Oil spills result in serious adverse impacts on the marine environment. Current response to oil spill and cleanup performance needs to improve in order to comply with sustainable environmental protection measures. Oil spill control technologies in operation now are not adequate in ensuring environmental safety and sustainability of the ecosystem. Cleanup efforts are not environmental friendly and thus lead to serious hazards triggering often a public outcry. Hence, it is imperative to work towards sustainable oil spill response and measures. In this review article, we describe the current state of the art control techniques for responding to an oil spill. The various techniques for the containment, cleanup and recovery are examined; with advantages and disadvantages of each being considered. Along with, we shall discuss the environmental factors that can contribute to the success or failure of a sustainable cleanup operation.

Keywords – Environment, marine, oil spill cleanup, spill control, sustainable technology, and environmental impacts.

INTRODUCTION

Modern industrial society relies on oil for its mere existence Petroleum is one of the most important energy resources in the modern era. It is the main source of energy that fuels the machines and lubricates the wheels. This vital resource go out of control usually in the form of an oil spill, it can destroy marine life and devastate the regional environment and economy. The technology of oil; namely its extraction, its transport, its refinery, and use have outpaced legislations to control that technology and prevent oil from polluting the environment [1]. Oil in its many forms has been serving its intended purpose for it is efficient, versatile, and productive. On the other hand, when oil goes out of control, it can be one of the most devastating substances in the environment. Once a spill in water occurs, it spreads for miles around and devastates the regional environment and economy [2].

Oil spills impose serious damage on the environment. No matter large or small, spills have long been of concern worldwide. When oil is spilled into a marine environment, there occur several processes including spreading, drifting, evaporation, dissolution, photolysis, biodegradation and formation of water–oil emulsions [3].

Environmental Impact:

Environmental pollution needs to draw immediate attention of researchers, environmentalists, petroleum industry experts, and all those involved. An area contaminated by oil undergoes a whole

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change in the character of the environment and ecosystem. The most threatened ecosystems are those of sea and coastal area and are subjected to severe damages to the ecosystem as well as economical charges. When it has encountered something solid to cling to, whether it be a beach, a rock, the feathers of a duck or gull, or a bather's hair, it does not readily let go [2,4]. Oil slicks on water are attractive to water birds. Once a bird contacts the oil slick mass its feathers become soaked with oil. This result in death by drowning through loss of buoyancy, ingestion of oil, loss of body heat, and inability to fly that result in starvation or they become targets for predators. Fish in the vicinity swim into the floating oil, their bodies and gills become coated with oil, which in most cases would result into death. Otherwise their bodies absorb the taste and odor of the oil and so become unfit for human consumption for a long time. As the oil moves towards the land, it could bring death to marine life that inhabits the shallow waters near shore areas [4].

The history of oil operations was not environment friendly and not sustainable. Operations such as seismic exploration, drilling and production, processing and transportation have a negative impact on the environment. During exploration, seismic noise kills planktons including eggs, larvae of fishes, shell fish species, and juvenile fishes that are near the seismic guns [5].

The possible effects of pollution upon our recreational areas must also be considered. The usefulness of beaches for recreation suddenly ends. Snow-white cruisers and sailboats will show a dark smear at the waterline; small children after playing on the beach come home with oily feet; swimmers are coated with oil patches which cling to their skin and their hair [2]. In addition to aesthetic and ecological concerns, one must also consider the economic concerns. Coastal regions can suffer economically from damage done by oil spills to recreation areas, harbors and vessels, and commercial shellfish grounds. During summer months, beaches along the coasts of most maritime countries are crowded with people on weekend outings and vacations. Thus, there is considerable economic incentive in coastal recreation areas to protect beaches from spills or to clean them up quickly [4].

Many factors: local currents, weather, water temperatures and the composition of the oil itself, among others, affect the degree of long-term environmental damage from big oil spills [6]. Crude oil shipped in tankers varies from light oils similar to gasoline, to heavy compounds that resemble asphalt. Lighter elements evaporate quickly while heavier ones spread out on waves and ocean currents and sink. Heavy oil is more likely to be deposited in shorelines and can be extremely difficult to clean up if it washes onto soft, absorbent sand [6]. Moreover, heavy oils are largely insoluble, forming coherent masses, which float on the surface or become stranded on the shore, and can thus cause damage at a considerable distance from their point of release [7]. The heavy oil that eventually sinks can cover bottom-dwelling species, such as crabs, with a thick film and damage feeding and breeding species

There are countless opportunities for oil to get out of control. Many are due to mechanical failure of the equipment, or due to human carelessness and mistake. There are risks implicated in the materials involved and the means of transporting the oil. The risks involve terminals, loading docks, refineries, tankers, freighters, pipelines, tank cars, trucks, filling stations, just to name a few [2]. In addition, sea pollution may result from the production, refining, and distribution patterns, which have been, developed to meet ever-increasing fuel demands. The main petroleum producing areas in the world do not coincide with the areas of greatest consumption; the transportation of petroleum has increased with consumption. Subsequently, an increased chance of sea pollution by persistent oil is quite apparent. This increasing movement and storage of products has also increased the risk of inland water contamination [8, 9].

Environmental pollution and damage to ecosystem by oil can occur almost anywhere at any time. During the Gulf War of 1991 at the Kuwaiti and Saudi Arabian coast. 240 million gallons of light Arabian crude was spilled. One should note that 1 metric ton is equivalent to 358.3 U.S. gallons. Some major incident took place at Huntington Beach, California in 1990 and by Exxon Valdez 1989 Alaska. Exxon spent over $6.2 billion cleaning up the spill. There are still some deposits of oil under rocks. Amoco Cadiz occurred in 1978 in the English Channel where 68.7 million gallons were spilled. The spill affected the ecosystem of France's Brittany coast, contaminated beaches, polluted the fishery and killed habitat in the marshes. Now, fisheries have regained pre-spilled levels, but globes of oil-soaked sand still remain on the beaches [6]. Major oil spill incidents had been summarized and are reported in Table I. [10].

Table I. Some major oil spills since 1967 [10]

	Shipname	Year	Location Spill	Size, ton
1	Gulf War	1990	650oil wells set ablaze, Kuwait	1 million
2	BP	2010	160 km of shoreline, Gulf of Mexico	666,400
3	ATLANTIC EMPRESS	1979	Off Tobago, West Indies	287,000
4	ABT SUMMER	1991	700 nautical miles off Angola	260,000
5	CASTILLO DE BELLVER	1983	Off Saldanha Bay, South Africa	252,000
6	AMOCO CADIZ 8	197	Off Brittany, France	223,000
7	HAVEN	1991	Genoa, Italy	144,000
8	ODYSSEY	1988	700 nautical miles off Nova Scotia, Canada	132,000
9	TORREY CANYON	1967	Scilly Isles, UK	119,000
10	SEA STAR	1972	Gulf of Oman	115,000
11	IRENES SERENADE	1980	Navarino Bay, Greece	100,000
12	URQUIOLA	1976	La Coruna, Spain	100,000
13	HAWAIIAN PATRIOT	1977	300 nautical miles off Honolulu	95,000
14	INDEPENDENTA	1979	Bosphorus, Turkey	94,000
15	JAKOB MAERSK	1975	Oporto,Portugal	88,000
16	BRAER	1993	Shetland Islands, UK	85,000
17	AEGEAN SEA	1992	La Coruna, Spain	74,000
18	SEA EMPRESS	1996	Milford Haven, UK	72,000
19	KHARK 5	1989	120 miles off Atlantic coast of Morocco	70,000
20	NOVA	1985	Off Kharg Island, Iran	70,000
21	KATINA P	1992	Off Maputo, Mozambique	67,000
22	PRESTIGE	2002	Off Galicia, Spain	63,000
23	EXXON VALDEZ	1989	Prince William Sound, Alaska, USA	37,000
24	HEBEI SPIRIT	2007	Taean, Republic of Korea	11,000

The cleaning up response is time-consuming, difficult, and quite costly moneywise. Damage could extend for months or years ahead to fish and other wildlife habitat, to property, contamination of public water supplies, and many other losses [2]. It must be emphasized that a key element in any effort aimed at limiting the consequences of a major oil spillage incident will be the ability to rapidly respond with contingency countermeasures [11].

People's health could be adversely affected by oils either when inhaling or touching oil products, or when eating contaminated sea food [12]. Protective clothing and a face mask or filter mask are required for protection against risks from contact with lingering oil on beaches and inhaling vapors.

As mentioned above, concentrations of petroleum contaminants in fish and crab tissue, as well as contamination of shellfish, could pose a significant potential for adverse human health effects.

Sustainable Cleanup and Recovery Technology:

Sustainability is the primary concern moral for technological development to be accountable for their effects on the natural environment and future generations [8, 13]. A truly sustainable process conforms to the natural phenomena, both in source and process. The concept makes important links between environmental conservation and socio-economic as regards the quality of life) but debatable issues include the balance between hard and soft sustainability. In other words, how the environment is valued; and how to address the dominance of unsustainable vested interests. Scientifically this means that true long-term considerations of humans should include the entire ecosystem [14].

Therefore a true sustainable technology should have the harmony with environment. On the other hand, an unsustainable technology is one which has adverse environmental impact in the long run while a sustainable technology has a good effect in the long run. Hence time criterion is the main factor in achieving sustainability. According to Khan and Islam [15], sustainability can be assessed only if technology emulates nature. In nature, all functions or techniques are inherently sustainable, if and only if they are efficient, beneficial, and functional for an infinite span of time, i.e. $\Delta t \rightarrow \infty$ [15].

Unfortunately, most of the current cleanup techniques that will be categorized below focus only on short term effects. Nonetheless, they have the potential to adversely affect the environment in the long term thus rendering them unsustainable.

Natural absorbents have a great potential in development of a sustainable technology to combat oil spills. Such absorbents include agricultural products, human hair, and animal skins, furs have been found to possess high absorption capacity.

It is important to look at the current state of technology of containment and control of major oil spillage on water, and the various techniques for the recovery of the oil. Each technique should be examined and its advantages and disadvantaged must be considered. In addition, environmental and sustainability factors, which can contribute to the success or failure of a cleanup operation, must also be examined.

CONTAINMENT, CLLEANUP, AND RECOVERY OF OIL SPILLS

The major countermeasures for combating oil spills are: mechanical containment and collection; use of chemical dispersants; and natural removal that does not require cleanup measures. Countermeasures that are less widely used or have major limitations are Burning, sinking, absorption and enhanced biodegradation are not of limited use and. Environmental sustainability is paramount in determining the countermeasure of choice [15].

Mechanical Recovery:

Mechanical recovery is the transfer of oil from the water surface to some transportable form of temporary storage by the help of booms to contain or divert oil, skimmers or sorbents to recover or remove it from the water surface, hoses, and pumps [16]. Mechanical method involves the use of booms to prevent the spread of oil slicks [17].

A boom is a floating barrier used to contain oil, they are mechanical barriers, which extend above and below the water surface. They are used to: 1) divert oil spills to areas where cleanup can be performed, 2) contain and concentrate spilled oil, and 3) protect environmentally sensitive areas threatened by oil spills [11]. The booms are combined to make 'V' shaped barriers which concentrate the oil for pickup by the skimmer barges and boats [16]. Booms are of particular interest in the protection of environmentally sensitive areas threatened by oil spills [11].

Skimmers are used for the recovery of the oil [18]. They ought to be brought very quickly to the scene before the oil spreads out into a thin layer. A large number of skimmers ought to be readily available at each of the most vulnerable places at all times [11]. Skimmers work most efficiently on a relatively thick and continuous layer of oil but, as they operate, they necessarily deplete this layer in their immediate vicinity [11].

Oceanic conditions, weather, and the nature of the oil slick can adversely limit the performance of this equipment [4]. The thickness of the slick is dependent on the amount of time the oil spends on the surface, the type of oil spilled, and its viscosity. Expediency in taking countermeasures is the principal factor in cleanup. The rate of mechanical oil recovery decreases with a decrease in oil thickness. For effective oil recovery, proper deployment of equipment is a must be employed at locations such as: 1) exposed waters of the open sea, 2) the more sheltered waters of narrows and estuaries and of harbor entrances, 3) rivers, and 4) enclosed waters of harbors and lakes.

Chemical Dispersants:

Spilled oils on water rapidly spread into a slick having thickness form several millimeters down to one micrometer depending on the oil type and the area available for spreading. Use of dispersants is the most widely utilized method [19]. Nonetheless, their usages could be restricted to sufficiently deep water where proper agitation will result in rapid dilution will take place and so toxic effect will be minimized at the sea bed [20]. They are able to treat large areas compared to other methods. Dispersants consist of different surfactants (i.e. surface active "soap-like" molecules). When it is sprayed on an oil slick, the surfactants reduce the interfacial tension between the oil and water [21]. This will enhance dispersion and increase the natural dilution and biodegradation process of oil in water.

Wind-driven waves and other turbulence can break up the slick, producing more or less spherical droplets ranging in size from a few micrometers to a few millimeters. Sometimes, these droplets can be stabilized by natural surface-acting agents (surfactants) present in the oil or contributed by the sea-surface micro layer [22].

However, ecological considerations, experience, and recent technological developments in the handling of oil spills have pushed the chemical dispersant very much out of the picture [23]. They are expensive and contain toxic compounds harmful to aquatic fauna and flora. For example, a research into fish health after the Exxon Valdez Spill of 1989 showed that the developing hearts of pacific herring and Pink Salmon embryos are affected [24. This could affect food industry and would adversely impact humans including respiratory, nervous system, liver, and kidney and blood disorders [25]. If the oil is dispersed into small volume of water with poor circulation, the ecological impact of dispersants may in fact be increased [4]. Dispersants may be especially valuable when other countermeasures fail.

Most oils spilled on water rapidly spread into a slick, with thickness form several millimeters down to one micrometer depending on the oil type and the area available for spreading. Wind-driven waves and other turbulence can break up the slick, producing more or less spherical droplets ranging in size from a few micrometers to a few millimeters. Sometimes, these droplets can be stabilized by natural surface-acting agents present in the oil or contributed by the sea-surface micro layer. They contain molecules with both water-compatible (hydrophilic) and oil-compatible (hydrophobic) portions; cf. Figure 1. These surfactants stabilize the droplets by orienting at the oil-water interface with the hydrophobic part of the surfactant molecule in the oil phase and the hydrophilic part in the water phase, thereby diminishing the interfacial tension [4]. Chemicals of various types are available for this purpose and have been known by a variety of names, including dispersants, detergents, solvent/emulsifiers, emulsifying agents, etc. [9]. Application of chemical dispersants to a slick greatly increases the amount of surfactant available and can reduce oil-water interfacial tension to very low values. The interface stabilized by the surfactant, permits droplets to survive despite frequent collision with adjacent droplets [21].

Utilization of chemical dispersants is more rapid in the recovery of oil in comparison to mechanical means. Aerial spraying of chemical dispersants is usually the preferred method of application at sea. Prior to application of dispersants, its impact on the habitats needs to be examined. Although, marine ecosystems, such as salt marshes, mangroves, and coral reefs, and bird nesting areas are extremely sensitive to damage by oil [8]. On the other hand, dispersants may be applied once it is judged that the impact of dispersed oil on organisms, habitats, and ecological processes will be less than that of oil alone [4]. Dispersants warrant use in case of large spill in the whale migration corridor during late August and in the case of oil slicks threatening a shoreline containing a large bird population [11].

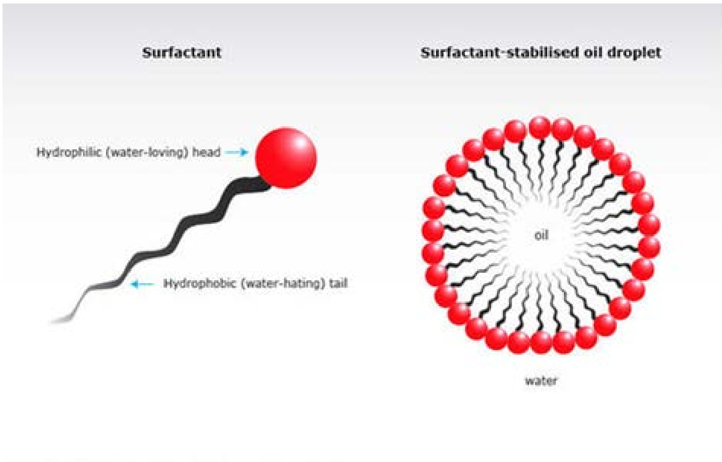

Figure 1. How do dispersants work? [21]

Shoreline Cleanup & Natural Cleanup:

Spilled oil could be stranded on shorelines. Removal countermeasures include using mechanical means: flushing, manual pickup, or by physically removing the substrate. In general, shoreline cleanup is an expensive and often could lead to environmental damage [11]. Oil slacks could be left alone and so will eventually be removed from water surfaces and shorelines by different natural means; including evaporation, photo-oxidation, physical dispersion, sedimentation, and biological degradation. These processes are quite slow and might take several years, but still acceptable practice in remote areas [4].

In-situ burning of oil slick:

This technique removes large spills by burning a relatively thick oil slick on the water surface. In order for oil on water to burn, the slick must be relatively fresh and at least 3 mm thick. An amount of 100-300 tons of oil could be removed per hour [26]. Ignition of an oil spill is performed using device such as Helitorch, a sort of flame-thrower suspended beneath a helicopter or a diesel-soaked rag dropped from the helicopter. Fire proof U-shaped booms are used to contain a large slick in place in order to carefully set it ablaze.

This technique is limited by a number of problems. Large amount of smokes can result in oily rain. In 1983, the fire accident on board resulted in clouds of black smoke that led an oily rain falling on farms up to 80 km inland contaminating farms in South Africa [27]. It is important to recognize that the combustion products from burning can travel great distances before falling to earth. In view of the environmental risk associated with burning .An incident occurred in 1992 where black cloud of smokes on board a tanker Aegean caused soot deposition on buildings and city structures in Spain [27]. However, burning is an effective clean up method where spilled oil is somehow constrained as in the Arctic and [4].

The formation and possible sinking of extremely viscous and dense residues damage the sea bed and its inhabitants. The viscous residues might be transported to shorelines and beaches that would have adverse environmental impacts.

An additional major concern is the incidence of air borne diseases when combustion has occurs close to residential areas. Carbon monoxide, Sulfur dioxide, polycyclic aromatic hydrocarbons (PAHs) are the common toxic compounds emitted while burning oil on water.

Sinking:

The addition of chalk or treated sand has been used or proposed as a means of sinking oil. However, sinking is seldom completely effective initially, and some oil tends to resurface. Moreover, oil that sinks to the bottom contaminates benthic life and degrades more slowly than when floating, dispersed, or dissolved in water [4]. A large number of powdered and granulated materials of high density are available which, if distributed over the oil, will absorb it and sink it. There are difficulties, of course, in applying light powdery materials in open-sea, such as windy conditions. A more serious drawback is that many sinking materials do not render the oil permanently immobile and release of the oil, causing re-pollution after some time, can normally be expected [9].

Bioremediation:

Being a hydrocarbon, constituents of oil degrade naturally when attacked by bacteria, algae, protozoa, and marine fungi. Microbes that degrade hydrocarbons are readily available everywhere in nature, except in polar waters where the rates of breakdown are very slow and variable [28]. Biodegradation is the option of choice to protect the environment mainly shorelines, wetland and other marshy areas covered by spill from further damages. Biodegradation is ineffective in removing oil spills that consist of large coherent masses and for sunken oil spills [4, 29]. Biodegradation is also limited by abiotic environmental factors such as a low level of nutrients, very low temperature and insufficient oxygen [30].

Sorbents:

There are numerous inorganic materials that are known as sinking absorbents are highly dense, fine grained mineral materials either natural or processed used to sink floating oil. For example stearate-treated chalk and silicone-treated pulverized fly ash, zeolites, graphite, activated carbon, organoclay, silica, and silica gel. They have drawbacks such as contamination of sea beds and adverse effects to aquatic habitats, as well as the release some of the absorbed oil while [23, 25]. Most important is that they are very expensive absorbents and thus are not commonly used. Absorption is applied mainly in the process of manual removal of small spillage of light fluid oils.

Care must be taken in the disposal of the oil-soaked agglomerate, preferably by scooping it into containers [7].

Synthetic organic sorbents, on the other hand, are the most widely used made from high molecular weight polymers such as polyurethane and polypropylene. They have good hydrophobic and oleophilic properties and high adsorption capacity, can absorb 100 times their weight of oil from oil-water mixtures [31]. Polyurethane foam can be recovered and reused in a mechanized process. However, a mechanized system incurs an additional cost.

Sustainable Technology: Natural and Agricultural Sorbents.

The usage of toxic chemicals in the previous conventional cleanup processes makes such countermeasures unsustainable in terms both for the short-term and long-term. Synthetic sorbents yields processes that are completely unsustainable. Alternatively, natural sorbents coming from agricultural products could embrace the sustainability principles by having regard for the environment and the ecosystem in addition to social responsibility concerns according to local people wishes. Most leaf-like plants when dry contain some natural oils and/or waxes which impart affinity for oil and subsequently water. Dry plants are light weight enough to float on water. Some agricultural products are efficient in oil cleanup process. Examples [8] are included here as straws [35], sugar cane bagasse [36], cotton [37], corn cobs [38], saw dust and peat moss [39], pine bark [40, 41], activated carbon [42], wool [43]. It has also been shown that some agricultural products such as straws, cellulosic fiber, milk weed, and cotton fiber significantly absorb more oil than synthetic polypropylene used commercially [35]. Furthermore, human and animal hairs have been shown to display strong absorption capacity for oil. However, these products are not given adequate attention in the oil industry. It is well known that every technology has its own limitations.

The application of agricultural sorbents is mainly limited by its high cost in recovering the oil soaked sorbent, removing the oil, and re-dispensing the sorbent. In case, agricultural or natural sorbents are limited to shorelines and smaller water, then the cost limitation can be overcome. It is believed that improvement on the agricultural technology will overcome this shortcoming in a very short period of time so that their usages for offshore will be equally cost effective. Natural sorbents do not pose any harm to the environment and its habitats unlike synthetic sorbents that harm the environment and habitat. [44]. Thus, the usage of natural sorbents can save our environment in a sustainable fashion.

CONCLUSIONS

In this article the various oil spill cleanup methods had been reviewed as well as their limitations and environmental impact. To be effective, an oil spill recovery operation must be seen as a whole. Since an oil spill usually spreads quickly and in doing so rapidly escalates the scale of the recovery problems, speed of action is crucial. Knowledge is required of the source of the oil, estimates of the amount that has already leaked and of the possible maximum amount of oil at risk. Mechanical containment and recovery provide the appropriate cleanup method.

Concepts of sustainability for oil spill control are accounted for. It is clearly apparent that natural sorbents provide the best sustainable spill cleanup technique that could overcome the limitations and non-sustainability of the existing cleanup countermeasures.

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DETERMINING REASONS OF DECOMMISSIONING IN A SHORT SPAN TIME FOR SEAFARERS WITH DEMATEL METHOD

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ABSTRACT

Recent acceleration and development in maritime trade has lead to increase the demand for the educated seafarers and created a deficit of well-trained crew supply for merchant ships. This problem becomes a high priority in maritime industry for some countries including Turkey. Turkish maritime companies suffer from well-trained experienced seagoing officer deficit. Compared to some other professional trade activity areas the working periods in a maritime company as a merchant ship officer is relatively short. After several years of working on a shipboard, officers tend to quit their jobs or looking for some other opportunities to work onshore. Therefore, a dynamic manning policy cycle is generally followed by human resources departments of the maritime companies which may adversely affect the overall productivity level of a ship or company. Therefore, there is an explicit need to search for, "why the maritime officers want to quit their positions on aboard ship in such a short period?" In this study, the reasons of job quitting among merchant ship officers were investigated by using multi criteria decision making approach. DEMATEL technique was applied to find the main causes of the problem and model the inner relationships among different factors affecting the officers' decision. Finally, some recommendations were suggested for the solution of the manning policy of the maritime industry.

Keywords: Maritime, Seafarers, MultiCriteria Decision Making, DEMATEL.

INTRODUCTION

Maritime is defined as a profession that jas been internationally accepted and has been a choice for people who had intellectual aspects and also who had overcome many challenges. These features of the profession have been at the forefront from geographical discoveries to the present in many ways [1 – 2]. Marine has always been a profession that requires effort and different from other professions. Work life below deck is strictly a different world than working on land, literally [3]. Maritime, unlike other professions, requires the performers to be isolated from the normal community, to work in a manner that they had been imprisoned inside a ship and to have a limited social life thereby keeping away from home for a considerable period of time [4]. It having said that maritime is a lifestyle as well as it is a profession. Seafarers, ranging from their job description to their place in the overall

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economic system, had been kept separate from other occupational group members and sometimes they had not been taken into account, and so, they sometimes have been forgotten.

Recently, with developing technology and ever-changing rules in the maritime shipping sector, more qualified and trained staffing needs is increasing. It distinctively attracts the attention that maritime sector deficit of manpower who will be employed on board has reached very high levels in Turkey when the last fifteen-year period examined. This situation in the maritime sector can lead to a variety of difficulties from the standpoint of human resources. At the same time, ships are extremely different workspace than the existing workspace onshore. Work life of vessels due to live out of a suitcase affects working conditions and living standards of seamen in the ships by reason of a number of factors such as the port conditions particularly, marine traffic, weather and sea condition. So, it triggers early decommissioning of seafarers and causes to be inability to overcome the inadequacy of the personel [1 – 5 – 6].

The volume of trade that carried by sea in the world, followed by about 8.5% of growth in 2010, has continued to grow in 2014 with 5.9% growth. Turkey, surrounded by sea on three sides, has a quite low market share from world maritime market that was ever-growing. The most important factor here is operation of vessel that could not been done appropriately in the maritime sector and in its center it is located to not place the necessary importance to the development of human resources [7].

The experienced and competent officer rank seaman is less than the number of staff needed in Turkey. Especially in the last decade seafarer resource shortage could not have been met, although nevertheless the number and quotas had been increased YÖK (Higher Education Council) directorial colleges and faculties. The sea trial experiences of Turkish and European officers are also different from each other. European countries has more experienced shipmaster potential compared to Turkish shipmasters who have been determined as they have average experience of 10 years, 3 months and 18 days. It is seen that difference is stem from Turkish crew assessments concerning sea related positions on land instead of working at sea. The reason of this preference is needed to investigate in its internal structure of the profession [8]. It has become traditional in any study related to seafarers that mention about ever-increasing seafarer shortage in future. In order to come up with a solution İt is important to state business expectations and dissatisfaction of seafarers thereby determining their profiles in the profession as well as increasing the number of officers. The objective of this study is to determine the reasons why seafarers leave the profession and the factors lead to short-term work at sea. The degree of dependency determination with each of these factors, presence of qualitative and quantitative reasons together and a proper solution to this problem are possible only with the use of scientific method in the decision-making process. Therefore, it has been tried to determine the reasons of decommissioning in a short span of time and their relationship with each of these reasons and also to propose a solution to problem by using DEMATEL method which is one of the multi-criteria decision-making models. Thus, it is considered as this study will have importance in terms of human resource management in the maritime sector.

METHODOLOGY

In this study, it has been determined the reasons of leaving the profession by another expression leaving working in a ship of Turkish seamen and the processes that lead to this decommissioning by extensive analysis and research [9 – 10]. There are, a large number of and related to each other conflicting and complex systems requiring decision-making which are forming this process as reasons of leaving the maritime profession. It makes a complex structure of the decision-making process in the sense that the presence of a large number of options and evaluation criteria, different benefits of each option to decision makers, the information necessary for decision-making which mostly could not be obtained notably and accurately and so the risk of erroneous decision and determination [11 – 12] Fuzzy multi-criteria decision-making methods are used to achieve the ideal and the practical results on the such complex problems difficult to model and which needs for experts' views. In the applications under study, the evaluation of the weighted reasons for seafarers leaving work at sea has been exploited DEMATEL method. In this way, a process has been obtained that decision makers express judicial decisions verbally and they unable to make judgement objectively. In addition, it has been aimed to present a realistic and applicable solution, and a more concrete set of alternatives thereby taking stochastic and subjective assessments of decision-makers into certain mathematical limits. The method and process used during the application phase are summarized below.

DEMATEL Method

In generally, the DEMATEL method is used to illustrate the relations between criteria and to reach the main factor/criteria to symbolize the impact of factor [11- 13- 14]. The DEMATEL method is established on digraphs which can discrete involved factors into cause and effect groups [15 - 16]. This method has also been individually used in many activities such as safety problems [17], transportation [18], supply chain management [16] , automotive industry [14] and maritime safety [11].

The DEMATEL method is briefly described as follow [12 – 14 – 17 -18].
Step 1: Calculating the direct-relation matrix. Suppose we have L experts in this study and n criteria to consider. Firstly, the relationship between criteria requires that the comparison scale be designed as with five levels, where scores ranging from 0 to 4 represent ‘‘no influence’’ to ‘‘very high influence’’, respectively. Experts are answered the direct influence degree between criterion ‘’u’’ and criterion ‘’v’’, as indicated by Zuv. The initial direct-relation matrix Z=[Zuv]|Y| is determined owing to pairwise comparisons in terms of influences and directions between criteria. Then, as the result of these evaluations, the initial data can be obtained as the direct-relation matrix that is a matrix Z, in which a Zuv is denoted as the degree to which the criterion u affects the criterion v. The scores by each expert will give us a ‘’n x n’’ non-negative answer matrix $X^k = [X_{uv}^k]_{nxn}$, with $1 \leq k \leq L$. Thus, $X^1, X^2, \ldots, X^L$ are the answer matrices for each of the L experts, and each element of is an integer denoted by X_{uv}^k. The diagonal elements of each answer matrix X^k are all set to zero. We can then compute the ‘’nxn’’ average matrix Z for all expert opinions by averaging the L experts’ scores as follows:

$$[Z_{uv}]_{nxn} = x = \frac{1}{L} \sum_{k=1}^{k} [X_{uv}^k]_{nxn} \quad (1)$$

Step 2: Normalizing the direct-relation matrix. The normalized direct-relation matrix M can be obtained by equation 2 and 3:

$$M = Z \, x \, L \quad (2)$$

$$L = \frac{1}{max_{1 \leq u \leq n} \sum_{v=1}^{n} Zuv} \quad , u, v = 1, 2, \ldots..n \quad (3)$$

Step 3: Calculating the total-relation matrix. After the normalized direct-relation matrix M is obtained, the total relation matrix K can be acquired by equation (4), in which the H is represented as the identity matrix.

$$K=M \times (H - M)^{-1} \quad (4)$$

Step 4: The sum of rows and columns are separately denoted as D and R within the total-relation matrix K through equations (5) to (7).

$$K= [k_{uv}]_{u,v=1,2,3,\ldots n} \quad (5)$$

$$D= (D_u) =(\textstyle\sum_{v=1}^{n} k_{uv}) \quad (6)$$

$$R= (R_v) = (\textstyle\sum_{u=1}^{n} k_{uv}) \quad (7)$$

The DEMATEL method analysis was used to obtain the initial direct-relation matrix with using pairwise comparison with the total relation matrix with “D+R”, “D-R” values and build a critical relative graph of criteria in the cluster effect. ‘’Du’’ denotes the row sum of “i”th row of matrix K. Then, “Du” denotes the sum of influence dispatching from factor v to the other factors both directly and indirectly. “Rv” shows the column sum of “v”th column of matrix K. “Rv” shows the sum of influence that factor u is receiving from the other factors. The sum of row sum and column sum (D + R) shows the index of representing the strength of influence both dispatching and receiving. Furthermore, if (D- R) is positive, then the factor ‘’u’’ is rather dispatching the influence to the other factors, and if (D - R) is negative, then the factor ‘’u’’ is rather receiving the influence from the other factors.

Step 5: Determining a threshold value to obtain the digraph. Since matrix K provides information on how one factor affects another, it is necessary for a decision maker to set up a threshold value to reduce some negligible effects. For these reason, only the effects greater than the threshold value is chosen and shown in digraph. In this study, the threshold value is set up by computing the average of the elements in Matrix K. The digraph can be acquired by mapping the dataset of (D+ R, D-R).

Empirical Study

An empirical example for the most important criteria selection for the reasons of decommissioning in a short span time for seafarers is illustrated to demonstrate the proposed method to be more rational and suitable in this section. A decision making team were invited to answer the questionnaire. The computation of using DEMATEL method is based eight decision making team’s opinions (To establish the network relationships among criteria in influence each other for the selection of the reasons of decommissioning in a short span time for seafarers a decision making team which includes 4 captain who left work at sea, 2 maritime academicians, 2 captain who still actively working at sea with long term working experience. The criteria and sub-criteria have been determined according to the review of literature and review with seafarers and then these major influencing criteria and sub-criteria involved in the reasons of decommissioning in a short span time for seafarers are given in Table 1.

Table 1. The Criterias of Decommissioning in a Short Span Time for Seafarers

The Criterias of Decommissioning in a Short Span Time for Seafarers

1- Undisciplined Life Style (R1)	8- The lack of career for future (R8)
2- Personal / familial problems (R2)	9- Working Conditions on Board (R9)
3- Lack of Social Life (R3)	10- Stay Away From Family (R10)
4-Ship Hierarchy (R4)	11-Rise of Maritime Piracy (R11)
5- Health Problems (R5)	12- The lack of career future (R12)
6- Low-Paid Job (R6)	13 -Difficulty Maritime Rules (R13)
7- Insufficient time for holidays (R7)	

Then, decision making team E1, E2, . . . E8 is constituted to determine the network relationships. And give the performance scores for each expert in terms of all criteria in the evaluation hierarchical structure respectively. A questionnaire was used to find out influential relations from each expert for ranking each criterion on the appropriate selection of decommissioning in a short span time for seafarers criteria with a four-point scale ranging from 0 to 4, representing from ‘No influence (0),’ to ‘Very high influence (4),’ respectively. For each pairwise comparison, the decision making team have to determine the intensity of the relative importance between two criteria.

The computation of using DEMATEL technique is based upon these eight experts’ opinions. So there are 8 dimensions, the eight 8 X 8 matrices. The computation of using DEMATEL method is based eight decision making team’s opinions. Using the 8X8 pairwise comparisons, the averages of their opinions were calculated. Then, the average initial direct matrix Z is obtained based on Eq. (1) as Table 2.

Tableti 2. Initial direct matrix Z.

Criteria	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13
R1	0.125	0.518	0.345	0.885	0.355	0.818	0.200	0.385	0.923	0.525	0.022	0.248	0.703
R2	0.320	0.278	0.564	0.510	0.188	0.302	0.388	0.108	0.818	0.301	0.248	0.347	0.259
R3	0.525	0.209	0.070	0.331	0.248	0.525	0.502	0.091	0.302	0.564	0.347	0.102	0.321
R4	0.301	0.474	0.329	0.212	0.347	0.301	0.419	0.209	0.022	0.070	0.102	0.278	0.861
R5	0.202	0.395	0.258	0.345	0.023	0.564	0.256	0.474	0.248	0.329	0.022	0.209	0.921
R6	0.01	0.811	0.151	0.014	0.458	0.070	0.506	0.395	0.347	0.921	0.703	0.278	0.387
R7	0.874	0.921	0.445	0.923	0.501	0.329	0.323	0.612	0.102	0.387	0.259	0.209	0.142
R8	0.235	0.387	0.895	0.818	0.472	0.258	0.612	0.703	0.278	0.142	0.321	0.474	0.802
R9	0.014	0.142	0.012	0.302	0.385	0.188	0.703	0.095	0.209	0.022	0.861	0.395	0.729
R10	0.178	0.802	0.095	0.022	0.108	0.248	0.259	0.258	0.474	0.307	0.445	0.345	0.307
R11	0.470	0.729	0.258	0.307	0.091	0.347	0.321	0.710	0.395	0.125	0.895	0.564	0.125
R12	0.658	0.019	0.710	0.125	0.905	0.102	0.861	0.365	0.095	0.547	0.012	0.070	0.547
R13	0.258	0.710	0.365	0.547	0.827	0.118	0.017	0.090	0.258	0.347	0.095	0.329	0.307

Normalized initial direct-relation matrix M is calculated through Eqs. (2) and (3). Sequentially, the total relation matrix K is also derived utilizing Eq. (4) shown in Table 3.

Table 3. Total influential relation matrix K.

Criteria	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	RV
R1	0.752	0.318	0.305	0.410	0.155	0.781	0.313	0.781	0.567	0.301	0.313	0.205	0.527	**5,728**
R2	0.627	0.250	0.660	0.202	0.408	0.345	0.567	0.781	0.762	0.670	0.762	0.214	2.742	**8,99**
R3	0.680	0.257	0.029	0.801	0.540	0.202	0.762	0.214	0.313	0.555	0.313	0.122	0.781	**5,569**
R4	0.527	0.410	0.509	0.781	0.745	0.801	0.313	0.122	0.762	0.522	0.513	0.410	0.410	**6,825**
R5	0.752	0.202	0.718	0.345	0.247	0.781	0.513	0.410	0.313	0.205	1.106	0.202	0.921	**6,715**
R6	0.280	0.801	0.301	0.202	0.228	0.781	1.106	0.202	0.513	0.214	0.627	0.122	0.513	**5,89**
R7	0.104	0.781	0.670	0.801	0.841	0.214	0.558	0.801	1.106	0.122	0.680	0.410	0.797	**7,885**
R8	0.135	0.214	0.555	0.781	0.262	0.122	0.513	0.781	0.278	0.410	0.527	0.781	0.489	**5,848**
R9	0.214	0.442	0.522	0.214	0.470	0.781	0.797	0.759	0.513	0.202	2.742	0.781	0.783	**9,22**
R10	0.308	0.622	0.205	0.122	0.228	0.410	0.489	0.313	0.797	0.313	0.781	0.214	0.661	**5,463**
R11	0.476	0.700	0.158	0.787	0.501	0.202	0.783	0.029	0.489	0.762	0.410	0.122	0.025	**5,444**
R12	0.558	0.403	0.310	0.223	0.225	0.801	0.661	0.509	0.783	0.313	0.202	0.270	0.747	**6,005**
R13	0.208	0.307	0.305	0.107	0.127	0.781	0.122	0.718	0.661	0.303	0.181	0.129	0.347	**4,296**
DU	**5,621**	**5,707**	**5,247**	**5,776**	**4,977**	**7,002**	**7,497**	**6,42**	**7,857**	**4,892**	**9,157**	**3,982**	**9,743**	

Total sum of effects given and received by each criterion is seen in Table 4 using Eqs. (6) and (7). Table 4 provides the direct and indirect effects of eight dimensions. Finally, the threshold value (0.6005) used in Step 5 is to compute the average of the elements in Matrix K. The digraph of these six dimensions is demonstrated and the network relationship map of DEMATEL method was obtained and shown in Fig. 1. The criteria above the threshold in Figure 2 is marked in bold and and these 7 criteria were taken into evaluation.

Table 4. Sum of influences given and received on each criterion.

Criteria	Du + RV	Du - Rv
R1	**11,349 (2)**	**0,048**
R2	**14,697 (1)**	**-4,013**
R3	5,569	-5,569
R4	**6,825 (5)**	**-6,825**
R5	**6,715 (6)**	**-6,715**
R6	5,89	-5,89
R7	**7,885 (4)**	**-7,885**
R8	5,848	-5,848
R9	**9,22 (3)**	**-9,22**
R10	5,463	-5,463
R11	5,444	-5,444
R12	**6,005 (7)**	**-6,005**
R13	4,296	-4,296

Table 4 shows that personal / familial problems (R2) is the most important dimension with the largest (D + R) value of 14,697 whereas difficulty maritime rules (R13) is the least important dimension with the smallest value of 4,296. The importance of dimensions can be determined by the (D + R) values. To further investigate the cause-effect relationship of dimensions, undisciplined life style (R1) is net causes based on positive (D - R) values.

Except of undisciplined life style (R1), other criterias are net receivers due to negative (D - R) values. Furthermore, these criterias are the most essential dimensions to improve the decommissioning in a short span time for seafarers by further considering the causal relationships. Therefore, undisciplined life style (R1) is the most essential dimensions to improve the decommissioning in a short span time for seafarers by further considering the causal relationships.

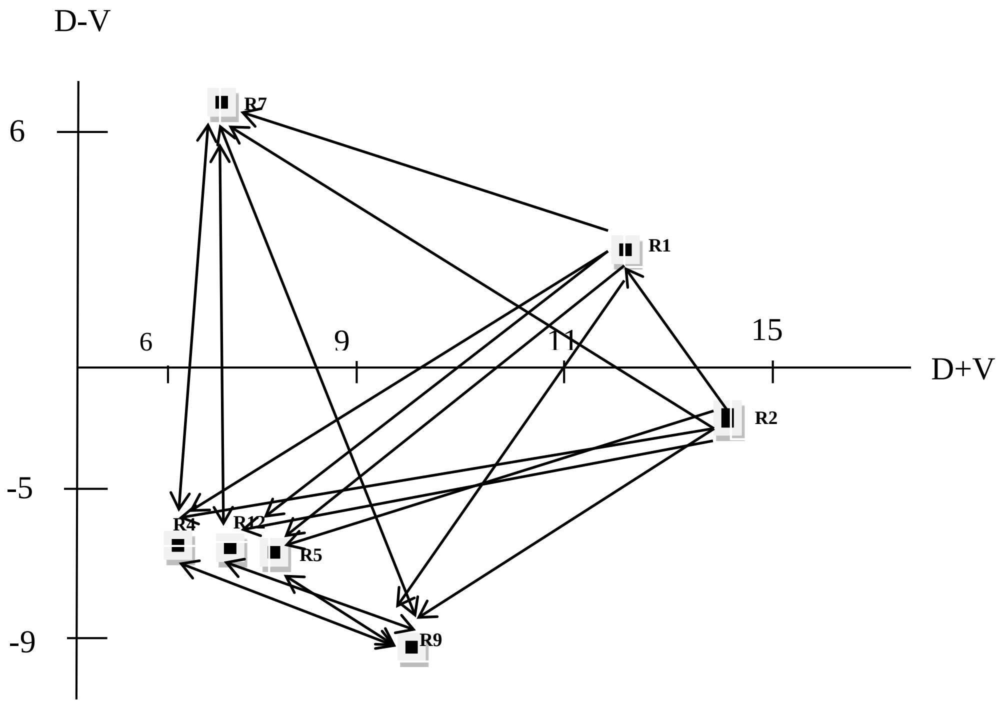

Fig. 1. The impact-digraph map of total relation.

RESULTS AND DISCUSSION

According to the weights of each sub-criterion, clusters of highly contributing factors appeared in first impressions from the results. Considering the distances between the priority weights is an ideal philosophy to eliminate factors which do not deal with the occurrence of decommissioning in a short span time for seafarers. personal / familial problems (R2) is the most important dimension with the largest (D + R) value of 14,697 whereas difficulty maritime rules (R13) is the least important dimension with the smallest value of 4,296. The importance of dimensions can be determined by the (D + R) values. To further investigate the cause-effect relationship of dimensions, undisciplined life style (R1) is net causes based on positive (D - R) values. The top five priorities in the evaluation systems are: Personal / familial problems (R2), Undisciplined Life Style (R1), Working Conditions on Board (R9), Insufficient time for holidays (R7), Ship Hierarchy (R4) and the least important criteria is Difficulty Maritime Rules (R13). After the weights of the evaluation systems are determined, the selection of decommissioning in a short span time for seafarers criteria can be easily obtained by the proposed method. Consequently, the proposed MCDM method ensures evaluation of active and latent selection of beach area criteria quantitatively.

As a result, leaving working in the marine environment of seafarers can be defined as being far from the family life (Personal / familial problems), on board working conditions (Working Conditions on Board) and irregular life style (Undisciplined Life Style).

It is considered as helpful in order to solve the problem of inadequate seafarer in the maritime trade in the sense that the shipping companies has made long-term investigations thereby considering these determined criteria.

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SIMULATION MODELLING-ASSISTED TRAINING IN THE MARITIME EDUCATION: AN EXAMPLE IN DEU MARITIME FACULTY

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ABSTRACT

It is difficult, even sometimes impossible to express real world systems - which consist of stochastic processes - with mathematical formulas and to examine system behaviors. With the simulation modelling method, a model of a real system is generated using computer softwares and the system can be analysed easily. In the maritime field, apart from the use of simulators for training purpose, simulation applications are conducted on various issues such as container terminal operations, marine traffic risk assessments, port/terminal capacity analysis, marine pollution risk assessments, optimisation of the resources in technical-nautical services. This study refers to the importance and application areas of the simulation modelling method and focuses on simulation modelling-assisted education which is given to senior students in Department of Marine Transportation Engineering at Maritime Faculty of Dokuz Eylul University. In addition to the simulator-assisted trainings, this study emphasises the importance of the development of modelling and analysing skills related to maritime issues for ship officer candidates using simulation softwares.

Keywords – Maritime Education, Simulation, Simulation Modelling, Promodel

INTRODUCTION

It is difficult to explain real-world systems - which consist of stochastic processes – with mathematical formulas and to examine these systems' behaviors. In particular, this difficulty further increases as the complexity of the system increases. The analysing of the system may become impossible. In addition, the interference to the system may lead to delays and cost risks. The system may be in a design stage and may not yet be formed, in other words the system may not exist. In such cases, simulation modelling method is used. Simulation animates the model of a physical system and shows how to act a particular object or phenomenon in the system. It is a useful technique for testing, analysing or training where real-world systems or concepts can be represented by a model [1]. Simulation is used in many contexts such as performance optimisation, testing, education, training, video games [2].

Since the Second World War, simulation has become an indispensable tool in system-related activities. The development of computers has greatly expanded the applicability of simulation modelling [3]. Simulation technique is widely used in [4]-[3]-[5]:

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- Manufacturing processes such as machining, assembling, material transfer, storage,
- Production systems,
- Inventory systems,
- Service systems such as hospitals and medical clinics, retail stores, food and entertainment facilities, information technologies, customer order systems, banking,
- Aviation, maritime, rail and bus transport,
- Ports and terminals,
- Logistic and distributions systems,
- Construction systems
- Communication networks and computer systems
- Business process reengineering
- Military activities.

Simulation applications in the maritime industry have a quite important place. Simulator trainings play a crucial role in the maritime education. Simulators which works according to action-reaction principle are used for the training of ship officers related to ship operations. Apart from simulator trainings, simulation modelling method is used in various fields such as container terminals, dry bulk and liquid bulk terminals, Ro-Ro and passenger terminals, marine traffic risk assessments, marine pollution risk assessments, technical-nautical services.

The aim of this study is to emphasises that simulation modelling method which used effectively in the maritime industry should be included in the maritime education. The study also aims to examine applied training provided by Maritime Faculty of Dokuz Eylul University. In the study, simulation modelling method was mentioned and literature review related to the studies performed using this method in the maritime industry was given. Thereafter, the applied training provided by Maritime Faculty of DEU was examined.

SIMULATION MODELLING

Chung [4] defines the simulation modelling and analysis as building and experimentation process of a computerised mathematical model of a physical system. The system is a group of interacting components which receive inputs and provides outputs for some purposes. A simple system consists of three main components; entities, queues, resources. Entities are components which processed or get service in a system. For instance, entities may be customers in a customer service center or may be parts which waiting to be processed in a factory. Entities queue to be processed or to get service. Resources are components which give service or process the entities in the queue. Customer service representatives, factory machines, ATMs can be examples for resources [4].

The simulation model is built in a computer program. The model requires to run in a simulation program to generate historical data. A set of statistics calculated from historical data are used to generate performance measurements [3].

The characteristics of the simulation models can be divided into three classes: static or dynamic, deterministic or stochastic, continuous or discrete. Static simulation models, also known as Monte Carlo simulation, are not based on a time basis. These simulation models represent a system for a specific time. The progress of the time doesn’t have a role in this type of simulation models. Dynamic simulation models represent a system which develops as the time progresses. While stochastic simulation inputs consist of random variables, deterministic simulation inputs consist of constant values. While a deterministic simulation model provides same outputs in every simulation run, a stochastic simulation model provides different outputs. Therefore, in stochastic simulation models, the model is run more than once for accurate predictions about the system performance. Average of results which obtained from each replication is calculated. While system status in discrete simulation models changes at different times, system status in continuous simulation models changes during the time. The number of customers in a restaurant can be an example for the state variable in discrete simulation models. On the other hand, the oil level in a tanker which makes loading/unloading operations can be an example for the state variable in continuous simulation models [6]-[7].

Today, various softwares are used in the development of simulation models. There are three options for simulation modellers; spreadsheets, programming languages and specialist simulation softwares. Spreadsheets such as Microsoft Excel allows some simple applications. General-purpose programming languages such as Visual Basic, C#, Java provide modelling flexibility and a wide range of application areas. Specialist simulation softwares can be general-purpose or can also be application-oriented in certain areas such as production, medical, call center. Arena, Promodel, FlexSim, Witness, Automod can be examples for specialist simulation softwares [5].

Advantages of simulation modelling can be summarised in the following subjects [5]-[4]-[8]:

- Development the model of a real system and observing the working of it in detail allows better understanding of the system.
- Experimentation on a real system may takes weeks or months. Experimental simulation runs can be done in a compressed time because the model of the system can be simulated on the computer. Results on the performance of the system are obtained in a few minutes or hours.
- It may be costly to experiment on the real system. With the simulation modelling, changes can be made on the model without any interference with the working of the real system.
- Simulation modelling allows to experiment with new or unknown situations.
- Development of special simulation software packages has rescued practitioners from complex calculations and programming obligation.

SIMULATION MODELLING APPLICATIONS IN THE MARITIME INDUSTRY

In literature review, studies which are related to the maritime industry and performed using simulation modelling method was researched. Table 1 summarises studies obtained from literature review. It was partitioned as application area, year, author(s), issue, used simulation software or programming language.

Table 1. Studies Which are Related to The Maritime Industry and Performed Using Simulation Modelling Method

Application Area	Year	Author(s)	Issue	Simulation Software	Programming Language
CONTAINER TERMINAL	2015	Tao and Qui [9]	Vehicle dispatching	AutoMod 11.2	-
	2015	Zeng et al. [10]	Dual-cycling problem	Arena 7.0	Visual Basic
	2015	Zhao et al. [11]	Storage allocation	Tecnomatix Plant Simulation 11	-
	2013	Sağlam [12]	Cargo operations (master thesis)	Flexsim CT3	-
	2012	Taner [13]	Terminal layout arrangements (master thesis)	Arena 10.0	-
	2010	Li and Li [14]	Container terminal logistics systems	AnyLogic 6.5.0	-

	2010	Vis and Anholt [15]	Performance analysis of berth configurations	Arena 11.0	-
	2010	Legato et al. [16]	Discharge/loading operations	-	Java 6.0
	2009	Park and Dragovic [17]	Terminal planning	Arena 12.0	-
	2009	Alp [18]	Port efficiency (master thesis)	Arena 10.0	-
	2009	Zeng and Yang [19]	Scheduling loading operations	Arena 7.0	Visual Basic 6.0
	2009	Carteni and Luca [20]	Handling equipment models	Witness	-
	2009	Esmer [21]	Optimisation of Logistics Processes (doctoral thesis)	Arena	-
	2006	Bielli et al. [22]	Terminal operations	-	Java
	2006	Ng and Wong [23]	Terminal capacity	Promodel	-
	2005	Parola and Sciomachen [24]	Intermodal container flows	Witness	-
	2004	Henesey et al. [25]	Berth allocation	-	Java
	2002	Shabayek and Yeung [26]	Terminal operations	Witness	-
	2002	Kia et al. [27]	Port capacity	Taylor II	-
	2001	Legato and Mazza [28]	Berth planning and resource optimisation	Visual SLAM	-
	1999	Yun and Choi [29]	Terminal operations	SIMPLE ++	-
BULK TERMINAL	2014	Vianen et al. [30]	Stockyard size	TOMAS	Delphi
	2013	Pjevcevic et al. [31]	Efficiency of cargo handling	Flexsim	-
	2012	Bugaric et al. [32]	Optimal utilization of the bulk cargo unloading	-	Pascal
	2007	Bugaric and Petrovic [33]	Terminal capacity	-	Pascal
RO-RO TERMINAL	2016	Iannone et al. [34]	Operation decisions	Arena	-
	2014	Özkan [35]	Terminal capacity (master thesis)	Promodel 2011	-
	2011	Aksoy [36]	Terminal operations (master thesis)	Arena 11.0	-
TECHNICAL - NAUTICAL SERVICES	2016	Nas et al. [37]	Tugboat quantity	Promodel 2011	-
	2015	Nas et al. [38]	Maritime pilot quantity	Promodel 2011	-
	2015	Uçan and Nas [39]	Istanbul Strait Maritime Pilot Capacity	Arena	-
	2013	Nas [40]	Optimisation of the resources in technical-nautical services	Promodel 2011	-
	2013	Uçan [41]	Optimisation of number of marine pilots serving at	Arena	-

			Istanbul Strait (master thesis)		
OTHER APPLICATION AREAS	2015	Uğurlu et al. [42]	Simulation of Tupras Izmit Oil Terminal	Awesim	-
	2014	Uğurlu et al. [43]	Simulation of BOTAS Ceyhan Marine Terminal	Awesim	-
	2012	Ja et al. [44]	Fuel consumption in the port industry	Witness	-
	2012	Dachyar [45]	Simulation and optimisation of port services in Indonesia	Promodel	-
	2010	Guo et al. [46]	Passing capacity of coastal waterway channel	Arena	-
	2009	Martagan et al. [47]	Port operations during crisis conditions	Promodel	-
	2008	Özlem [48]	Vessel traffic in the Strait of Istanbul (master thesis)	Arena 11.0	-
	2007	Özbaş and Or [49]	Vessel transit traffic through the Istanbul Channel	Arena 9.0	-
	2007	Tekkanat [50]	Optimisation of ferry line management (master thesis)	Automod 11.1	-
	2007	Aydın [51]	Planning of ferry services (master thesis)	Promodel	-
	2006	Uğurlu [52]	Simulation of BTC and BOTAS Ceyhan Terminals (master thesis)	Awesim	-
	2002	Faghri and Wahed [53]	Optimisation of the operations of a multipurpose seaport	Promodel	-
	1998	Swedish [54]	Inland waterway barge fleet distribution network	Promodel	-

*Blue parts represents studies performed in Turkey.
Source: Author

As seen in Table 1, simulation modelling method in the maritime industry was mainly used in ‘container terminal’ problems. One of the main causes of this situation is that container terminal systems have a more complex structure than other systems. Besides of container terminal systems, it is seen that simulation modelling method was used in bulk terminals, oil terminals, Ro-Ro terminals, technical-nautical services and other areas.

It is observed that specialist simulation softwares were used in most of studies rather than programming language. While in some of studies a programming language has been used, in some of other studies a simulation software and a programming language have been used together. ‘Arena’ simulation software which was used in 14 of 46 studies is the most widely used software. It is seen that ‘Promodel’ simulation software which was used in 10 studies is the second widely used software.

Application areas of studies which performed in Turkey using simulation modelling on issues of the maritime industry can be summarised under the following headings:

- Container terminals
- Ro-Ro terminals
- Oil terminals

- Technical-nautical services
- Vessel traffic
- Ferry services

SIMULATION MODELLING-ASSISTED TRAINING IN THE MARITIME EDUCATION: AN EXAMPLE IN DEU MARITIME FACULTY

In this part of the study, simulation modelling-assisted training which provided by the Department of Marine Transportation Management Engineering at Maritime Faculty of Dokuz Eylul University was examined. This training is given to senior students within the scope of the lesson named 'Simulation Techniques in Maritime Transportation'. 'Promodel 2011' simulation software is used in the training. This simulation software was gained for the Department of Marine Transportation Engineering as part of a scientific research project named 'Optimisation of the Resources with Simulation Modelling Method in Technical Navigation Services'. The training is carried out in a multi-purpose simulation laboratory.

Figure 1. 'Multi-purpose Simulation Laboratory', DEU Maritime Faculty
Source: Author

As part of this training, general information about simulation modelling is primarily taught. Importance, using and purposes of simulation modelling method, simulation types, application areas, applications in the maritime industry are mentioned. System, model, modelling and other concepts are referred and the information about the basic components of a simulation model is given. A few studies which performed using simulation modelling method are examined. In the following weeks, steps of simulation modelling are mentioned [3]:

- Problem analysis and information collection
- Data collection
- Model construction
- Model verification

- Model validation
- Designing and conducting simulation experiments
- Output analysis

In the following weeks, Promodel 2011 simulation software is introduced. Promodel is flexible and an easy-to-use program. It has a good simulation and animation power and capability of modelling the most complex systems [55]. When examining Table 1, it is seen that Promodel simulation software was used on various issues in the maritime industry.

Basic modelling elements of Promodel 2011 are:

- Entities: Units which will be processed or get service,
- Locations: Places where operations or services are performed,
- Resources: Units which carry or process entities,
- Path networks: Paths which followed by resources or entities,
- Arrivals: Entry of entities to the system,
- Processing: Process logic and routing of entities

After the explanation of basic modelling elements of Promodel 2011, various modellings are done in the remaining weeks. The first few models are exercise-purpose and consist of simple models which are not related to the maritime industry issues. Subsequent models consist of marine operations and are applied from simple to complex:

- A model on ship arrivals - terminal operations of ships,
- A model on ship arrivals - berthing/unberthing of ships in company with tugs and marine pilots - terminal operations of ships,
- A model on ship arrivals - berthing/unberthing of ships with 1 or 2 tugs in accordance with tonnages of ships and bollard pulls of tugs - terminal operations of ships,
- A model on ship arrivals - berthing/unberthing of different type of ships in different type of terminals with 1 or 2 tugs in accordance with tonnages of ships and bollard pulls of tugs – terminal operations of ships,
- A model on ship voyages between 2 terminals - berthing/unberthing of ships with 1 or 2 tugs in accordance with tonnages of ships and bollard pulls of tugs – loading/discharging operations of ships.

A Sample Model

The model that examined as a sample in this study is a model on ship arrivals - berthing/unberthing of ships in company with tugs and marine pilots - terminal operations of ships. Modelling approach is as below:

- Entities: Ships,
- Locations: Anchorage area, terminal and exit area,
- Resources: Tugs and marine pilots,
- Path networks: 3 paths between anchorage area, terminal and exit area,
- Arrivals: Anchorage area,
- Processing: Ships which arrives to the system in the anchorage area berths in company with a tug and a marine pilot, if there is an empty berth in the terminal. If berths are empty, ships wait in the anchorage area. Ships that berthed wait in the terminal until completion of all procedures. After completion of all procedures in the terminal, ships unberths in company with a tug and a marine pilot. Ships exit from the system in the exit area. Tugs and marine pilots wait in the terminal unless there is a service request.

Some assumptions are made for the model. There is one terminal in the system. There is no constraint on the number of tugs and marine pilots. Berthing and unberthing maneuvers can be performed simultaneously. The variables of the system are frequency of ship arrivals, anchorage area capacity, number of berths, waiting time in the terminal for ships. The frequency of ship arrivals is entered into the model as the exponential distribution. Berthing, unberthing and terminal operation processes are entered into the model as the normal distribution.

Figure 2 shows the algorithm of the sample model. Animation display of the sample model is shown in Figure 3.

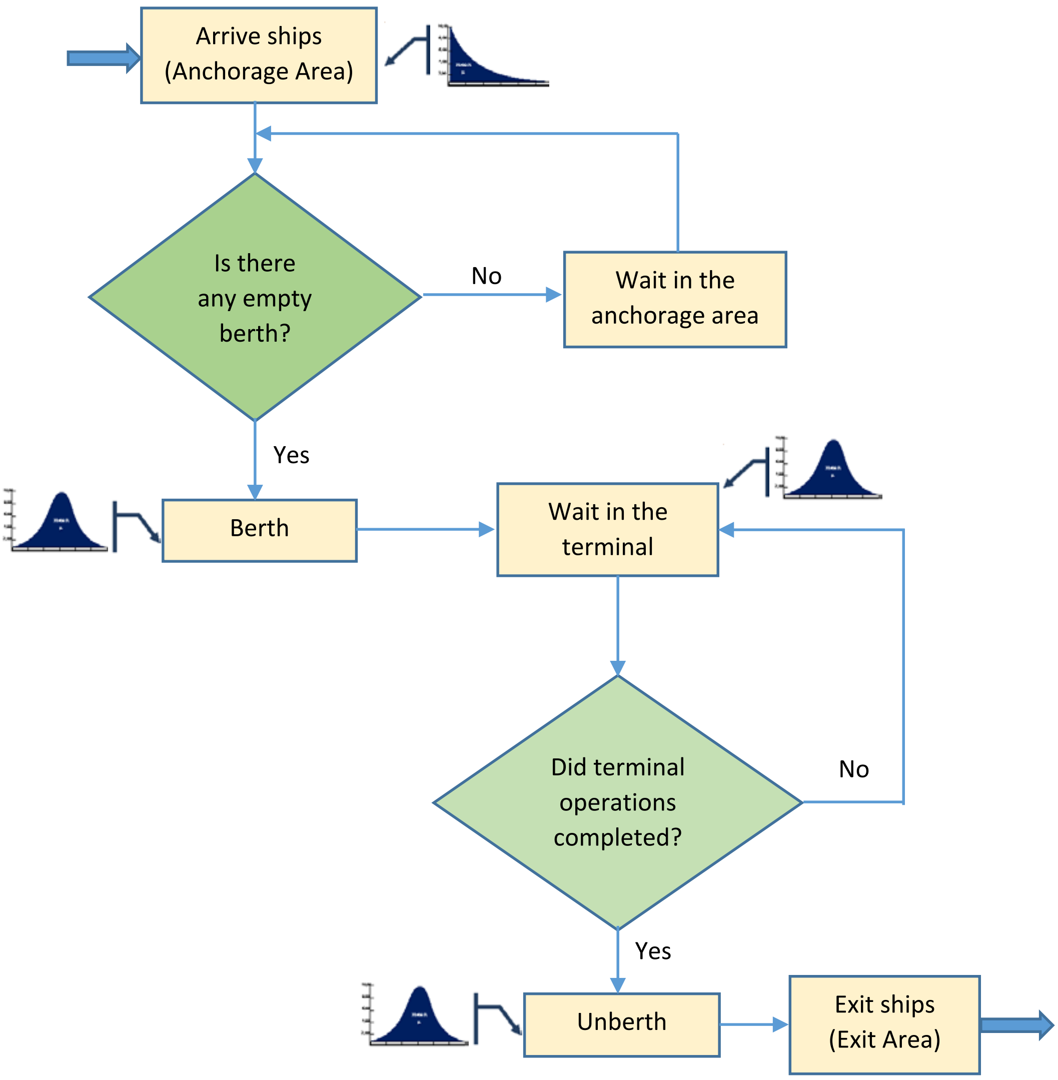

Figure 2. Algorithm of the sample model
Source: Author

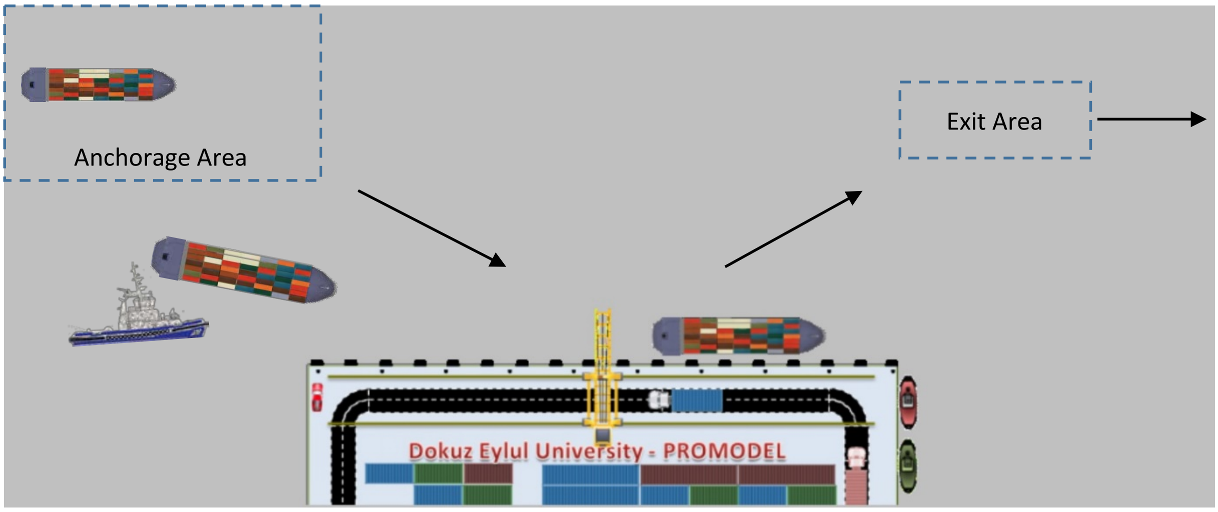

Figure 3. Animation display of the sample model
Source: Author

Promodel 2011 simulation software contain 'Stat::Fit' program in itself. Stat::Fit allows to determine the most appropriate statistical distributons for the available data and to enter these data into the model. In this sample model, students can enter distributions into the model using Stat::Fit for these processes; ship arrivals, berthing, terminal operations and unberthing. Entering statistical distributions for these processes ensures that the model works in compliance with the real-life.

Students check whether the model has been correctly built. They make necessary corrections in case of any failure. Subsequent to verification and validation, the model is run to perform output analysis. 'Output Viewer' program which is available in Promodel 2011 is used for output analysis. Output Viewer allows a variety of performance indicators related to the model:

- Total number of entities entering the locations,
- Percentages of occupancy, emptiness and breakdown related to the locations,
- Percentages of usage, traveling to, idleness and breakdown related to the resources,
- Average time in system, average time in move logic, average time in operation, average waiting and blocked times related to the entities.

Students run the model with a variety of scenarios. Each student runs the model with different variable values. For instance, it may be asked to examine the effect of the ship arrivals frequency on berth capacity. In that case, each student runs the model with different values of ship arrivals frequency and with a constant value of the number of berths. Students seek solutions for occurred bottlenecks. They determine the optimum number of berths to meet the ship arrivals frequency.

CONCLUSION

It is seen that simulation modelling method is applied on various issues in the maritime industry and it has an important place. This method which has such a wide application in the maritime industry should also be included in the maritime education. Simulation modelling allows students to be able to see working of the subsystems consisting of stochastic processes in maritime industry related systems. Students can see the interactions between the subsystems. They try to find solutions for problems or bottlenecks related to working of processes in the systems. These efforts contribute the development of their analytical thinking skills.

It is thought collaborations on simulation modelling can be conducted between maritime schools. An environment can be organised in which training models can be shared and competitions between students can be carried out. The implementation of simulation modelling-assisted training in maritime schools will allow students to develop their perspectives on the analysis of real-life problems.

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ASSESSING SEAFARERS' COGNITIVE ABILITIES BY USING NEUROCOGNITIVE TEST BATTERY

Umut TAÇ[1], Leyla TAVACIOĞLU[2], Pelin BOLAT[3]

ABSTRACT

Human factor has been one of the elements that cause vulnerabilities which can be resulted with accidents in maritime transportation. When the roots of human factor based accidents are analyzed, gaps in performing cognitive abilities (perception, attention, memory…) are faced as the main reasons for the vulnerabilities in complex environment of maritime systems. Thus cognitive processes in maritime systems have become important subject that should be investigated comprehensively. At this point, neurocognitive tests have arisen as coherent tools that enable us to make valid assessments for cognitive status and functioning of the agents who are in charge of the performing tasks. In the foregoing circumstances, the aim of this study to introduce neurocognitive tests and their implications in maritime domain. After an extensive literature, how to apply these tests and use them in the education and selection of the seafarer will be introduced in separate chapters through the paper.

Keywords – Cognitive ability, Neurocognitive test battery, Seafarers.

INTRODUCTION

Relation between safety and human factor is an increasingly important topic in literature and definitely relied on a known fact that humans -as operational members of a system- can make errors. However, the main question is what the risk level of these errors. Answers of these question may be replied by assessing the level of criticality of the errors, which is a function of the variables in operations [1]. These variables can be the environmental conditions, workload and psychological/ physical state of the individuals that constitute "human factor/element" concept. The human factor theme as a multidisciplinary field that deals with the human capability and limitations can refer to functional design, workplace safety, human error, human capability and human-computer interactions. As a result of fact that, main research topics of this concept aims to produce safe, comfortable, and effective human performance within an operational tasks that include the equipment, systems, software, facilities, procedures, environments, training, staffing, and personnel management [2]-[3].

In this regard, human factor-based errors can be arisen from the loss of information during the information processing cycle. Thus, performing a given task or solving an operational problem is a function of capacity of information processing which can also be defined as cognitive ability which is are mostly associated with capacity of learning, capacity of acquiring knowledge, capacity of

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adaptation to unfamiliar conditions and capacity of configuration of knowledge for future events [4] – [5].

In the forementioned circumstances, cognitive abilities of the individuals such as memory, reaction time, attention plays a key role to perform a safe and effective operation. However, age-related cognitive decline is an important human experience which differs between individuals. The reasons of this differences are not fully clarified but researches are especially carried out on biomedical and psychosocial fields considering cognitive functions, diseases, health conditions, genetic contributions, lifestyles [6]. In cognitive way, except a little cognitive functions such as verbal ability, some numerical abilities and general knowledge most of the cognitive capabilities decline from middle age onwards, or even earlier [7].

The aim of this study to comprehensively monitor and compare the cognitive abilities of the seafarers who belongs the different experience levels and age groups in points of concentration, attention, memory and reaction time. For this purpose, a particular ANAM^{R} battery consists of three tests including Running Memory CPT test, Stroop test and 2-Choice Reaction Time test derived from Automated Neuropsychological Assessment Metrics (ANAM4$^{R)}$ was applied to seafarers. In this context, this paper is consisted of four parts. In the introduction part, the human factor and cognition literature that motivate us for this research are given. Secondly methodology is explained. In the third part, results are introduced. Lastly a brief conclusion is presented.

METHOD

Data Collection

In this study, Automated Neuropsychological Assessment Metrics (ANAM4$^{R)}$ computer-based software test library which is developed by USA Defense Department in 1970 is used to investigate the cognitive changes of seafarers using the parameters such as speed and accuracy of attention, reaction time, memory, decision making, concentration. ANAM4^{R} enables to collect data for assessing the cognitive status changes and neuropsychological function of an individual in a given time.

ANAM4^{R} consists of 30 performance assessment tests, which are widely used in the literature especially in military and clinical domains, are very sensitive with regard to cognition. Researchers can build special batteries (subtests) derived from these 30 different tests for specific purposes. Our particular ANAM^{R} battery consists of three tests including Running Memory CPT test, Stroop test and 2-Choice Reaction Time test. Apart from the cognitive tests, ANAM^{R} provides forms such as the symptom assessment test and the emotional status assessment form. These forms are presented, before the cognitive tests, to evaluate the instantaneous emotional statuses and the obstacles that would influence cognitive performance. Additionally, ANAM^{R} Validity Indicator Report is another tool for evaluating the validity of scores from an ANAM^{R} battery by calculating the ANAM^{R} Performance Validity Index and highlighting other validity indicators [8].

Participants

Research is conducted on three main groups consisted of 12 oceangoing watchkeeping officers (age = 23 ± 1 year), 12 oceangoing chief officers (age = 28 ± 1 year) and 12 oceangoing masters (age = 44 ± 1 year) in order to measure differences of the cognitive ability and performance of the seafarers by using Automated Neuropsychological Assessment Metrics (ANAM4^{R}). Within the scope of this study, a particular ANAM^{R} battery consist of Running Memory CPT test, Stroop test and 2-Choice Reaction Time test applied to participants, each lasting approximately five minutes. All participants are volunteers and received no immediate benefits from participating in this study. Each participant took the ANAM4[R] test while seated at a computer, using the handheld mouse to perform the individual cognitive assessment. Testing process conducted in a quiet environment to enable the participant to concentrate solely on the tests.

Running Memory CPT Test

This neurocognitive test is used to evaluate concentration, attention, and working memory skills of the individuals. During "Running Memory- Continuous Performance Task" test single characters appear on the screen in rapid sequence. The user completes the test by pressing designated buttons, in the shortest time possible, to indicate whether the displayed character matches or does not match the preceding character.

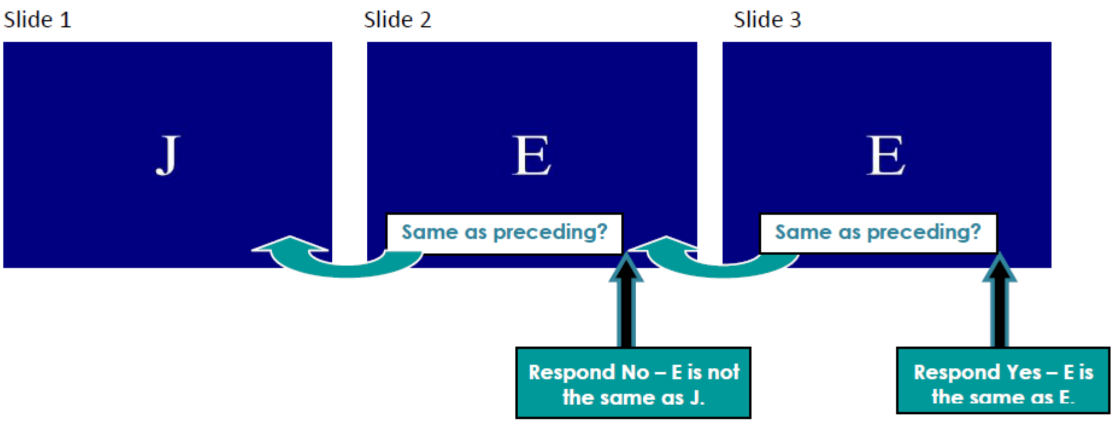

Figure 1. Running Memory CPT Test

Stroop Test

"Stroop Color and Word" test assesses interference, processing speed, selective attention, and executive functioning. There are three blocks of trials for this test. In the first one, the words RED, GREEN, and BLUE are presented randomly in black type on the screen. The participant is directed to read each word and to press a related key for each word (1 for RED, 2 for GREEN, 3 for BLUE). In the second block, a series of XXXX's is demonstrated on the screen in one of three colors. The participant is instructed to indicate the color of the XXXX and to press the related key based on color. In the last block, a series of individual words (RED, GREEN, BLUE) are presented in a color that does not match the name of the color depicted by the word. For example, the word "BLUE" appears in either red or green. The participant is instructed to press the response key allocated to that color. The test includes three scores, based on the number of items completed on each of the three blocks.

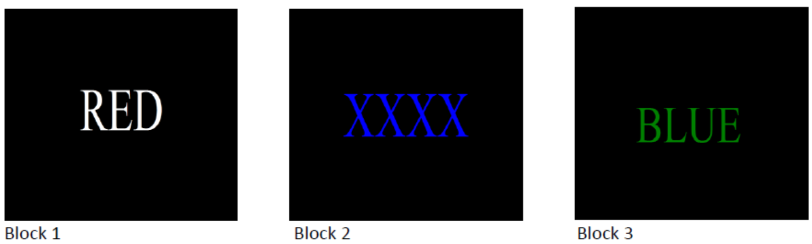

Figure 2. Stroop Test

2-Choice Reaction Time Test

This test results are used to evaluate processing speed and alternating attention with a motor speed component. The test presents the users a series of (*) and (o) symbols on a screen. The user completes the test by pressing the designated button for each symbols as soon as the symbols appears on the screen.

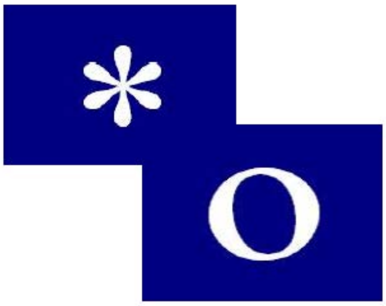

Figure 3. 2-Choice Reaction Time Test

RESULTS

In order to evaluate the cognitive status of seafarers who belongs the different experience levels and age groups, a particular ANAM[R] battery comprising of three tests including Running Memory CPT test, Stroop test and 2-Choice Reaction Time test was applied to seafarers and their test performances were analyzed comparatively.

Running Memory CPT Test Results

The results of the 'Simple reaction time' test, which is administered to evaluate the concentration, attention, and working memory skills of the seafarers, are presented below.

Table 1. Running Memory CPT Test Results

	Mean Response Time (msec)	Number of Correct / 80
Oceangoing Watchkeeping Officers	516	78
Oceangoing Chief officers	589	76
Oceangoing Masters	784	68

When the mean response time and the number of correct responses are evaluated, a significant difference could not be found between oceangoing watchkeeping officers (age = 23 ± 1 year) and oceangoing chief officers (age = 28 ± 1 year). However, test performance of the oceangoing masters (age = 44 ± 1 year) shows a distinct decline compared to other test groups. Thus, the possibility of human induced errors occurrence which are related to concentration, attention, and working memory skills may increase.

Stroop Test Results

The results of the 'Stroop' test, which is conducted to evaluate the interference, processing speed, selective attention, and executive functioning skills of the individuals, are presented below.

Table 2. Stroop Test Results

	Word test	Color test	Word / color test
Oceangoing Watchkeeping Officers	37	41	39
Oceangoing Chief officers	38	37	33
Oceangoing Masters	35	30	21

As it can be seen in Table.2 oceangoing watchkeeping officers (age = 23 ± 1 year) have highest scores according to other test groups, but there are no considerable differences with oceangoing chief officers (age = 28 ± 1 year) as in the previous measurement. Oceangoing masters (age = 44 ± 1 year) have by far lowest scores for this assessment. In this respect, the interference, processing speed, selective attention, and executive functioning skills of oceangoing masters can pose a risk in operational processes cognitively.

2-Choice Reaction Time Test

The results of the '2-Choice Reaction Time test' test, which is conducted to evaluate processing speed and alternating attention skills of the individuals, are presented below.

Table 3. 2-Choise Reaction Time Test Results

	Mean Response Time (msec)	Number of Correct / 40
Oceangoing Watchkeeping Officers	365	39
Oceangoing Chief officers	405	37
Oceangoing Masters	521	32

According to test results, oceangoing masters (age = 44 ± 1 year) have significant slowing in the reaction times and an observable decrease in the number of correct compared to oceangoing watchkeeping officers (age = 23 ± 1 year) and oceangoing chief officers (age = 28 ± 1 year). In this regard oceangoing masters (age = 44 ± 1 year) represent the higher risk group for cognitive abilities which are processing speed and alternating attention.

CONCLUSION

This paper is one of the preliminary research results of our project “Modeling of the cognitive processes of seafarers and its effects on collision avoidance”, funded by ITU Scientific Research Project Funds. Through the results of measurement based on ANAM battery, we can see that there can be differences in cognitive abilities such as memory, attention, reaction time of the seafarers due to experience levels and age groups. Based on the measurements, there is no a significant difference in cognitive abilities between oceangoing watchkeeping officers (age = 23 ± 1 year) and oceangoing chief officers (age = 28 ± 1 year) while the oceangoing masters (age = 44 ± 1 year) have lowest cognitive scores compared to other test groups. This fact can be consisted with the literature that advocates direct relationship between declines in cognitive abilities and age [6]. It is obvious that performing a safe and effective task is in direct relation with cognitive competence required for the task. And deficient cognitive competence can increase the possibility of human induced errors occurrence. Accordingly this study has consecutive prospective studies which include a high number of participants (seafarers) to understand the cognitive processes of seafarers and their effect on operational procedures and navigational safety.

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A QUALITATIVE ANALYSIS OF JOURNAL OF ETA MARITIME SCIENCE (JEMS) AND ITS MANAGEMENT PROCESS

Remzi Fışkın[1], Selçuk Nas[2]

ABSTRACT

This article is dealing with the bibliometric analysis of articles published between the years 2013-2016 in Journal of ETA Maritime Science which has been indexed by the ULAKBIM TR Dizin, Directory of Open Access Journals (DOAJ) and Index-Copernicus and whose owner is UCTEA, The Chamber of Marine Engineers (GEMIMO). Furthermore, the management process of the journal is also mentioned to give an example of good management process. In this study the following research questions have been discussed: What are the journal's evaluation criteria? What are the types of published articles and statistics? What are the categories of the published articles and statistics? What are the reviewer statistics and articles statistics?

Keywords: JEMS, Journal Management Process, Qualitative Analysis

INTRODUCTION

The Journal of ETA Maritime Science which has been indexed by the ULAKBIM TR Dizin, Directory of Open Access Journals (DOAJ) and Index-Copernicus has begun its publication life in 2013. The journal aims to encourage and publish research studies about the challenges and opportunities associated with numerous numbers of understandings in maritime sector. Besides, JEMS also aims to reach out to relevant audience by publishing the studies covering latest scientific and technological developments. JEMS journal which is published periodically (4 times annually) and regularly may also publish special issues related to the selected topics. Scope of the journal covers national, international and local studies regarding Marine Engineering, Marine Transportation Engineering, Naval Architecture Engineering, Marine Operations, Logistics, Logistics Engineering, Maritime History, Coastal Engineering, Marine Pollution and Environment, Fishing and Fisheries Technology, Shipbuilding and Ocean Engineering. The journal owner is UCTEA, The Chamber of Marine Engineers (GEMIMO) and its management process carried on by experienced academicians, fluently. The journal has submission policy, plagiarism policy advertisement policy and also has CC (Creative Commons) license that allows others to share the work with an acknowledgement of the work's authorship and initial publication in this journal. These policies and their detailed content can be accessed from official web page of the journal www.jemsjournal.org.

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OBJECTIVE AND SCOPE OF THE STUDY

The objective of the study is to examine articles published in JEMS and also the following research questions have been discussed: What are the journal's evaluation criteria? What are the types of published articles and statistics? What are the categories of the published articles and statistics? What are the reviewer statistics and articles statistics? The scope of the study includes 52 articles published in the journal between 2013-2016.

THE CONCEPT OF ACADEMIC JOURNAL

Scientific journals motivate academics and scientists about 350 years to follow current developments and to share their research [1]. The first scientific journal was published which *Journal des Scavans* in 1665 and was followed by the *Philosophical Transactions of the Royal Society* (Osburn, 1984 [2] as cited in Harter and Kim, 1996 [3]). Scientific journals without losing the main function from the past, it has undergone enormous changes in the last fifteen years due to advanced technology and communication facilities [1].

A Journal is a publication that publish at least twice a year under a common name. Its each issue has number and date and it is also prepared for specific purpose [4]. On the other hand, the scholarly journal is created to enable sharing the results of studies conducted in areas where the relevant scientific environment (Köksoy, 2000 [5] as cited in Kozak, 2003: 151 [6]). If a publication is authored by experts or academic researchers, it is regarded as academic or scholarly publication. The scholarly journal focus on original research, research methodology or theory. Ordinarily, scholarly journals are aimed for academic researchers or professional and provide detailed analysis concentrating on a single discipline or academic field. The journals will likely be peer reviewed (refereed) by external reviewers who are expert on related issue [7].

A scholarly journal is also named a scientific journal, as well. It is a periodical authored by scientific professionals and experts in such areas. A "peer review" journal is a subset within scholarly journals. The articles submitted to scholarly journals are reviewed by researchers in the same discipline to specify whether the article deserves publication or not. The evaluation process of articles assists to ensure that only high-quality and original articles are published [8]. The review process also improves quality of the article. Many researchers believe that the process develops quality of their research paper [9].

All authors who publish in the scholarly literature have to cite sources used in the writing of the article, so readers will find a section at the end named variously as bibliography, sources cited, works cited, or footnotes [8]. There is a special status of scientific journals for communication and sharing of information. This type of journals are the most important resources of the library, because they include the most current and newest information from different disciplines. The scholarly journal is also important because of their quick reflection of research results of natural sciences, engineering and medical researches [4].

OPEN ACCESS, OPEN ACCESS LICENSES (CREATIVE COMMON), PUBLICATION ETHICS AND MALPRACTICE STATEMENT

Scientific Open Access (OA) journals make their content getable online to everyone and helping solve the access problems created by subscription journals. Because Open Access journal doesn't charge any fund for access the articles, they count on other means of funding publication. Most of the early OA journals were published by academics largely using voluntary labor [10]. Open Access is also a model for publishing scientific journals that made access possible via online. The articles of open access journal can be accessed without constraint and it is funded excepting subscriptions [11]. Directory of Open Access Journals (DOAJ) has a substantial vocation in the context of accession Open Access Journal. DOAJ is an online directory that indexed and provides access to high quality, open access, peer reviewed journals. 11,367 Open Access Journal and 2,213,098 articles from 136 countries has indexed in DOAJ currently [12]. JEMS is also within indexed journal in DOAJ. This is important for the recognition of the journal and it is thought that this is the crucial step to be indexed in other important indexes such as Scopus, Web of Knowledge, etc. JEMS also signed Budapest Open Access Initiative (BOAI). According to BOAI [13]; "*By "open access" to peer-reviewed research literature, the articles free availability on the internet, permitting any researchers to read, cite, download, copy, print or link to the full texts of these articles, or utilized from them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. The authors grant to all beneficiaries a free access to articles".*

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JEMS is an independent publication in terms of academic research and the editor make decision its publication policy. The statement indicates the ethical behavior of the publisher, the editor, the reviewers and the authors. The ethics statement for JEMS is predicated on *COPE Code of Conduct and Best Practice Guidelines for Journal Editors* and *COPE Best Practice Guidelines for Journal Editors* available at www.publicationethics.org [15].

THE REVIEW PROCESS OF JEMS

Beside the scientific quality, the articles should be in accordance with scientific standards and also be easily readable for enhancing the journal's impact factor [16]. The manuscripts submitted to JEMS are reviewed firstly by layout editors for compliance with the scope and writing rules of the journal and also checked under plagiarism policy. The appropriate manuscripts are forwarded to the section editors by means of the subject. The section editors have task to appoint at least 2 reviewers to evaluate the manuscript. JEMS implements double-blind review process. Both the reviewer and the author identities are concealed during double-blind review process. Authors need to be sure that their manuscript are prepared in a way that does not disclose identity of them. In this context, the manuscript that submitting to JEMS does not have author identity. The identity of author is taken separately in order to conceal. After review process, if there is one revision or accept and one reject, another reviewer is appointed by section editor. Finally, if the manuscript is accepted for publishing, it is forwarded to the language editors to proffcheck. After the related language revision has been carried out, the manuscript can be published in the journal. The detailed peer review process of JEMS can be seen in Figure 1.

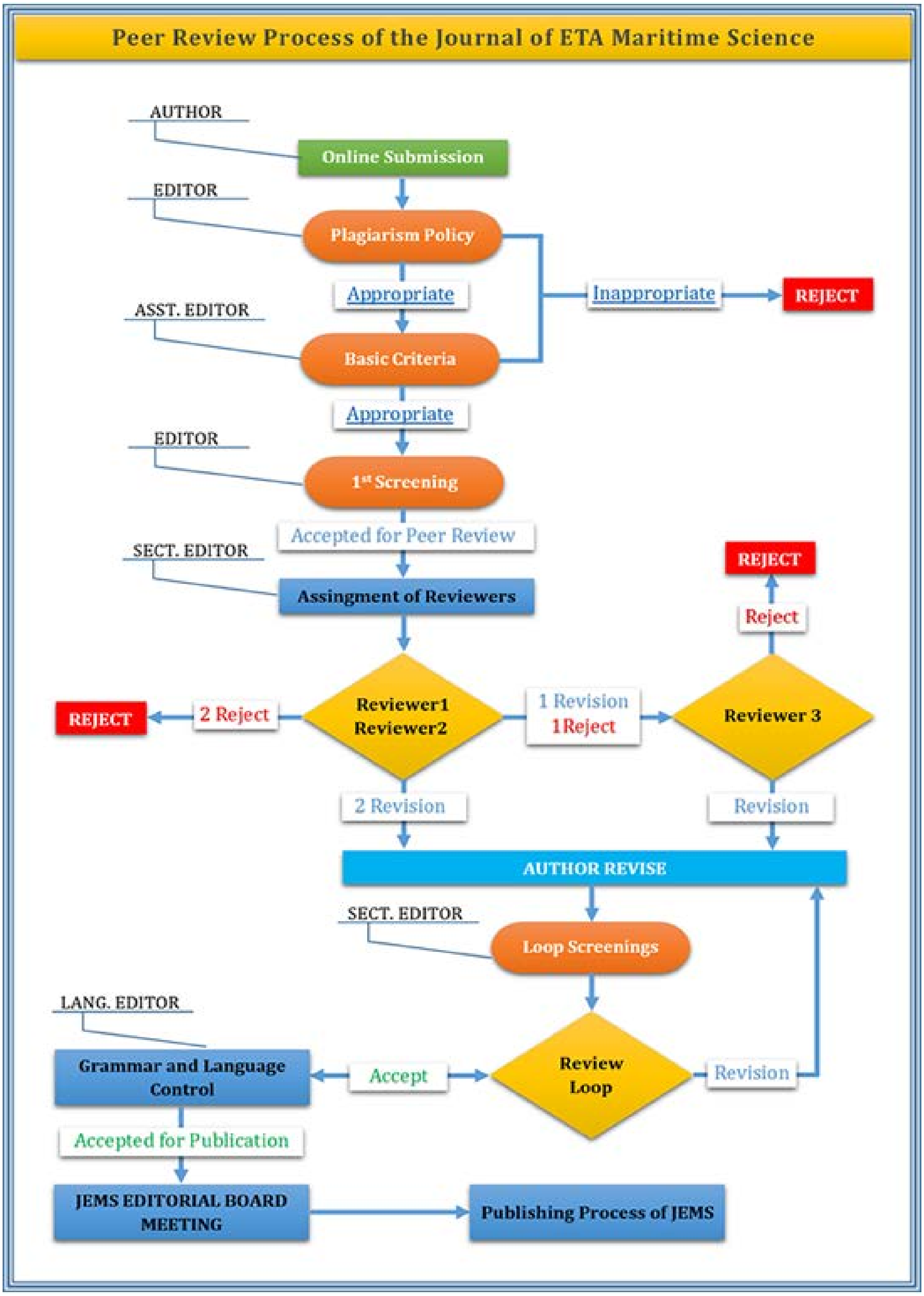

Figure 1. The Review Process of JEMS

FINDINGS

Article Statistics

JEMS published 52 articles within 8 issues between 2013-2016. As seen in Figure 2, 2013/2 is the year that the most article published with a total of 9 articles. All these articles have been published in Turkish language or in English language. As seen in Figure 3 in detailed, a total of 40 articles were published in Turkish language, the remaining were in published in English language.

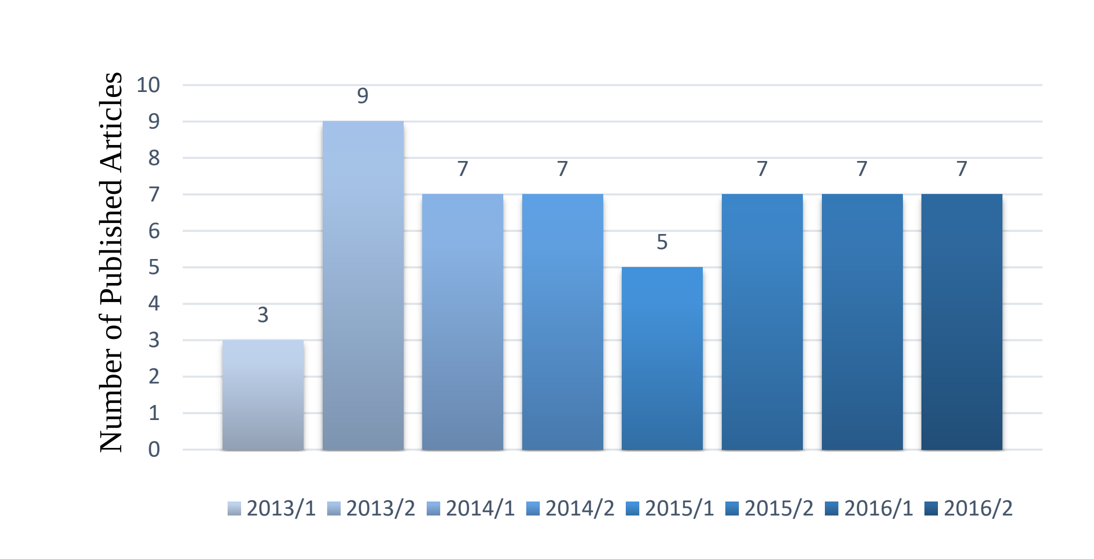

Figure 2. Number of Published Articles by Year

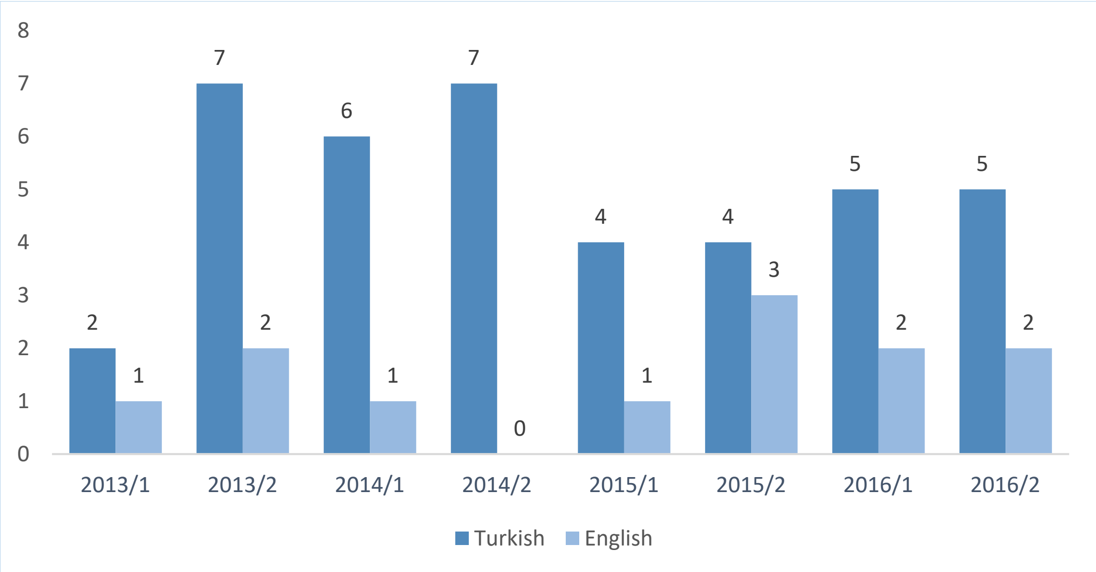

Figure 3. Language of Published Articles by Year

Categories of manuscripts accepted for publication is shown in Table 1. The articles that related with the subject of "Marine Transportation Engineering" is on the first rank with the number of 18 published articles. The articles that related with the subject of "Marine Engineering" and "Maritime Business and Management" are the other mainly published manuscripts by the journal with the number of 11 and 9, respectively. Moreover, a total of 13 manuscripts submitted to the journal for publishing were rejected and a total of 7 manuscripts were withdrawn by their authors. Consequently, the total acceptance rate of the journal is 72%.

Table 1. The Categories of Articles Submitted for Publication

Category	Published	Rejected	Withdrawn	Acceptance Rate
Marine Transportation Engineering	18	3	4	72%
Marine Engineering	11	1	2	79%
Maritime Business and Management	9	3	0	75%
Logistic	6	4	1	55%
Shipbuilding and Ocean Engineering	3	0	0	100%
Maritime History	2	1	0	66%
Marine Pollution and Environment	1	1	0	50%
Fishing and Fisheries Technology	1	0	0	100%
Naval Architecture Engineering	1	0	0	100%
Coastal Engineering	0	0	0	-
Maritime Law	0	0	0	-
Total	**52**	**13**	**7**	**72%**

Types of manuscripts submitted for publication is shown in Table 2. The "Original Research" articles are on the first rank with the number of 42 published articles. The "Editorial" and "Review" articles are the other mainly published manuscripts by the journal with the number of 6. Moreover, a total of 11 "Original Research" articles and a total of 2 "Review" articles submitted to the journal for publishing were rejected and a total of 7 "Original Research" articles withdrawn by their authors. Consequently, the total acceptance rate of the journal is 72%.

Table 2. The Types of Articles Submitted for Publication

Type	Published	Rejected	Withdrawn	Acceptance Rate
Editorial (ED)*	6	0	0	100%
Original Research (AR)	42	11	7	70%
Erratum (ER)*	1	0	0	100%
Review (RE)	6	2	0	85%
Technical Report (RP)	2	0	0	100%
Book Review (BK)	1	0	0	100%
Industrial Perspective	1	0	0	100%
Case Investigation (RP)	0	0	0	0
Academic Perspective	0	0	0	0
Letter to Editor (LE)	0	0	0	0
After Meeting *	1	0	0	100%
Total	**60**	**13**	**7**	**72%**

*Excluded from the percentage of acceptance rate

Article rejection reasons in the journal are divided into reviewers and editors' origin. The manuscripts submitted to journal are subjected to plagiarism analysis provided by Ithenticate Plagiarism Detection Software. If submitted manuscripts are not on the acceptable limit, it will be rejected by the editors. On the other hand, if the references are not shown within the phrases and any plagiarism is detected, such articles are also rejected by the editors due to journal publication policy. Another reason for the rejection can be about data analyzed in the study. The data in the study submitted to journal should be up to date. In addition to all these, the manuscripts should be also in accordance with the scope of the journal. If the subject of the manuscript is not appropriate for journal, it can be rejected as well.

The most accessed articles of the journal are shown in Table 3. The data were obtained in 15 June 2016. The article prepared by Talay et al., 2014 [17] is the most accessed article and it has been accessed 406 times until that day. The other studies that mostly accessed can be seen in detailed from related table.

Table 3. The Most Accessed Articles

Article	Author	Volume/Issue	Access
Analysis of Effects of Methods Applied to Increase the Efficiency on Ships for Reducing CO2 Emissions	Talay et al., 2014 [17]	2/1	512
Human Error in Grounding Accidents: Case Study for Container Ships	Yıldırım et al., 2015 [18]	3/1	452
Automation of Loading and Discharging Operation System in Tankers	Altun et al., 2013 [19]	1/2	425
Analysis from Statistical Perspective of Deficiencies Originated from the Bridge Causing Ship Accidents	Keçeci and Arslan, 2015 [20]	2/1	419
Economic Analysis of a Ship Refrigeration System in case of Variable Sea Water Temperature Condition	Başhan and Parlak, 2015 [21]	3/2	404
Effect of the Oil Areas on Marine Traffic and Oil Spill Risks at the Black Sea	Başar and Yıldırım, 2014 [22]	2/2	399
Evaluation of Health and Safety Conditions for Seafarers: An Example in DEU Maritime Faculty	Kuleyin et al., 2014 [23]	2/1	383
Operational Planning in Ports: A Study on the Present State of Turkish Ports	Kişi et al., 2015 [24]	3/1	381
Cold Ironing Method; An Application of Marport Terminal	Pekşen et al., 2014 [25]	2/1	367
The Obesity Research Among the Students of Dokuz Eylül University Maritime Faculty	Nas and Okşayan, 2014 [26]	2/2	365

Reviewer Statistics

The journal has a total of 63 different reviewers who carried out a total of 139 reviews so far. The average evaluation time of all reviewers were determined 14 days. The reviewers who are on the top rank as to average review duration is shown in Table 4 in detailed.

Table 4. The Average Review Duration of Reviewers

Reviewer	Number of Reviewed Article	Number of Review	Average Review Duration (day)
Soner Esmer	2	2	1
Barış Kuleyin	3	5	2
Özkan Uğurlu	4	5	4
Yusuf Zorba	1	3	5
Ali Cömert	1	2	5
Ercan Yüksekyıldız	2	4	6
Gesa Praetorius	1	3	6
Çimen Karataş Çetin	1	3	6
Burcu Özsoy Çiçek	1	2	7
Volkan Çağlar	1	4	8
A total 63 Reviewers		**139**	**14**

The distribution of the reviewers' country is shown in Figure 4. As it can be seen in related figure, reviewers from Turkey has made the most contribution to the article evaluation process. The administrative of journal try to enhance the contribution by reviewers from different countries.

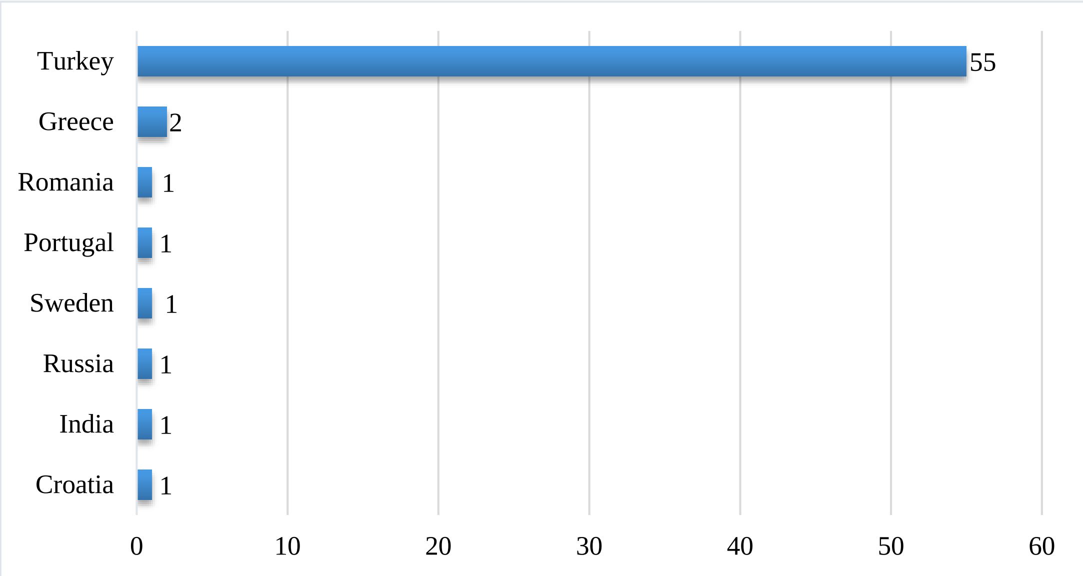

Figure 4. The Distribution of the Reviewers' Country

Author Statistics

The journal has received contribution from a total of 89 authors so far. Selçuk Nas and Adnan Parlak presented 4 articles are the authors that provide the most contribution to the journal. The other authors who are on the top rank as to contribution is shown in Table 5 in detailed.

Table 5. The Contribution of Authors

Author	Institution	Nation	Number of Article
Selçuk Nas	Dokuz Eylül University	Turkey	4
Adnan Parlak	Yıldız Technical University	Turkey	4
Alami Semma	1st Hassan University	Morocco	3
Barış Kuleyin	Dokuz Eylül University	Turkey	3
Charif Mabrouki	1st Hassan University	Morocco	3
Fatimazahra Bentaleb	1st Hassan University	Morocco	3
Durmuş Ali Deveci	Dokuz Eylül University	Turkey	3
Serdar Kum	İstanbul Technical University	Turkey	3
Umut Yıldırım	Karadeniz Technical University	Turkey	3

CONCLUSION

When it comes to 2000s, many scientific journals have become accessible via internet, but it has brought various problems to be solved including archiving, copyright and technical [1]. At this point, the indexing of journal has been come to play and contribute to the solution of these problem. Taking place in index is also extremely important for journals in order to enhance the national and international recognition. When researchers try to access any article via internet, it is easy to access the article that published in indexed journals. Many national and international indexes are available and they have various evaluation criteria. In this respect, JEMS aims to increase the number of index and database

for enhancing the recognition. In this respect, it has been applied many database and index (such as EBSCO, ISI, Proquest, and etc.) and the monitoring process is still going on. JEMS launched in 2013 has made a great development in short time. During this period, it started to indexing various database and index. The situation has brought national and international recognition to journal. The journal is currently covered by a total of 9 index and database such as ULAKBIM TR Dizin, DOAJ, Index-Copernicus, CiteFactor and etc., but the primary objective for JEMS is to be indexed by SCOPUS and Web of Science is in the near future. The impact factor is important for indexing by such index. The administrative of JEMS aims to enhance the impact factor of journal to achieve the objective.
Especially in the last one year, the editorial board have contentedly following that interest of local and foreign researchers on JEMS progressively increase. “Online accessibility of the journal” and “commencing to being searched by international indexes” can be listed as reasons of this interest. To response to this interest, administrative of the journal has decided to publish the journal from biannually to quarterly period (March, June, September and December). Additionally, it was decided to give “Best Reviewer” award for our reviewers which perform an important and valuable task in the journal. The award will be given to four reviewers which will be determined during the year considering criteria of quick, guiding, supportive and fair evaluation. These awards will not have any tangible value.

On the other hand, the request has been made to service provider for preservation policy. The preservation policy provides to preserve and maintain physical integrity of the material in any journal or library documents. If the service is provided for the policy, “Elsevier English Index” application will be made.

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AN EVALUATION OF MARITIME TRANSPORTATION AND MANAGEMENT ENGINEERING PROGRAMME STUDENTS' LEARNING STYLES: TWO CASE STUDIES

Mehmet Şeremet[1], Mustafa Samet Cetin[2]

ABSTRACT

The quality standards of vocational subjects in Higher Education needs to be revisited, focussing on different aspects. In this manner, the case studies would provide a detailed analysis to discover the issues in the wider context. While there are many studies focused on prospective teachers' and geography students' learning styles, so far, it has been little known about the Maritime students' learning styles which is always vital for organising teaching and learning activities. In this case, the current study focuses on a programme that includes both camps (Social and Sciences). This study therefore aims to discover the students' learning styles in the Deck Programmes, utilizing Kolb's Learning Style Inventory which is the most common tool to portray the way in which pupils learn. The data collected has been undertaken by the second author from two group of students reading Deck degree. The inventory has been completed by 324 students. The descriptive and inferential statistical techniques (Frequency, Chi-square and One-ANOVA) were employed to analyse the data. The results presented are placing more emphasis on the factors affecting students' learning styles such as gender, grade and personal intuitive, living place etc. In addition to these analysis, the paper presents a comparison of students' views on their learning experience in the maritime programme and their learning styles. The paper has been finalised by offering a discussion section which might offer some clues how to improve the quality of students' learning experience in Deck programmes of Maritime Faculties.

***Keywords**: Kolb's Learning Styles, Teaching, Learning, Maritime Teaching, Engineering Education.*

INTRODUCTION

Maritime training in Turkish higher education has been rapidly developing in terms of the total number of students and graduates. The issue of quality is one of the most important focus of the training in this domain. These requirements have been provided by various accreditation bodies (ISO 9001 etc.) and Ministry of Transportation, Maritime Affairs and Communications in Turkey on behalf of 'International Maritime Organisation' (IMO). Several processes are followed in ensuring the quality of teaching at higher education level. It is probably considered that the most important issues at the quality principles are students' satisfaction and evaluation of student learning experience in programmes. Maritime education and training programmes having the compulsory accreditation which is obviously as one of the routine operations which have been carried out as part of the 'IMO' requirements [1].

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Therefore, 'the opinions and suggestions of students' are the most important phases of the quality management process.

In evaluation of students' expectations and recommendations, it is a situation that is expected to be aware of the detailed specifications for the people being prepared to the programs. However, Marine Transportation and Management Engineering (MTME) programs in subjective is an engineering program which requires our knowledge of mental, namely cognitive features with the exception of their physiological characteristics (it is only tested through physical proficiency exam to which the candidates are subjected when they enrolled into the programme) of the students studying in the programmes are not much more than adequate. However, if it is considered that the students are participated in 240 ECTS credits of a 4-year programme that has a partially practical training which requires at least a 12-month practical experience in sea vessels, these students' individual learning characteristics and evaluations of the learning process are obviously important for improving the quality of the learning experiences of students who are studying in the programs.

It is not very clear that how reflections of the implementation processes were within the context of individual learning characteristics whether practical training in maritime programs have been served within the framework of the detailed information in the documents. Therefore, this study aims to determine the individual learning styles of students who receive MTME education by means of two case study programs and also it intends to evaluate that the students' learning styles which affects their learning experiences at which level. In this sense, it has been targeted to reveal through a questionnaire developed on learning styles that derived from Kolb's learning styles inventory and to achieve the following sub-objectives:

- To reveal the learning styles of MTME students.
- To explain the relationship between students' learning styles and a variety of factors.
- To reveal whether there is any relationship between learning experiences learning styles of the students.
- To evaluate critically the factors affecting students' learning experience in a qualitative manner.

LITERATURE REVIEW

There seems to be very limited research in the area of maritime education, particularly related to the domain of educational research at higher education level. Many studies conducted, so far, indicate that teaching approaches were the major focus. For example, problem-based, inquiry-based, project-based and computer-based teaching [2-4]. As for these issues, it can be stated that they focus on practical courses which are an important part of maritime education [5-7]. However, studies in the literature have shown that it is difficult to say that a single teaching strategy can be applied to all students [8-9]. In this sense, it is important to reveal the students' individual learning features in order to increase student success and the quality of teaching-learning process in the program.

There is a fact that the papers in the literature have often focused on Geography, Teacher Training, and the Basic Sciences with respect to studies on higher education students' learning styles. Therefore, this study has the feature of the first research made in both as engineering education and as maritime training in Turkey. Keefe describe learning style as environmental perceptions of individuals, an interaction with the environment is an integrated reflex patterns of their psychological and media learning, and as a mix of emotional and mental characteristic [9-10].

The learning theory model revealed by Kolb, suggests that individuals realize learning as a result of a combination of different processes such as experience, behaviour, perception and mental [11]. Therefore, he tackles learning activities model in four different stages in his developed model: Concrete Experimentation, Abstract Conceptualization Active Experience and Creative Observation. It is said that experimentation is the most suitable process for concrete experimentation; creative observation is more appropriate for learning through observation; learning through excogitation is for abstract conceptualization; as to learning by practising is for active experience. Active Experimentation says that individual take cognizance of experience rather than conceptualization and theory [9].

Researchers have identified four basic learning styles as the basis of the above-mentioned process. Individuals have an assimilation style tend to learning by observation and listening more. Even if this kind of students are especially good at bringing large sizes of knowledge and issues together, they have difficulty to take an active role in the planning and implementation processes based on the application in particular [12]. The direct instruction techniques and test approaches to information retrieval may especially be beneficial to assessment of the success at the course for assimilative students [9]. On the other hand, as to the individuals who have Diverger Learning Style mainly learn by observation methods, and they are facing more to observe the process instead of ‘right-away’ decision whether to come into activity immediately in the face of an event. The diverger students are often patient and they are thorough and process monitoring usually. However, they can learn better by activities including interactive group discussions such as group discussion and brainstorming [13].

As for the students who have Converger Learning Style are able to infer with deductive analysis, and they are individuals who have problem solving and analytical thinking skills. The individuals have converger style, especially prefer technical tasks and to deal with issues relating to social problems and they are very successful in the process of converting theory to practice. They can provide a significant contribution to problem solution and decision-making at the end of the process. In the general sense, it might be expected especially 'Converger' of individuals to be more successful in the profession considering seafaring qualifications and skills required by the profession. The prominent learning characteristic of 'Accommodation' individuals is using their learnings from the past in the most appropriate way. The individuals who learn through accommodation style have more leadership qualities, investigative and researcher personality. The other general characteristics; initiative, flexibility and being open-minded [13]. These students would rather to be involved experientially that is actively in learning process [9].

While examining the results of learning style studies for the students which have been conducted apart from maritime training programs, for example, Ozdemir revealed that the students have more Assimilator and Converger style in a research conducted by her on geography education students [14]. Similarly, there also has been led to results that has supported these findings asserted by Geçit and Delihasan in their research carried out for the geography teacher candidates [15]. There is also seen that Assimilation Style emerges as the dominant group while Converger Style is second majority way of learning in the research carried out by Can for primary school teacher candidates [16]. The similar results also ensued from the research conducted by Şahin and Çelik that has been studied up on physical education teacher candidates [17].

Especially, the emergence of Assimilative Style as dominantly shows us that the students who indigenise passive and teacher-centered education system seen at the university in Turkey [13]. In this sense, it can be expected that the students choosing discipline of physical sciences which has more practical and laboratory-based education, than the social sciences and the students who have a profile which is prone to practical and active training. In this context, if we look at the studies in the field of science, for example Converger learning style students are the dominant group of science teacher candidates, it is also observed that Converger style followed by the Accomodator style [13]. Similarly, it has been revealed that science teacher candidates have Converger style as dominant at the research done by Fettahlıoğlu [18]. In this case, especially students such as Converger can be said that they could learn better through more active and constructivist experimentation. Similarly, converger style is seen as the most referenced way of learning in the research conducted by Oskay (et al.) for Chemistry Teacher candidates [19]. However, it is seen that Assimilator style is still the second most preferred individual learning style which is remaining too much at the forefront of the researches in the social sciences particularly.

Although there are considerable researches in literature of individuals' learning styles in school education as well as in higher education, there are relatively few such studies in the field of engineering education and even there has been hardly ever at national level of Turkey. In this context, this study will reveal individual differences in learning styles of MTME program students who will have important role at vessel management in the future and also the study aimed to explain the relationship between these styles and their learning experiences in a critical manner.

METHODOLOGY

The case study has been adopted as the research model for the research method. The most important feature of this method is having in-depth knowledge on the subject within the scope of samples selected and to increase the generalizability of the results [20]. In this context, two established organizations have been selected as a case study for programs that provide training for MTME in Turkey. Particularly, a variety of convenience features played an essential role in the selection of these programs. Foremost among these can be expressed as the program curriculum features that share similarity with other programmes, different regional distribution of the students who has chosen these programs, collaboration and good communication that have been shown to researchers. Except for 3rd grade students training in the program, the questionnaire was conducted on the total of 364 students by the second researcher personally in the spring semester of 2015-2016 academic year. 3rd grade students are not included in this application on the occasion of the open sea training period of themselves currently. However, it is considered to create any negativity in terms of generalizations of this research to programs due to not vary much with friends of these students training in other classes within the framework of the transcript information obtained from student records and also because of the lecturers who attended these students' class in the first course period were of the single mind about this result. In addition, little or nothing impact on the learning style of the class variable as in many studies in the literature can be stated as another reason why this situation can be tolerated. Some students are excluded from the questionnaire evaluation because they have shown poor performance and negligence while filling out forms during conduction of questionnaires. Therefore, only 324 of total 364 students participated in the survey were included in the data analysis of the survey results for the learning styles.

A questionnaire also including the Kolb's learning inventory was used throughout collecting data and there are 3 groups question parts in the form. While questions for the demographic characteristics of students take place in the first group of questions, there are the questions located in this part especially as students' gender, age, class, whether they live in the seaside town before getting into the university and their interests in topics for the program. Also in the second section, learning style inventory that developed by Kolb adopted into Turkish form by Gencel was attached to the questionnaire, providing the necessary permissions from the researcher [21]. In this sense, a similar process was not followed in this process in as much as the validity and reliability of inventory is made by Gencel [21].

In the last chapter there is a section consisting of closed-ended questions of which pilot applications have been made and also that used by researchers in various researches and two open-ended questions that follow them. This section in particular has been included in the questionnaire in order to respond to associated research questions in the process of revealing the relationship between students' learning styles and their learning experience.

Both quantitative and qualitative data analysis methods have been put to work in the analysis of the data. Also both descriptive and inferential multivariate statistical techniques were used in the process of qualitative data analysis. Frequency analysis, Chi-square, one-way ANOVA and Spearman correlation analysis techniques are utilized in the analysis of quantitative data.

FINDINGS: STUDENT LEARNING STYLES AND LEARNING EXPERIENCES

Learning Styles of Maritime Transportation and Management Engineering Students

Having looked at the demographics of the respondent students in Turkey, gender and age distribution of those who prefer this program shows similarities with data obtained from other college students. (Female = 7.5%, male = 92.5%). Here, it is seen that especially female students are quite few in number in a comparable level. But in this case, it is obviously shown a similar feature of this condition if it is looked at the distribution in the number of students of other countrywide programs (female = 10%, male = 90%) according to student selection and placement centre (OSYM) in 2013 [22]. Therefore, it has not been reached statistically significant results in chi-square analysis that queried whether gender have an effect upon learning styles. Here, female students relatively few in number than male is considered to have a share in this condition. Nevertheless, these results which were similar in the studies carried out in other departments and programmes showed almost equal gender distribution revealed that there is no ‘bias’ in this circumstances [14, 16].

When glimpsed into the students' learning characteristics in general at descriptive level, most of the students seems to have ' Assimilative ' feature (%35.4). This learning style is followed by students’ 'Converger' style with the rate of 30.7 percent. The students who have 'Diverger' and 'Accomodater' learning aspects constitute the minimum two rate (Table 1). In light of this view, distribution of MTME students' learning styles have demonstrate compatibility with the learning styles of the students studying in the social sciences program characteristically. If it is referred to the topics which attract the majority of the students studying in MTME programs it seems that the students stated themselves as more relevant to lessons including 'Simulator Applications and Navigation (39.8%)', 'Seamanship (%39.5) ' and again the lessons that includes application based course and trainings in general. In this sense, learning characteristics of students ' Converger ' to be seen as normal. However, A substantial majority that have ' Assimilator ' style here refers to the situation a little contrast. It can be explained with the individuals that come of traditional education system in general and the rate of the theoretical training to the practical training in program. On the other hand, the low motivation of students in the applied training that revealed by the real case observations which were carried out by the second author of the article, which can be considered as potential impacts of the students coming from an education tradition which make the students passive at learning continually.

Table 1: Descriptive Statistics Results of the Students' Learning Styles

Learning Styles	N	Frequency (%)
Assimilative	128	35,4
Diverger	60	16,6
Accomodater	25	6,9
Converger	111	30,7
Total	324	100

It was analysed through chi-square and one-way ANOVA which were good compliance tests whether the learning characteristics of the students have a statistical discrepancy or not with regard to variables as gender, age, grade and program. According to statistical data analysis, it has revealed no statistically significant results for none of variables (Table 2). With respect to these findings it shows that the demographic factors have not been changed the framework of students' learning styles also shows that a great fit for generalization of the results.

Table 2: Hypothesis test results according to statistical analysis of demographic variables.

Chi-square Variables	$\chi 2$	Probability	H0 Accept/Refuse
Gender	3,484	0,323	Accept
Age	6,603	0,359	Accept
Grade	10,954	0,090	Accept
Program	5,834	0,120	Accept

Even so, if we look detailed in 'grade' variable which that rarely makes statistical discrepancy in other studies, the 1st grade students that remain between 'Assimilative' and 'Converger' is especially seen to be the most fundamental difference between the observed two basic learning styles. It has been revealed that this difference reduced as progressed towards the upper grades (Table 3).

Table 3: Distribution of MTME students' learning styles according to variables.

	Learning Styles									
Variable	**Assimilative**		**Diverger**		**Accomodater**		**Converger**		**Total**	
Gender	N	%	N	%	N	%	N	%	N	%
Female	8	%33,3	2	%8,3	3	%12,5	11	%45,8%	24	%7.4
Male	120	%40,0	58	%19,3	22	%7,3	100	%33,3%	300	%92.6
Age										
17-19	8	%38,1	3	%14,3	0	%,0	10	%47,6%	21	6.5
20-22	77	%40,3	41	%21,5	19	%9,9	54	%28,3%	191	%59
22+	43	%38,4	16	%14,3	6	%5,4	47	%42,0%	112	%34.6
Grade										
1.Grade	43	%40,0	21	%12,4	8	%6,7	28	%41,0	100	%30.9
2.Grade	43	%36,1	26	%21,8	10	%8,4	40	%33,6	119	%36.7
4.Grade	42	%40,0	13	%12,4	7	%6,7	43	%41,0	105	%32.4
Program										
Department 1	64	%36,6	28	%16,0	13	%7,4	70	%40,0	175	%54
Department 2	64	%43,0	32	%21,5	12	%8,1	41	%27,5	149	%46

Comparison of Learning Experience and Student Learning Styles

There was no statistically significant relationship between the learning styles and neither of teaching-learning process and assessment-evaluation process in the results of the tests that have been compared individuals' comments from their learning styles to learning experiences consisting of teaching-learning process activity and assessment-evaluation activity (Table 4). However, significant results have been achieved in the chi-square analysis made of the learning experience for individuals with demographic variables (Table 4). Chi-square analysis results has revealed significant results for teaching and learning activities according to variables of age, class and program. However, it was observed that assessment-evaluation activities have statistically significant discrepancy only for age and class variables. Here it is seen that class (grade) variable especially moved along with the age variable. With this emerged result, it can be said that experiences in different grades showed a variability. In this sense, although there are more sharings about students' individual learning characteristics compromising with teaching-learning activities especially in the lower grades, it is seen that this ratio has decreased towards the upper grades. It is possible enough to say that similar situation is also valid for assessment-evaluation activities. This situation may be related to the shortage of application oriented lessons due to both theoretical and service courses (especially basic science lessons) many more at the lower grades despite the increased number of application courses in the upper grades. Especially when it has taken into account the status of going to sea training as from the end of the 1st grade it can be alleged that this result is about what students' expectations differ from the lower classes towards the upper class. Although there is no statistical difference in learning styles, it has emerged a significant difference between the two programs for teaching-learning activities in this study which was conducted in two different sample departments. This in terms of learning styles may be related to Converger Learning Style is proportionally more at the students involved in the first program compared to students of the second sample program.

Table 4: Hypothesis testing results according to performed statistical analysis of the individuals' learning experiences on demographic variables.

Variable	χ^2	*Probability*	*H0 Accept/Refuse*
Gender TLA	,959	,619	Accept
Gender AEA	1,688	,430	Accept
Age TLA	14,072	**,007**	Refuse
Age AEA	27,028	**,000**	Refuse
Grade TLA	15,235	**,004**	Refuse
Grade AEA	42,480	**,000**	Refuse
Program TLA	33,548	**,000**	Refuse
Program AEA	1,764	,414	Accept

However, a significant relationship which was at low level and in the positive direction has been found in Spearman correlation analysis results that has been made to measure the relationship between the students' answers about TLA and AEA ($r=0,387$, $p<0.05$). The two major components of the learning experience seem to be interrelated according to the results of the correlations.

Despite the statements of the students who gave 'yes' answer to 'TLA' questions (%52.5) and expressed that they were generally compatible with the learning styles, they present a variety of opinions with regard to increasing application size.

Table 5: Comparison of compliance with individual learning styles and their learning experience.

	Learning Styles				
	Assimilative	**Diverger**	**Accomodater**	**Converger**	**Total**
Yes	68	32	16	49	190
No	37	13	7	47	111
No Comment	23	15	2	15	61
Total	128	60	25	111	364

$\chi 2=12,55$ sd=8 p=0,051

There is an apparent discrepancy arises with reference to the students who gave 'No' answers (%30.7) taking more place in 'Converger' learning groups and who were expected that they learn best through 'problem-solving' and 'application based' trainings mostly. This disequilibrium attracts the attention at foremost among the most emphasized points by the students indicating incompatibility.

When we look at the students' comments for the evaluation, despite not any appearance of a difference ($\chi 2=2.67$, $p>0.05$), the results show that the students' learning styles comply with the evaluation method. However, within the framework of qualitative data, various opinions have emerged of the students. It is not escape the attention that the students who said 'No' (%42.8) brought several critics to this case in their reviews. The students are expressing that process based evaluation is more necessary in activities related to assessment-evaluation.

However, one of the most important complaints to the evaluation process is also about the differences between learning outcomes of the courses and evaluation methods. The students, while expressing their satisfaction with the teaching methods of the courses on the other hand, they say that the evaluation instruments of the courses are not applicable for the lesson contents.

The students who evaluate their own learning styles were in accordance with measuring techniques (%43.6), expect to review and try to learn by more information memorisation. It seems that the participants who said 'Yes' have positive interpretations.

One of the most important points that indicate students who find it difficult to express their opinions by joining these two views as stated above, the students' general expectation from theoretical lessons was realized in the form of theoretical exam while they were not satisfied particularly with their examinations which applied to the practical courses.

DISCUSSION AND CONCLUSIONS

The scope of the two example programs in this research it was discussed with a critical approach to the comparison of the learning experiences and their learning styles of "MTME" program students. When examining the key findings of the research it is seen that students learn through more Assimilation and Converger of learning styles. In this regard, a lot of research done in compliance with the literature as mentioned [14-16]. However, due to many of these studies were for the students studying social sciences program there was no difference occurred between the results despite the students who were studying at maritime programs and checked in at the program by MF-4 (mathematics and science) and YGS-1 score in the transition to higher education examination (YGS) and the undergraduate placement exam (LYS). However, it maybe occurs one of the main differences in here that the divergence between 'Assimilation' and 'Converger' is not too much proportionally. Still, the difference between the findings of this study and other studies on the students in science is clearly striking [13, 18, 19].

Perhaps one of the most emerging difference in here that was in the nature of the program is predicted as the basic science courses make the students placing a passive position which was required for engineering formation in maritime program given in the early years. This is also one of the most important factors especially which reduces the motivation and the level of satisfaction of the students in the maritime training [23]. In particular the 'Converger' learning style can be considered one of the most suitable because of the developed active and problem-solving-based learning for the students like as maritime (MTME) students who therefore have professional experience which includes at least a 12-month period of open sea training before graduation.

Nevertheless, it is an issue to be emphasized is a considerable level of the individuals who learn by listening and watching only through 'Assimilative' learning style and how successful these students may be in ship management profession which requires the skills of leadership, good organizational and problem solving. It can be assumed as one of the main indicators of this condition that the students turning onto an idea of changing their careers in the profession after their open sea training experience which is the primary of the findings revealed by Şeremet [23]. On the other hand, the structure of general education system and the student's past experiences can also be considered to be effective at this point. For example, as highlighted by Gencel and Kose, it can be considered as it stems from that the individuals have regarded their instructors as the main focus of knowledge and experience with their learning traditions from the past [13].

It reveals that none of the variables is a significantly factor according to the findings of the analysis carried out for that at what level demographic variables on the learning styles of the students were effective. In this sense, these findings differ from the findings of many studies in the literature. This results, especially for the gender variable, reveal a very consistent results with literature [14-16, 24]. However, a variation is emerging in terms of some variables: For instance, while 'grade' variable causes a variation by chi-square test in the study of Ozdemir, it has not been reached similar findings at ANOVA test by him. It shows that the individuals' learning styles cannot be determined by variables such as gender, age, grade (class) and interest, so it already complies with the situation expected.

One of the issues expressed by Kolb is that the learning styles can be standardized pursuant to a variety of curriculum [11]. In this sense, 'Assimilative' is emerging as the dominant way of learning in the programs which is socio-scientific or in other words admits the students by 'TS' and 'TM' scores (score types of social science in the transition to higher education examination). However, although there is not existing extensive researches, it appears that there is a variation with respect to learning styles between the prospective science teachers and the other students who were admitted the program by 'MF-2' score (score type of science and math in the transition to higher education examination) [18, 19, 25]. Nevertheless. In the research conducted on 'MTME' students, it seems that maritime students are in tendency to approximate the Social Sciences content programs more.

The findings of the learning experiences and the learning styles of the individuals as for it is observed that the results were compatible in general. The nature of this program, instructor-centred lecture is seen as one of the predominance of learning and teaching based activities. However, one of the points which is ignored especially by the students is that the number of students and crowded classrooms were seen to exceed the equilibrium of student-instructor numbers in the programs. Although the students mostly express that their learning styles were in great harmony with the teaching-learning activities, they particularly underline the need to increase the proportion of practical (applied) training in their comments marked through qualitative data. It is also very important for a considerable amount of student, who learn by 'Converger' style, to learn better and to be able to provide career advancement. As it was also stated in the Oskay's findings that the students especially learning by 'Converger' style wanted to see more practical and problem solving exercises [19]. In this sense, the activities used in the teaching-learning processes in the maritime education must be diversified.

There is the educational assessment process which is one of the most important phases in the students' learning experiences. In line with the results from here, it seems to come to the forefront that educational assessment was for the students to recall information in order to pass the course rather than it was a learning tool. But even here, it can be seen among the factors which reduces the quality of the learning experiences of the students that there was used conventional measuring (assessment) instruments even in practice-based lessons. Nevertheless, quantitative findings which has been put forward by the students verify that the students' learning experiences were quite consistent with their learning styles.

As it was expressed by Abdulwahed and Nagy that a good pedagogical practice process could be turned into a good engineering education by transferring from theory to practice through a well-planning [26]. Hereby in this research, it has been attempted to develop a critical approach for the students' learning styles and their learning experiences through two sample programs. It can be presented important contributions to improving the quality of the learning experiences of the students studying at the Maritime education programs. Within this scope, there is a need for more extensive studies for learning characteristics of maritime students.

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MARITIME VOCATIONAL SCHOOL STUDENTS' OCCUPATIONAL CHOICE PROFICIENCY AND THE FACTORS EFFECTING THEIR OCCUPATIONAL CHOICE

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ABSTRACT

Vocational High Schools have a significant place in the national education system and contribute to the economy by fostering qualified mid-level technician. Students give direction to their future by chosing their major in the vocational high school at a very early age. Dissatisfaction of occupation due to choose made at early ages result with waste of resources which effect not only students and their families but also the national economy. In this study, occupational choice subject was examined on specific to 'marine occupations'. Factors affecting their occupational choice which is made at early ages and level of satisfaction from their occupational choice investigated by raking method. Frequency, ANOVA and T-test analysis were performed in the analysis of research data. Questionnaire survey conducted was on the students in severel maritime high school in the Izmir Region namely İzmir Çeşme Ulusoy Maritime Anatolian Vocational School, İzmir Güzelbahçe İMKB Maritime Anatolian Vocational School and İzmir Konak Nevvar Salih İşgören Maritime Anatolian Vocational School. Survey carried out in 2013-14 academic year. Results revealed that most of the students making their occupational with their own decision or under the influence of their families. The satisfaction level of students from their occupational choice is increasing day by day. Males think they are suitable for marine occupation and are more satify than female at occupational choice. Also it was appointed that there are significant differences at the analysis factors between the schools.

Key Words: *Marine Occupation, Occupational choice, Factors affecting occupational choice*

INTRODUCTION

Occupation is to produce useful goods or services for people to earn money in return, acquired by specific training, based on systematic knowledge and skills, the whole activities which its rules are determined by community [4]. Choosing the suitable occupation for individuals ensure to make their job caresively, to advance in their occupation and thus resume their lives both happily and productively. From this aspect occupational choice is important in terms of personal and social happiness.

Occupational choice process is tendency to an occupation which is within the bounds of possibilities and have stronger positive aspects. But ideally, individuals should make their occupational choice by reducing the chance and probability factor to minimum degree and taking into account their interests, skills and significances [6]. Occupational choice is a

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process from childhood ages until occupational choice. This process has been examined under different theories. Development theorists emphasize the self-concept consisting of the interaction between the individual and the environment [3], behaviourists emphasize the anxiety concept consisting on individuals as a result of the generalizations and beliefs [1], structuralists emphasize economical, sociological and psychological structure of society [9], fractionalist theorists emphasize the personel characteristcs of individual [1] and needs theorists emphasize the attitude of parents [2].

Vocational guidance is very important with the aspect of the maturity of occupation choice which the individual wants, likes and can do [7]. In Turkey, the students which choose the vocational high school before the end of puberty ages, don't benefit from vocational guidance fully because vocational guidance services focus on transition from high school to college [8]. While their peers which educated in Anatolian high school, reach to the maturity of occupational choice during 4 years high school education, the students which tend to vocational high school finalise their occupational choice process. What extent do the maritime vocational high school's students make their occupational choice according to their skills and interests? This is the main question of the research and the response of this question is tried to find. Maritime occupation is an occupation which is vulnerable to danger, profess under severe nature condition and done away from the home and has rigid hierarchical structure, in addition to being large employment opportunities [5].

Vurucu (2010) has reach the conclusion of being effective in decision of choice the vocational high school, first the student's own decision and then their family's wishes and their course grade, being satisfied from their occupational choice, not thinking change their occupation and the student's which choose their occupation fondly having high occupational choice capability at the research of 13 different field of occupation.

METHODOLOGY

Aim

The aim of the research is determining the factors of affecting the occupational choice of the maritime high school students which tend to marine occupation at early age, capability of their choice and the satisfaction level from their choice.

Data Collcetion Method

'Occupational Choice Satisfaction Questionnaire', 'The Questionnaire about Factors Affecting Occupational Choice' and 'The Scale of Occupational Choice Capability' which were developed by Vurucu (2010), were applied on April 2014 to the 9th, 10th, 11th and 12th grade students of Çeşme Ulusoy Maritime Anatolian Vocational High School, İzmir Güzelbahçe İMKB Maritime Anatolian Vocational High School and İzmir Konak Nevvar Salih İşgören Maritime Anatolian High School with the permission of İzmir Provincial Directorate for National Education dated 21.01.2014.

Universe and selection of participants

The universe of our research is the students which educate on the field of maritime in high school level. In this context, it's determined that three maritime vocational high school in

İzmir. The questionnaire was applied to students of Çeşme Ulusoy Maritime Anatolian Vocational High School, İzmir Güzelbahçe İMKB Maritime Anatolian Vocational High School and İzmir Konak Nevvar Salih İşgören Maritime Anatolian High School. 680 students of total 784 students joined the research and 637 (%81) of them were elegible for analysis. 43 questionnaire were cancelled due to filling error.

Data Analysis Method

Frequency, ANOVA and T-test analysis were performed in the analysis of research data. Research data were analyzed using SPSS 20 software. The significance level was accepted as P <0.05 as in the statistical analysis.

RESULTS

Analysis of Affectings the Occupational Choice of Students

In Figure-1, those who affecting the students' occupational choice shown as graphic. Most of the students who join our research, declared that make their occupational choice with own decisions (%57,16) and their family's wishes (21,94).

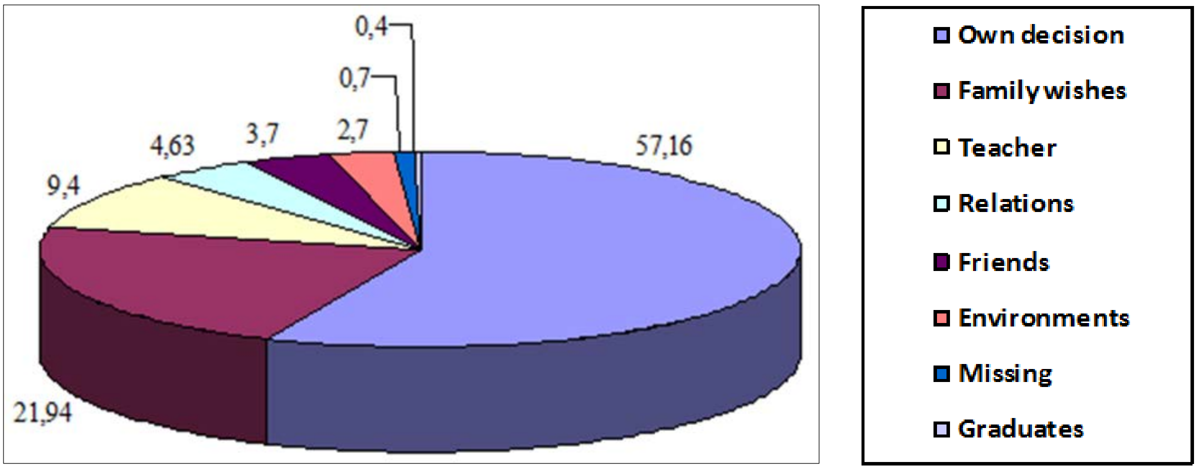

Figure 1- Affectings the occupational choice

Analysis of Factors Affecting the Occupational Choice

Anova and T-test analysis were performed for indicating the significant differences between 'The Questionnaire about Factors Affecting Occupational Choice's variables and profile datas of students. Test analysis shown on Table-1. It is appointed that the students of Çeşme Ulusoy M.A.V.H.S. take in consideration the socio-economical status and family' wishes factors more than the students of Nevvar Salih İşgören M.A.V.H.S. while making their occupational choice. Male students take in consideration socio-economical status more than female and female students take in consideration course grade more than male while making their occupational choice. Also new generation students take into consideration course grades.

Tablo 1: Relation between 'The Questionnaire about Factors Affecting Occupational Choice's variables and profile datas of students.

FACTORS AFFECTING OCCUPATIONAL CHOICE	PROFILE DATAS		
	Schools	Gender	Rank
Socio-economical status	✓	✓	x
Family' wishes	✓	x	x
Friends and surroundings	x	x	x
Course grade	x	✓	✓

✓ :Supported x: Non supported

✓

Analysis of the Scale of Occupational Choice Capability

Anova and T-test analysis were performed for indicating the significant differences between 'The Scale of Occupational Choice Capability's variables and profile datas of students. Test analysis shown on Table-2. It is appointed that the students of Çeşme Ulusoy M.A.V.H.S. has adequate capability more than the students of Nevvar Salih İşgören M.A.V.H.S. Male students declare that marine occupation is convinience to their skills and phsical features. Female students are hopeful employment opportunity and retiring condition on marine occupation. New generation students have more information about marine occupation and its advantages/disadvantages.

Tablo 2: Relation between 'The Scale of Occupational Choice Capability's variables and profile datas of students

THE SCALE OF OCCUPATIONAL CHOICE CAPABILITY'S VARIABLES	PROFILE DATAS		
	Schools	Gender	Rank
The place of occupation in society	x	x	x
Well-informed about occupation	✓	x	✓
Convenience to skills	✓	✓	x
Convenience to physical features	✓	✓	x
Information about other occupations	x	x	x
Find employment opportunity	✓	✓	x
Career advancement opportunity	x	x	x
Retiring condition	x	✓	x
Opportunity to gain in future	✓	x	x
Advantages / Disadvantages	x	x	✓
Information about work environement	✓	x	x

✓ : Supported x: Non supported

Analysis of Occupational Choice Satisfaction Questionnaire

Anova and T-test analysis were performed for indicating the significant differences between 'Occupational Choice Satisfaction Questionnaire's variables and profile datas of students. Test analysis shown on Table-3. The students of Çeşme Ulusoy M.A.V.H.S. are more satisfy than the students of Nevvar Salih İşgören M.A.V.H.S. Male students like the marine occupation more than female. New generation students like the marine occupation more than the olders.

Tablo 3: Relation between 'Occupational Choice Satisfaction Questionnaire's variables and profile datas of students

'OCCUPATIONAL CHOICE SATISFACTION QUESTIONNAIRE'S VARIABLES	PROFILE DATAS		
	Schools	Gender	Rank
Transition to college	✓	x	✓
Change of the occupation	✓	x	✓
Like the occupation	x	✓	✓

✓ **: Supported** **x: Non supported**

CONCLUSIONS

Most of the students which tend to maritime vocational high school indicate making their occupational choice with their own decision or under the influence of their family's wishes. And also half of the students don't care about their own decision while making occupational choice. The students perceived the solutions and decisions which have been made by their family or surroundings, are right and thus the decision making ability of the students are impaired day by day.

The students of Çeşme Ulusoy Maritime Anatolian High School which is located far from İzmir city center, taking into consideration their family income levels and make their occupational decisions consciously more than the students of Nevvar Salih İşgören Maritime Anatolian High School which is located in İzmir city center.

The male students think they are more suitable on physical features and skills for marine occupation according to female students. Males are also more satisfy than females at their choice. Although the female mariners numbers increasing day by day, it is clearly understood that the perception of marine occupation is an males' occupation is continue in Turkey.

It is appointed that the new generation students to marine occupation are more satisfy. So we could think there are positive developments at the vocational guidance day by day in Turkey. The numbers of right decisions on occupational choice has increased according to vocational guidance about field of occupation for the students which plan to tend to vocational high school.

It's necessary to understood the perception of occupational choice is a process which is shaped since childhood and occupational guidance should be extended to cover all ages of students. It should guide to individuals in order to explore their own interests, skills and wishes while they are making occupational choice which holds important place in their life. By this means it could be provided social and individual happiness. At the same time it would have been an education system used the country economy efficiently.

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THE ROLE OF MARINE SIMULATOR INSTRUCTORS IN HIGH SCHOOLS

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ABSTRACT

In our country, maritime education is carried out under the provisions of the International Convention on Standards of Certification and Watchkeeping (STCW) which recognized by Turkey. This convention entail the simulator based maritime training. Therefore, in our country, fifty high schools equipped with several simulators to provide simulated based maritime training. Acording to the data which are received from Seafarers Training Information System (GAEBS), fortyone of them are authorized to provide the maritime training and seven of them are waiting to be authorized. Although simulators are expensive educational tools,they are prefered to improve quality of education by the authorities. Because of this, some question could be occured. For example, Could the presence of the simulators be enough alone to improve the quality of maritime education? and What is the role of the educator in the simulator based maritime training? The role and qualification of marine simulator instructors evokes considerable discussion and debate. Some people in the marine simulator field believe the instructor is the most important training element; others believe the trainee is the most important part of the simulation because beneficial changes in trainee behavior and performance are the desired product. A third view is that the simulator and the simulation produced are particularly important In the light of the above mentioned explanations,this paper has aimed to analize the role of marine simulator ınstructor in high schools and reveal the troubles about using simulator effectively. The study has been limited to ship management departmant in high schools and will be conducted using paper questionnaires.

Keywords - high school, marine simulator ınstructor, simulator based maritime training

INTRODUCTION

Simulators are computer assisted teaching type that provides more permanent learning,motivation and object teaching close to the real life rather than the other methods.

The usage of the simulators in marine teaching is dependent on a standart which our country has also signed in according to the international contracts parallel to the 02.03.2013 dated and 14739 numbered proviso 47 “Seamanship Training and Exam Directives.According to this prescription,the schools that give marine teaching; are equipped with necessary simulators related to their marine branches that they teach.

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According to this item;

All the available simulators in the training institiutions need to provide the stated condiions in STCW Contract rule I/ 12 , A-I / 12 and B- I / 12 .And they need to have the certificate of convenience organized by internationally accepted classification foundations onthe necessary training.The simulators that are approved will get registered to GAEBS.

Unapproved simulators won't be accepted for the related training..

The simulators necessary to be approved are :
a) Top of the bridge Simulator
b) Engine Control Room Simulator
c) Petroleum,Chemical and Liquefied Gas Tanker ,Load Lifting Simulator
ç) ECDIS (Electronic Chart Display and Information System) Simulator
d) GMDSS (Global Maritime Distress Safety System) Simulator
e) RADAR (Radio Detection and Ranging) Simulator
f) ARPA (Automatic Radar Plotting Aids) Simulator

In accordance with this item ; the chools that give maritime training ,are equipped with the necessary simulators on their field of maritime teaching..The main target of using that expensive technological equipments in seamenship training is its contribution to the teaching .But it is open to the debate whether the usage of only simulators in teaching is sufficient to the realization of learning or not.A lot of research has shown that the importance of instructor is in the first place in this field.Although simulators are equipped with latest technology and software ; they can’t contribute to learning without the guidance of instructors.In order to use technology effectively in teaching system and get the intented performance ; it is not only necessary to have the new and technologically advanced devices, but also we require trainers who can pilot technology and trainees and who knows a lot about these technological appliances and who can plan their teaching using these.

Even though infinite resources are given to the infrastructure investments,it is not possible to fulfil the need of qualified seaman ,the most important component of intellectual fund that is to convert these resources into value.The value of infinite infrastructure resources will be only like the value given to the human fund. From this it is understood one more time that the human fund is the most critical resource to increase the supply of qualified seaman. (Nas, 2011).

The Brief Analysis Of High Schools

From the year 2016 .according to the data received from GAEBS (Seafarer Training Information System) 50 schools give maritime training lessons.In table 1 , we can see the scholls that give maritime training in Turkey and their branches and their related parts.When we examine Table 1 ,we can see 2 of the schools are private among these 50 schools. 41 schools are capacitated .In these schools ,12 of them don't have the branch of " SHIP MANAGEMENT " .As the Ministry of Education doesn't assign teachers to the Private Schools,these schools are left out of running like the schools that don't have the "Ship Management " field.Only 32 of these 50 schools have "Ship Management " branch so analyzing covers only these 32 schools.

In the table below, we can see the capacitated schools,unauthorized schools and authority expectant schools.But there can be some alterations from the continuous controls of the Ministry of Transmission,Maritime and Communication .

Table 1 : The Schools teaching Ship Management in Maritime Training

	NAME OF THE SCHOOL	NAME OF THE PORT	SCHOOL DEPARTMENTS
1.	ANTALYA KONYAALTI FETTAH TAMİNCE VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	ANTALYA	SHIP MANAGEMENT MARINE ENGINE
2.	ANTALYA MANAVGAT TİCARET VE SANAYİ ODASI (MATSO) MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	MANAVGAT	SHIP MANAGEMENT YACHT MASTER
3.	AYDIN DİDİM SELÇUK ÖZSOY GIRLS' TECHNICAL AND VOCATİONAL HİGH SCHOOL	KUŞADASI	MARINE ENGINE SHIP ELECTRONICS AND COMMUNICATION
4.	BİTLİS TATVAN MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	TATVAN	SHIP MANAGEMENT
5.	ÇANAKKALE GELİBOLU ARMATÖR YAKUP AKSOY) MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	ÇANAKKALE	SHIP MANAGEMENT MARINE ENGINE SHIP BUILDING DECK DEPARTMENT
6.	GİRESUN BULANCAK KAPTAN AHMET FATOĞLU MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	GİRESUN	SHIP MANAGEMENT MARINE ENGINE
7.	GİRESUN ESPİYE ŞEHİT CENGİZ SARIBAŞ TEKNİK VE ENDÜSTRİ MESLEK LİSESİ, MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL , MARITIME HIGH SCHOOL	TİREBOLU	MARINE ENGINE FISHING BOAT MASTER SHIP MANAGEMENT
8.	GİRESUN TİREBOLU PİRİ REİS VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	TİREBOLU	SHIP MANAGEMENT
9.	HATAY İSKENDERUN SEFA ATAKAŞ VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	İSKENDERUN	SHIP MANAGEMENT MARINE ENGINE
10.	HATİCE ERDEM VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	KDZ. EREĞLİSİ	SHIP MANAGEMENT MARINE ENGINE
11.	İNEBOLU MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	İNEBOLU	SHIP MANAGEMENT MARINE ENGINE
12.	İSTANBUL BEYKOZ BARBOROS HAYRETTİN MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	İSTANBUL	FISHING BOAT MASTER SHIP MANAGEMENT MARINE ENGINE FISHERY PRODUCTS
13.	İSTANBUL BEŞİKTAŞ ZİYA KALKAVAN VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	İSTANBUL	SHIP MANAGEMENT SHIP ELECTRONICS AND COMMUNICATION, MARINE ENGINE
14.	İSTANBUL PENDİK BARBAROS HAYRETTİN PAŞA VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	TUZLA	SHIP MANAGEMENT MARINE ENGINE
15.	İSTANBUL PENDİK ERYETİŞ REİS MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	TUZLA	SHIP MANAGEMENT

16.	İSTANBUL TUZLA PİRİ REİS MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	TUZLA	SHIP MANAGEMENT MARINE ENGINE
17.	İSTANBUL ÜSKÜDAR HACI RAHİME ULUSOY MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	İSTANBUL	FISHING BOAT MASTER YACHT MASTER SHIP MANAGEMENT
18.	İZMİR ÇEŞME ULUSOY MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	ÇEŞME	SHIP MANAGEMENT MARINE ENGINE YACHT MASTER
19.	İZMİR ÇINARLI TEKNİK VE E.M.L MARITIME VOCATIONAL HIGH SCHOOL	İZMİR	FISHERY PRODUCTS FISHING BOAT MASTER (NOT ACTIVE)
20.	İZMİR GÜZELBAHÇE İMKB MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	İZMİR	SHIP MANAGEMENT FISHERY PRODUCTS YACHT MASTER
21.	İZMİR KONAK NEVVAR SALİH İŞGÖREN MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	İZMİR	SHIP MANAGEMENT FISHING BOAT MASTER
22.	İZMİR ŞEHİT İDARİ ATEŞE ÇAĞLAR YÜCEL MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	İZMİR	MARINE ENGINE
23.	KOCAELİ GÖLCÜK MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	KOCAELİ	SHIP MANAGEMENT MARINE ENGINE
24.	KOCAELİ KÖRFEZ HEREKE NUH ÇİMENTO MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	KOCAELİ	SHIP MANAGEMENT
25.	KUŞADASI ADVİYE ERTUĞRUL ACUN VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	KUŞADASI	SHIP MANAGEMENT
26.	MUĞLA BODRUM VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	BODRUM	YACHT MASTER
27.	MUĞLA BODRUM TURGUTREİS ANATOLIAN HOTEL MANAGEMENT AND TOURISM VOCATIONAL HIGH SCHOOL	BODRUM	YACHT MASTER
28.	MUĞLA BOZBURUN DTO MULTI-PROGRAM HIGH SCHOOL	MARMARİS	YACHT MASTER
29.	MUĞLA KÖYCEĞİZ VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	GÖCEK	YACHT MASTER
30.	MUĞLA MARMARİS 75.YIL VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	MARMARİS	YACHT MASTER
31.	ORDU FATSA ATATÜRK VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	FATSA	SHIP MANAGEMENT MARINE ENGINE
32.	RİZE ARDEŞEN IŞIKLI VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	RİZE	MARINE ENGINE
33.	RİZE ÇAYELİ AHMET HAMDİ İSHAKOĞLU VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	RİZE	MARINE ENGINE SHIP MANAGEMENT
34.	RİZE HASAN KEMAL YARDIMCI İMKB MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	RİZE	MARINE ENGINE SHIP MANAGEMENT

35.	SAMSUN TEKKEKÖY NEDİME SERAP ULUSOY VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	SAMSUN	SHIP MANAGEMENT MARINE ENGINE FISHING BOAT MASTER
36.	TRABZON ÇARŞIBAŞI MARITIME VOCATIONAL HIGH SCHOOL	TRABZON	FISHERY PRODUCTS
37.	TRABZON OF HACI MEHMET BAHATTİN ULUSOY VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	TRABZON	MARINE ENGINE SHIP MANAGEMENT
38.	TRABZON ORTAHİSAR VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	TRABZON	MARINE ENGINE
39.	TRABZON SÜRMENE TÜRK TELEKOM VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	SÜRMENE	MARINE ENGINE
40.	VAN MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	TATVAN	SHIP MANAGEMENT
41.	YALOVA ALTINOVA TERSANE GİRİŞİMCİLERİ A.Ş. MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	YALOVA	MARINE ENGINE SHIP MANAGEMENT
	AUTHORITY EXPECTANT SCHOOLS		
42.	BALIKESİR AYVALIK PAKMAYA KENAN KAPTAN MARITIME ANATOLIAN VOCATIONAL HIGH SCHOOL	AYVALIK	SHIP MANAGEMENT MARINE ENGINE
43.	ERDEK KARŞIYAKA MULTİ-PROGRAM HIGH SCHOOL	ERDEK	SHIP MANAGEMENT FISHING BOAT MASTER
44.	ISPARTA EĞİRDİR MARITIME VOCATIONAL HIGH SCHOOL	ANTALYA	SHIP MANAGEMENT
45.	İZMİR KARABURUN MORDOĞAN FATMA EMİN KARAAĞAÇ MULTI-PROGRAM HIGH SCHOOL VE MARITIME VOCATIONAL HIGH SCHOOL	İZMİR	FISHERY PRODUCTS
46.	İZMİR ÖZEL ALBATROS VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	İZMİR	SHIP MANAGEMENT MARINE ENGINE
47.	SİLİFKE TAŞUCU PROFESÖR DOKTOR DURMUŞ TEZCAN VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	MERSİN	SHIP BUILDIG
	SUSPENDED AUTHORITY		
48.	MERSİN DENİZ TİCARET ODASI VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	MERSİN	SHIP MANAGEMENT
49.	SİNOP SEYDİ ALİ REİS VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	SİNOP	MARINE ENGINE
50.	KUMBAĞ VOCATIONAL AND TECHNICAL ANATOLIAN HIGH SCHOOL	TEKİRDAĞ	MARINE ENGINE

The departments that are to guide the “ Yacht Master Programme and Fishing Vessel Master Programme are also same and no special quality is pointed out.The teachers designated with the title of vessel supervisors are competent to teach the vocational lessons of these areas.

Table 2 : Schools from which teachers are assigned in the field of Ship Management / Maritime

THE FIELD ESSENTIAL TO DESIGNATION	THE PROGRAMME / FACULTY GRADUATED FROM	LESSONS TO TEACH
Maritime (Change: 18/08/2015 tarih ve 74 sayılı HCED ((Head Council of Education and Discipline)))	1.Deck Department (*) 2.Maritime Transportation Management Engineering(*) 3.Fishing Technology Engineering(*) (**) 4. Seafood Department / Engineering (*) (**) (**) Designated if the need is not fulfilled with the graduates of number 1 and 2 departments.	In the Field of Marine; • Deck Management part branch lessons The other branches of this field The other departments’ lessons related to this field and modules

Taken from website of The Ministry of Education, General Directorate Of Vocational And Technical Education

Table 3: The previos and up to date branches in Marine Field Syllabus

FIELD	*PREVIOUS BRANCHES*		*FIELD*	*UP TO DATE BRANCHES*
MARITIME	Ship Management,		*MARITIME*	Deck Training
	Marine engine officer			
	Ship Electronics and Communication,			Marine engines Operation
	Ship Automation,			Ship Electronics and Communication,
	Yacht Master			
	Fishing Boat Master			Fishery and Seafood
	Fıshery Production			

The previos branches will shift to the up to date ones according to The Syllabus of Marine Field by Ministry of Education

When we look at the data in the tables 2 and 3 ; it is a research subject that how succesful will be a graduate of teaching fishing technologies or sea products engineering on teaching vessel management branch or vice versa.As a country policy , it is related to that we still haven’t reached the intended goals.This study is limited to only simulator assisted marine teaching..

THE OBJECTIVE OF THE RESEARCH

In this research ,we made an analysis of instructors that give seamanship lessons and vessel management instructors on he track of the mentioned prescriptions and articles of these prescriptions.We also tried to explain the roles of these instructors in the simulator assisted marine training

ANALYSIS AND FINDINGS

In the training of simulator assisted seamanship , the instructor's role is to guide and set up. The intructor writes the script related to the syllabus and puts it into practice .Also he / she assigns the duties and starts a debate on the script at the end of the lesson and evaluates it. As the teachers are guides and role models ,they can not participate to the implementation area.Trainees need to act as professional as they can and complete their mission given to them as in the scripts..The instructor is the key role in this programme bcause simulators are bound to the person's ability and knowledge who uses it like the other technological devices.

To operate the simulators effectively and to provide highly qualified teaching; a simulator operator should have these qualities that will be given under three headings.

To Have The Experınce And Knowledge Of Marine

Among the marine instructors , it is strongly believed that sımulator traıners should have the far away captainship certificate which is the most important satisactoriness given by flag country.This certificate is seen as the proof of knowledge and ability. (Simulated Voyages,1996 s.88)
"In order to train qualified seaman , we first need to train qualified instructors that have sufficient marine experience." (Nas, S.,& Çelik, B. 2012). The simulator trainer should be well qualified in his field.In order to become a simulator trainer, they need to have broad knowledge of maritime.To illustrate, a simulator trainer should not only have a good knowledge of journey; but also he he should be proficient on the fields of GMDSS,shift ,management of the top of the bridge,load lifting or vessel stability.Andthis expertness and skills can only be gained by sailing. Marine experience is extremely important to provide scripts related to the aims of the lesson and syllabus.Also to guide the trainees when necessary ,to use all the simulated devices effectively and to make persuasive and motivative organizations ; we need marine experience. For example we can't mention a well qualified marine training in the case of a lesson on Bosphorus journey if the instructor doesn't know to cox or to set a route .If it happens like that then the syllabus aims will be disregarded and trainees will cross the strain in idleness.If the sımulator assisted teaching isn't based on the needs of the syllabus ; then it is indifferent from computer games.It is open to negotiation that we can't wait a detailed ,event -oriented training from an istructor who hasn't got any marine experiment .Neither can he develop his students ,nor he can foresee the problems that they would face in the future.

"According to Shulman's approach , in order to teach one subject; an instructor should know the subject in the level of explaining the relatıons with the other subjects beyong just knowing encyclopaedic information.."(Pamuk, S., Ülken, A., & Dilek, N. Ş. (2012).

Simulator assisted training is not only for teaching; but also for implementing the customs of maritime.So this training should be given by experienced trainersthat sail.By this we can provide behaoviour training,motivation to the lessonand persuasiveness to the lessons for the students.Maritime training is involved in satisfactoriness.So if this training is given by insufficient teachers; we can not expect for success.

Gettıng The Traınıng Skills (Formation)

Instructors are wanted to choose the suitable teaching methods and techniques appropriate for the needs the syllabus, determine the requirements,make the lesson plan,reach the aims and improve the syllabus.Likewise they should also know how to transfer their professional knowledge and skills to their trainees and how to evaluate them.

They need to get pedagogical formation training in order to manage their classes ,determine their trainees' personal needs, set organizations according to learning levels,rise interest and motivation and also improve students' pychology.They must have their training .No matter how knowledgeable and successful a trainer on his field; if he can't transfer his knowledge to the trainees , the learning won't come true.Therefore a simulator trainer not only should have marine experience , but also he should have training skills.

Technology Literacy

"Computer literacy can be explained as understanding basic concepts on technology and using fundemental computer programs while teaching." (Lupo, 2001; Childers, 2003).

We can't wait from a simulator traıners to know simulators in everyway.But they are required to have knowledge on basic simulator hardware and software and follow technological processes and innovations.It puts a limit if the trainer is unaware of the simulator's operational functions.It would cause a waste of time or hinder the training if all the details of the script can't be conveyed to the simulator or a script not in the simulator's functıons.

Besides an instructor should have the knowledge of understanding the technical breakdown and instruct it to the people in charge by phone.He should also distinguish the hardware problems from the software issues. .(http://bilgdestekliegt.blogcu.com/bde-de-ogretmenin-rolu/6664495, Access Date : April 19 , 2016) For example there would be problems on class management or on motivation provision if the instructor doesn't know how to diagnose the issue during the practice.

According to the operative prescriptions , part 39 , proviso 4,paragraph b in order to be a simulator trainer , an instructor should have given at least 3 years of marine training and he should also finish the programme of IMO model 6.10 " The Training of Simulator Instructor " , he should also have attended Ministry of Education in service training certified by administration.He shuld also attend the programme of the simulator manufacturers.Or he should get the international programmes by IMO.In accordance with this regulations , instructors are obliged to attend not only to the programme of in service training , but also to the operation training given by the simulator producer .

Table 4:The analyses of Administration Certified Ministry of Education In Service Training and IMO Model Course 6.10 and Instructors of Vessel Management .(The class on October ,2016 is excluded.)

The Number of the Instructors attended to the training of the Simulator Instructors.	Schools that are Graduated			
	Fisherman Technologies Engineering	Maritime Transportation Management Engineering Graduates		Sea Food Department / Engineering
		Management	Deck	
Wth marine experience	0	0	4	---------
Without marine experience	14	1	0	----------

These findings are acquired by using present-day communication technologies and by interviewing.The phrase of " With Marine Experiment " include the people that have the satisfactoriness of Oceangoing Watckeeping Officers and the superiors

Table 5: The academic analyzes of designated instructors with the title of Ship Management by Ministry of Education in 32 schools since 2016

The number of designated instructors of ship Management by Ministry of Education	Fisherman Technologies Engineering Graduates	Maritime Transportation Management Engineering Graduates		Sea Food Department / Engineering Graduates	Number of theInstructors with sea experience.
		Management	Deck		
	68	6	61	7	62

These findings are acquired by using present-day communication technologies and by interviewing.

RESULTS AND DEBATE

If the attendants of the simulator trainer course are chosen from the instructors that have basic knowledge of this field; it would contribute to the issue of qualified trainer.It should be negotiated how useful of a trainers' attending to the class if he/she hasn't experienced Bridge Management or hasn't cruised before or he isn't familiar with the journey instrments.

The simulator trainer courses are divided 30 lessons in 5 days determined by IMO.It is not possible to train teachers that are not sufficient enough on simulator assisted seamanshiptraining insuch a short time.If it is thought that the 32 schools doesn't all have a qualified trainers on teaching Vessel Management (Deck Trainig) ; then we should go on new ways like making effective distributions as at least having one instructor that has more experience.It should be provided that one instructor should be chosen with marine experience from every school and they should be trained first with computer programming and operating.This training is of utmost importance in underlying simulator technologies literacy.Besides the trainer candidates should be prepared by providing them to attend a training that includes technical information such as simulator parts,hardware and software and the usage of simulators operationally.It shouldn't be forgetten that simulators are programmed in English Language ,so the instructor candidates should be proficient in English.

After getting the classes of IMO model 6.09 and IMO model 6.10 ,they should be certified with simulator instructorsçThen they should be appointed to guide the other vessel management teachers after they turn back to their schools..

Also if there is one person that others can reach in the case of problems during the training ;then the issues like time and motivation loss will diminish.It can also help providing teamwork in simulator training and using the simulators effectively.

But at this point it should also be negotiated whether the IMO Model training that is given in our country is sufficient enough or not.Our instructors should attend obligatory sea service every year at least for one week in order to be updated ,and in order not to lose their control on Seamanship.

If Simulator assisted marine training is not given efficiently ; simulators will be nothing but computer games to the trainees.Unfortunately, their perception would cause the destruction of the qualified devices in long term.

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A CONTENT ANALYSIS OF THE ACADEMIC STUDIES RELATED TO RISK ANALYSIS IN MARITIME INDUSTRY

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ABSTRACT

There has been an increasing interest in the studies related to risk analysis in maritime industry in the last two decades. This paper attempted to review the academic articles published in academic journals, which can be accessed as full text via Dokuz Eylul University Online Library. The aim of this study is to analyze the published literature, finding out studied areas and finding literature gaps. A content analysis was conducted for 71 studies, in which both "maritime" and "risk" terms are included in the headings. Studies were grouped considering publishing dates, methodologies, key words, related topics, author profiles and case studies to reveal the tendency of published literature. The results showed that studies became more frequent after 2010, Bayesian network was used as the most frequent method, safety and security of maritime transportation was the most studied subject and oil and LNG tankers were used as most common case studies. Surprisingly, only a few studies had conducted on risk analysis of ships' engine rooms.

Key Words: Content Analysis, Literature Review, Maritime Industry, Risk Analysis

INTRODUCTION

Maritime transportation is critical to the world's economy as over 90 % of the world's trade is carried by sea and it is, by far, the most cost-effective way to move goods and raw materials around the world [1]. Shipping is the most international of all the world's great industries while it is one of the most dangerous one [2]. Thus provision of security and safety in maritime sector is a crucial issue [3]. In addition, risk management has become a major part of operating decisions for companies in the maritime transportation sector and thus an important research domain [4]. Thus the identification of risk and hazards in maritime is an important research theme [5].

Risk assessment is a process to identify the potential hazards arising from an activity and the likelihood of harm resulting from those hazards, then putting the two together to estimate the risk involved in the activity [6]. Within the context of these activities, risk and risk assessment concepts are being used widely and grown significantly in various industries especially in major hazard industries in recent years [7]. However, risk assessment is not a new field. Formal risk assessment techniques have their origins in the insurance industry [8]. Additionally numerous scientific studies have also been conducted in several industries [7]. The first serious studies related to risk perception in maritime was started in 1900 by "*The Law of Insurance As Applied to Fire, Life Accident, Guaranty and Other Non-Maritime Risks* [9]" study of John Wilder May. Then, one of the first study related to risk analysis in

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maritime sector was "*When the Lighter Fades Away Who Pays? A Problem in the Distribution of Maritime Risk* [10]" published in 1964, in the Yale Law Journal. Besides interest in the improvement of the safety of large engineering systems through safety analysis from the initial stages has been growing considerably, both within the industries and within the regulatory authorities [11].

In shipping industry, one of the main concepts of ship operators, ship builders and ship-owners is to ensure safety of ships at sea. Lack of safety may result by enormous penalties in terms of live loss, environmental damages, cargo damages and financial costs [12]. As a result of this penalties and being one of the most dangerous industry, risk analyze and assessment are critical for maritime industry and a wide range of studies related to risk concept in maritime industry have been conducted so far.

Despite the growing body of literature that recognizes the importance of risk concept in maritime industry there may still be gaps in the literature. This study seeks to obtain data which will help to address these research gaps. Consequently, this paper aims to analyze the studies on risk concept in maritime industry in terms of certain variables, and find out the trends of the studies via a systematic approach. This study is divided into four parts. First part deals with risk concept in maritime industry and explains aim of the study. Second part details sample selection and describe the methods of analyzing the studies. Third part gives findings according to the analysis and interpretations about the findings. Finally, last part indicates the analysis that is discussed in the conclusion.

METHODOLOGY

A content analysis approach was selected due to the fact that it can synthesize both qualitative and quantitative results [13]. According to Saban [14], content analysis is the subjective analysis of impressed, visual, and other materials in terms of certain categories by reviewing them systematically. Content analysis method is used to find out the trends in the selected studies related to risk concept in maritime industry.

In this study a content analysis was conducted for 71 academic articles in which both "*maritime*" and "*risk*" terms are included in the headings and which can be accessed as full text via "Dokuz Eylul University Online Library" [15]. The publishing languages of all the selected articles are English. Complete list of the articles is given as **Appendix 1** at the end of the study.

There are some limitations in this study. One of the most critical limitations is related articles were found via "*Dokuz Eylül University Online Library*". Despite the fact that the library has been subscribed 56 different databases as of the date of 31.05.2016, there may still be articles about risk conception in maritime industry and didn't published by any of the subscribed databases. Additionally, only the articles which include both "*maritime*" and "*risk*" word in the titles are investigated. Indeed there may be various articles which doesn't contain both the words in the title but related to risk conception in maritime industry. These groups of articles were also disregarded during the conduction.

Articles are investigated based on 17 key criterions. These criterions are determined via literature reviews of content analysis studies on various topics. Thus selected criterions to analyze the articles are authors' profiles, authors' countries, article quantities for each author, author quantities for each article, most frequent universities in studies, publishing year of articles, published journal of the articles, subject of the articles, subject of the articles after 2010, methodologies used in articles, methodologies used in articles after 2010, mentioned vessel types in the articles, mentioned vessel types in the articles after 2010, mentioned casualty types in the articles, mentioned casualty types in the articles after 2010, frequency of risk related phrases and frequency of key words in the full text of the articles.

FINDINGS

Once all the 71 studies which include both maritime and risk words in their titles are examined, some findings might be discussed about authors' profiles. It is seen that in **Figure 1**, 83 % of 156 authors are academicians, 10 % of them work for governments or international agencies and 7 % of them work for private sector companies.

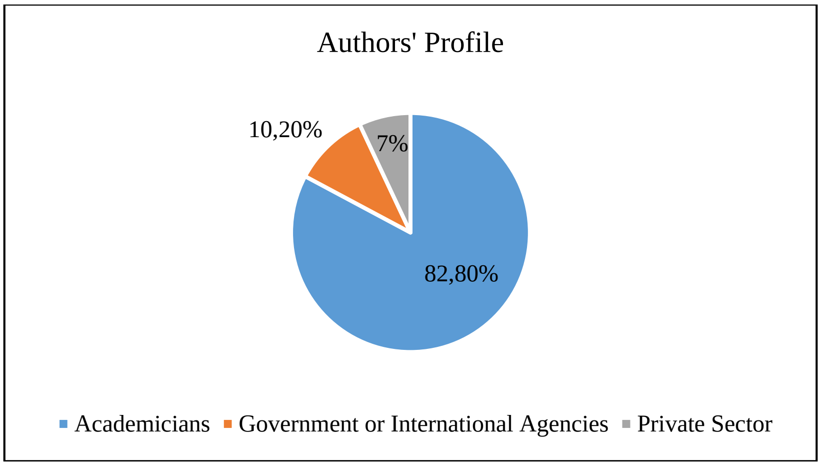

Figure 1: Authors' profiles, rates according to the professions

Table 1 shows the classification of 26 different countries of the authors. It was classified on the basis of the working countries of the authors rather than country of birth. Once article sources countries of 71 studies which include both maritime and risk words in their titles are investigated, it's found that the better part of the articles were published from five countries, USA, UK, China, France and Italy.

Table 1: Countries of the authors

Country	Qty	%
USA	27	17.31%
UK	20	12.82%
China	16	10.26%
France	12	7.69%
Italy	12	7.69%
Australia	9	5.77%
Norway	8	5.13%
Finland	7	4.49%
Sweden	6	3.85%
Serbia	4	2.56%
Singapore	4	2.56%
Hungary	4	2.56%
Portugal	4	2.56%
Canada	3	1.92%
Hong Kong	3	1.92%
Japan	2	1.28%
Greece	2	1.28%
Morocco	2	1.28%
Turkey	2	1.28%
S.Cyprus	2	1.28%

Taiwan	2	1.28%
Argentina	1	0.64%
Spain	1	0.64%
Estonia	1	0.64%
S.Korea	1	0.64%
Poland	1	0.64%
Total	156	100%

156 authors of the articles from 80 universities, companies or agencies were grouped in terms of their study quantities among reviewed studies. Thus the most frequent authors, their reviewed article quantities and their universities were given in the list below (see **Table 2**).

Table 2: The most frequent authors

Authors	Qty of Articles	University
Jin Wang	6	Liverpool John Moores University
J. René van Dorp	4	George Washington University
Jason R. W. Merrick	4	Virginia Commonwealth University
Cullinane, K	3	University of Newcastle
Floris Goerlandt	3	Aalto University
Jakub Montewka	3	Aalto University

The distribution of articles according to the number of authors is given in **Table 3**. According to the table, it can be seen that mean number for each article is approximately 2.61 and more than 75 % of all articles were published by three or less authors.

Table 3: Distribution of articles according to the number of authors

	Qty	%
1 Authors	26	36.62%
2 Authors	14	19.72%
3 Authors	14	19.72%
4 Authors	8	11.27%
5 Authors	4	5.63%
6 Authors	4	5.63%
7 Authors	1	1.41%
Total	71	100%

Except of the authors, universities were grouped in terms of published articles quantities. Accordingly, most frequent three universities (see **Table 4**) according to the results are as follows;

Table 4: The most frequent universities

University	Qty
Liverpool John Moores University	7
Imperial College London	5
MINES Paris-Tech	5

Reviewed articles have been analyzed in terms of publishing year, author numbers in the articles and published journals. Distribution of studies on maritime risk according to the year of publication was presented in **Figure 2**. According to the figure, articles were mostly published in 2014-2016 with 21 articles in each of those years out of all 71 articles. Besides, 39 of the 71 studies published in the last five years.

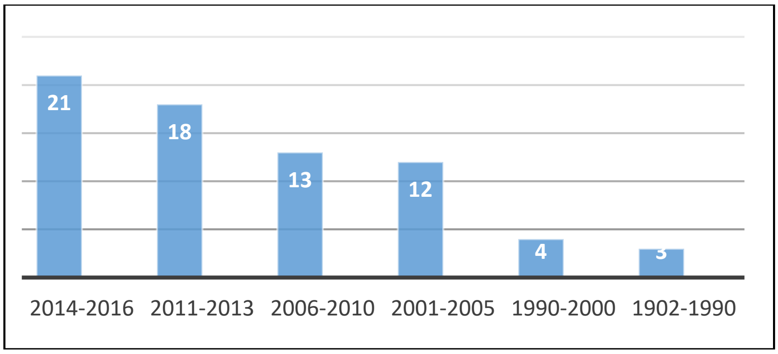

Figure 2: Distribution of studies according to the year of publication

The distribution of articles according to the journals in which they were published was given in **Table 5**. Only the journals in which three or more articles were published are selected. Once the table analyzed it can be seen that articles which include both maritime and risk words in their titles were published in 46 different journals. In addition, most popular journals are "*Risk Analysis*" with seven articles, "*Reliability Engineering and System Safety*" and "*Safety Science*" with five articles.

Table 5: Distribution of articles due to published journals

Journals	Qty	%
Risk Analysis	7	9.86%
Reliability Engineering and System Safety	5	7.04%
Safety Science	5	7.04%
Annals of Operations Research	3	4.23%
Marine Policy	3	4.23%
Others	20	67.6%
Total	46	100%

In this section, reviewed articles were examined according to subject of the studies, followed methodologies, mentioned vessel types in the studies, casualty types and key words. Subject of the studies were grouped according to the key words that were related to subject of the articles. Thus subject of all 71 studies are given in **Table 6**. According to the table most frequent subjects are maritime accidents with 23 articles, maritime transportation with 23 articles, maritime law with 22 articles and insurance with 22 articles. Total quantity of all subjects is more than 71 (article number). This is because some articles considered two or more subjects.

Table 6: Subject of the studies

Subject of the Studies	Qty	%
Maritime Accidents	23	20.00%
Maritime Transportation	23	20.00%
Law	22	19.13%
Insurance	22	19.13%
Supply Chain	9	7.83%
Piracy	8	6.96%
Maritime Regulations	7	6.09%
Helicopter Operations	1	0.87%
Total	115	

In addition, subject of the studies published after 2010 are examined as well. The aim of this examination is to find out trends in recent years. Thus subject of all 39 studies are given in **Table 7**. According to the table most frequent subjects are maritime transportation with 16 articles, maritime accidents with 10 articles, maritime law with 10 articles and insurance with 11 articles. Furthermore according to comparative analysis of **Table 6** and **Table 7**, it can be implicated that maritime transportation and piracy are getting more popular as a subject of studies in recent years. Total quantity of all subjects is more than 39 (article number). This is because some articles considered two or more subjects.

Table 7: Subject of the studies after 2010

Subject of the Studies	Qty	%
Maritime Accidents	10	25.64%
Maritime Transportation	16	41.03%
Law	10	25.64%
Insurance	11	28.21%
Supply Chain	5	12.82%
Piracy	6	15.38%
Maritime Regulations	4	10.26%
Helicopter Operations	1	2.56%
Total	63	

Distribution of studies which include both maritime and risk words in their titles according to followed research methodologies is presented in **Table 8**. It has seen that the most popular methodology followed in the studies is "*Bayesian Network Modeling*" within 19 articles. Following that "*Optimization*" with 11 articles and "*Fuzzy Approach*" with 10 articles is placed.

Table 8: Distribution of studies according to research methodologies

Methodology	Qty	%
Bayesian Network	19	26.76%
Optimization	11	15.49%
Fuzzy Approach	10	14.08%
FTA (Fault Tree Analysis)	8	11.27%
ETA (Event Tree Analysis)	6	8.45%
Monte Carlo Simulation	5	7.04%
Linear Programming	3	4.23%
Artificial Neural Networks	2	2.82%
Total	64	

Methodologies of the studies published after 2010 are examined as separately. The aim of this examination is to find out the most popular methodologies used in the studies in recent years. The distribution table is given in **Table 9**. According to the comparative analysis of **Table 8** and **Table 9**, it can be implicated that fuzzy approach, ETA and FTA are getting more popular as the methodologies used in studies in recent years. Additionally, linear programming and artificial neural networks have been introduced as alternative methodologies for the studies in recent years. Total quantity of all methodologies is more than 39 (article number). This is because some articles considered two or more methodologies.

Table 9: Distribution of studies according to research methodologies after 2010

Methodology	Qty	%
Bayesian Network	13	33.33%
Optimization	8	20.51%
Fuzzy Approach	8	20.51%
FTA	6	12.82%
ETA	5	12.82%
Monte Carlo Simulation	3	7.69%
Linear Programming	3	7.69%
Artificial Neural Networks	2	5.13%
Total	48	

Distribution of the articles according to mentioned vessel types inside of the studies is given in **Table 10**. Thus, it is seen that most popular vessel types mentioned in the articles are oil tankers, passenger ships and ferries. Vessel type classification is made in light of EMSA (European Maritime Safety Agency) 2015 statistics [16]. Total quantity of all vessel types is more than 71 (article number). This is because some articles considered two or more vessel types.

Table 10: Distribution of the articles according to vessel types

Vessel type	Qty	%
Ferries	17	23.94%
Oil Tankers	14	19.72%
Passenger Ships	11	15.49%
Bulk Carriers	11	15.49%
Container Ships	8	11.27%
LNG Tankers	7	9.86%
LPG Tankers	3	4.23%
Oil and Gas Platforms	2	2.82%
	73	

In addition, articles in which vessel types are mentioned and which were published after 2010 are examined too. Distribution of the quantities of each vessel types mentioned in the articles is given in **Table 11**. Comparison of the **Table 10** and **Table 11** shows that there has been a slight increase in the number of the articles that mentioned LNG tankers in recent years. Besides, studies related to oil and gas platforms have been introduced to literature in recent years.

Table 11: Distribution of the articles according to vessel types after 2010

Vessel type	Qty	%
Ferries	13	33.34%
Oil Tankers	8	20.51%
Passenger Ships	6	15.38%
Container Ships	5	12.82%
LNG Tankers	5	12.82%
Bulk Carriers	6	15.38%
LPG Tankers	2	5.13%

Oil and Gas Platforms	2	5.13%
Total	47	

Studies which include both maritime and risk words in their titles were examined in **Table 12** according to frequency of mentioned casualty type analysis. According to the table it is seen that most frequent casualty types that were examined in the studies are "*collision*" and "*grounding*".

Table 12: Distribution of casualty types in the studies

Casualty Type	Qty	%
Collision	26	36.62%
Grounding	18	25.35%
Explosion	12	16.90%
Weather Conditions	9	12.68%
Leakage	7	9.86%
Capsizing	5	7.04%
Flooding	5	7.04%
Engine Fails	4	5.63%

Distribution of the quantities of each casualty type mentioned in the articles is given in **Table 13**. The comparison of **Table 12** and **Table 13** reveals that there has been a marked decrease in the number of the studies which mentioned leakage, capsizing and engine fails.

Table 12: Distribution of casualty types in the studies after 2010

Casualty Type	Qty	%
Collision	16	41.03%
Grounding	13	33.33%
Explosion	6	15.38%
Weather Conditions	6	15.38%
Leakage	1	2.56%
Flooding	3	7.69%
Engine Fails	1	2.56%

Table 14 presents the distribution of the phrases related to risk concept in the full text of the articles. According to the results, the most frequent phrases related to risk are "*risk assessment*" and "*risk analysis*" which were mentioned in more than half of all articles which include both maritime and risk words in their titles. The selected phrases are determined among the keywords of the articles which don't mean any kind of methodology, subject, vessel type or casualty type. Total phrase number is by far high then total article numbers. This is because of some articles consists a few of the phrases in same time.

Table 14: Distribution of the phrases related to risk concept

Phrase	Qty	%
Risk Assessment	38	53.52%
Risk Analysis	34	47.89%
Risk Reduction	12	16.90%
Risk Mitigation	11	15.49%
Risk Modeling	8	11.27%
Total	103	

Table 15 illustrates the distributions of the key words or phrases which used as key words in the reviewed articles but have not been classified in any classification groups above. The table shows the distribution of the phrases or words in the full text of the articles.

Table 15: Distribution of the key words in the full text of the articles

Key Words	Qty	%
Safety	52	73.24%
Decision making	34	47.89%
Uncertainty	32	45.07%
Security	23	32.39%
Fault	23	32.39%
Hazard	21	29.58%
Casualty	15	21.13%
Liability	10	14.08%
Health and Safety	7	9.86%
Resilience	6	8.45%
Fatigue	6	8.45%
Acceptance Criteria	5	7.04%
Crisis Management	5	7.04%

In this table frequencies of all the key words in the full text of articles are found out. For example "*safety*" term is mentioned in 52 of 71 articles. Yet, it didn't mentioned in 19 articles. The aim of this classification is to determine the frequency of risk related key words in selected articles.

CONCLUSIONS

In this study a content analysis was conducted for 71 academic articles in which both "*maritime*" and "*risk*" terms are included in the headings. This study set out to determine trends in scientific articles which are related to risk concept in maritime industry. Once all the findings were investigated, more than half of authors of all selected studies are from five countries - USA, UK, China, France and Italy. This study has shown that studies related to risk concept in maritime industry are mostly subjected "*maritime accidents*", "*maritime transportation*", "*insurance*" and "*law*" topics. However "*maritime transportation and piracy*" topics are getting more popular after 2010. Bayesian network analysis was used as the most popular in the studies. However, fuzzy approach, FTA and ETA methods have been used frequently in recent years. Once the increasing interest in recent years considered it is predictable that these methodologies will be used more frequently in the next years. Mentioned vessel types in the studies are given in the study. According to the findings risk analysis for oil and gas platforms hasn't been studied frequently up to 2016. Thus, there is a literature gap on studies related to risk analysis of oil and gas platforms. More studies may be conducted on this topic in the coming years. The frequency of casualty types mentioned in the articles are investigated it is seen that "*engine fails*" are draw very few interest in the studies. Considering, 23 % of the maritime casualties in cargo ships has been occurred in engine rooms, it is obvious that more studies should be conducted to analyze the risk conception and avoid accidents in engine room of ships. Finally, a more comprehensive content analysis may be conducted in further studies. In addition further researches may examine more closely the links between trends in the studies and current events in the world.

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APPENDIX 1

COMPLETE LIST OF ARTICLES

	Author(s)	Year	Journal	Title
1	Norris	1902	Michigan Law Review	The Law of Insurance as Applied to Fire, Life, Accident, Guaranty and Other Non-Maritime Risks
2	The Yale Law Journal Company, Inc	1964	The Yale Law Journal	When the Lighter 'Fades Away,' Who Pays? A Problem in the Distribution of Maritime Risk
3	Baxter	1984	American Historical Review	Risks at sea: Amsterdam insurance and maritime Europe, 1766-1780
4	Sweeney	1991	Journal of Maritime Law and Commerce	Uncitral and the Hamburg Rules - The Risk Allocation Problem In Maritime Transport Of Goods
5	Blanco-Bazán	1992	Geneva Papers on Risk and Insurance	The Role of the International Maritime Organization (IMO) in the Management of Maritime Risks
6	Wheeler	1993	Risk Analysis	Risk-Based Ranking of Dominant Contributors to Maritime Pollution Events
7	Ritchie	1995	Journal of Coastal Conservation	Maritime Oil Spills - Environmental Lessons and Experiences with Special Reference to Low-Risk Coastlines
8	Iakovou	2001	Safety Science	An interactive multiobjective model for the strategic maritime transportation of petroleum products: risk analysis and routing
9	Bennett	2001	Marine Policy	Mutual risk: P and I insurance clubs and maritime safety and environmental performance
10	Olsson et al.	2001	European Conference on Safety in Modern Society	A pilot study focusing on people,human, machine systems and organisations as risk and safety factors in maritime activities
11	Sii et al.	2001	International Journal of Quality and Reliability Management	Novel risk assessment techniques for maritime safety management system

12	Akatsuka & Leggate	2001	Maritime Policy and Management	Perceptions of foreign exchange rate risk in the shipping industry
13	Guedes & Teixeira	2001	Reliability Engineering and System Safety	Risk assessment in maritime transportation
14	Li & Cullinane	2003	Maritime Economics and Logistics	An Economic Approach to Maritime Risk Management and Safety Regulation
15	Reddish	2004	Tulane Maritime Law Journal	Forgotten fears present imminent threats to the maritime shipping and recreation industries: the risk posed by the availability of sea mines
16	Wang et al.	2004	Risk Analysis	Use of advances in technology for maritime risk assessment
17	Merrick et al.	2005	Risk Analysis	Assessing uncertainty in simulation-based maritime risk assessment
18	Barnes & Oloruntoba	2005	Journal of International Management	Assurance of security in maritime supply chains: Conceptual issues of vulnerability and crisis management
19	Bekker	2005	Natural Gas & Electricity	Maritime Boundary Disputes Risk Investment in Offshore Energy Projects.
20	Wang	2006	Quality and Reliability Engineering International	Maritime risk assessment and its current status
21	Wang	2006	Quality and Reliability Engineering International	Maritime risk modelling and decision making
22	Guzmán	2006	Revista E-mercatoria	Maritime Risks and Credits: Financers and Guarantors. Should They Play or Should They Stand Behind The Owner
23	Raymond	2006	Terrorism and Political Violence	Maritime terrorism in Southeast Asia: A risk assessment
24	Merrick & van Dorp	2006	Risk Analysis	Speaking the Truth in Maritime Risk Assessment

25	Darbra et al.	2007	Marine Policy	Safety culture and hazard risk perception of Australian and New Zealand maritime pilots
26	Trucco et al.	2008	Reliability Engineering and System Safety	A Bayesian Belief Network modelling of organisational factors in risk analysis: A case study in maritime transportation
27	Vanem et al.	2008	Reliability Engineering and System Safety	Analysing the risk of LNG carrier operations
28	Riskko et al.	2008	International Journal of Occupational Safety and Ergonomics	Implementation of cold risk management in occupational safety, occupational health and quality practices. Evaluation of a development process and its effects at the Finnish Maritime Administration
29	Quin et al.	2008	Journal of Marine Science and Application	Risk management modeling and its application in maritime safety
30	Balmat et al.	2009	Ocean Engineering	MAritime RISk Assessment (MARISA), a fuzzy approach to define an individual ship risk factor
31	Bubbico et al.	2009	Journal of Loss Prevention in the Process Industries	Preliminary risk analysis for LNG tankers approaching a maritime terminal
32	Psarros et al.	2009	Journal of Transportation Security	The acceptability of maritime security risk
33	Balmat et al.	2011	Ocean Engineering	A decision-making system to maritime risk assessment
34	Bell et al.	2011	Transportation Research, Part B	A frequency-based maritime container assignment model
35	Merrick & van Dorp	2011	Annals of Operations Research	On a risk management analysis of oil spill risk using maritime transportation system simulation
36	Porthin	2011	Nordic Road & Transport Research	Online maritime risk indication

37	Idelhakkar & Hamza	2011	Energy Systems	Risk management of oil maritime transportation
38	Chih	2011	Safety Science	Risk management of Taiwan's maritime supply chain security
39	Grasso et al.	2012	Ocean Dynamics	A maritime decision support system to assess risk in the presence of environmental uncertainties: The REP10 experiment
40	Ghofoori & Altiok	2012	Journal of Transportation Security	A mixed integer programming framework for sonar placement to mitigate maritime security risk
41	Lİ et al.	2012	Risk Analysis	An Overview of Maritime Waterway Quantitative Risk Assessment Models
42	Rigaud et al.	2012	Procedia Social and Behavioral Sicences	Impact: More Than Maritime Risk Assessment
43	Delis	2012	International Journal of Maritime History	Shipping Finance and Risks in Sea Trade during the French Wars: Maritime Loan Operations in the Republic of Ragusa.
44	Wright & Ellis	2013	Loyola Maritime Law Journal	Assumption of the Risk in Boat Racing: A Study in Maritıme Jurisprudence
45	Özbaş et al.	2013	Journal of Risk Research	Comprehensive scenario analysis for mitigation of risks of the maritime traffic in the Strait of Istanbul
46	Panayides et al.	2013	Maritime Financial Management, Transportation Research, Part E	Liquidity risk premium and asset pricing in US water transportation
47	Čokorilo et al.	2013	Journal of Risk Research	Managing safety risks in helicopter maritime operations
48	Oka & Gipouloux	2013	Itinerario	Pooling Capital and Spreading Risk Maritime Investment in East Asia at the Beginning of the Seventeenth Century
49	Hu et al.	2013	Annals of Human Biology	Prevalence and risk factors of Helicobacter pylori infection in Chinese maritime workers

50	Bouejla et al.	2014	Safety Science	A Bayesian network to manage risks of maritime piracy against offshore oil fields
51	Aydoğdu	2014	The Journal of Navigation	A Comparison of Maritime Risk Perception and Accident Statistics in the Istanbul Straight
52	Montewka et al.	2014	Reliability Engineering and System Safety	A framework for risk assessment for maritime transportation systems—A case study for open sea collisions involving RoPax vessels
53	Ung	2014	Expert Systems	A novel maritime risk assessment model incorporating a fuzzy rule based approach
54	Malik et al.	2014	Information Visualization	A visual analytics process for maritime response, resource allocation and risk assessment
55	Li et al.	2014	Transportmetrica A: Transport Science	Bayesian network with quantitative input for maritime risk analysis
56	Akhtar & Utne	2014	Safety Science	Human fatigue's effect on the risk of maritime groundings – A Bayesian Network modeling approach
57	Cordner	2014	Journal of the Indian Ocean Region	Risk managing maritime security in the Indian Ocean Region
58	Goerlandt & Montewka	2015	Safety Science	A framework for risk analysis of maritime transportation systems: A case study for oil spill from tankers in a ship–ship collision
59	Karahalios et al.	2015	Maritime Policy & Management	A risk appraisal system regarding the implementation of maritime regulations by a ship operator
60	Lale et al.	2015	Nase More	Application of Bayesian Networks in risk analysis in Maritime traffic
61	Langard et al.	2015	Psychologie française	Collision **risk** management in passenger transportation: A study of the conditions for success in a safe shipping company
62	Goerlandt & Montewka	2015	Reliability Engineering and System Safety	Maritime transportation risk analysis: Review and analysis in light of some foundational issues

63	Taquechel et al.	2015	Homeland Security Affairs, 11	Measuring the Deterrence Value of Securing Maritime Supply Chains against WMD Transfer and Measuring Subsequent WMD Risk Reduction
64	Hans et al.	2015	Journal of Maritime Affairs	Ship security challenges in high-risk areas: manageable or insurmountable?
65	Lİ et al.	2015	Annals of Operations Research	Risk integration and optimization of oil-importing maritime system: a multi-objective programming approach
66	Gray	2015	Risk Analysis	Risk Reduction of an Invasive Insect by Targeting Surveillance Efforts with the Assistance of a Phenology Model and International Maritime Shipping Routes and Schedules
67	Goldman	2015	Journal of Maritime Law and Commerce	The fortuity rule of federal maritime law: The scope of "all risks" coverage under policies of marine insurance and the new decision of the eleventh circuit court of appeals
68	Bateman	2015	Journal of International and Strategic Affairs	The Future Maritime Security Environment in Asia: A Risk Assessment Approach
69	Grech	2016	International Journal of Environmental Research and Public Health	Fatigue risk management: A maritime framework
70	Zhang et al.	2016	Risk Analysis	Maritime Transportation Risk Assessment of Tianjin Port with Bayesian Belief Networks
71	Boulos et al.	2016	Journal of Occupational and Environmental Medicine	Potentially modifiable risk factors for mental health problems in deployed UK maritime forces

LEARNING MANAGEMENT SYSTEM MOODLE APPLICATION FOR MARITIME TRANSPORT SPECIALISTS PREPARING

Vladlen Shapo[1]

ABSTRACT

Learning management system Moodle application for maritime transport specialists preparing in university with territorially distributed subdivisions and worldwide moving students is described.

Keywords – Electronic teaching and methodical materials, learning management system, maritime transport, remote subdivisions, specialists preparing

INTRODUCTION

Last years Ukrainian universities implement learning management systems (LMS) very actively. In connection with impossibility to buy quite expensive software the choice usually stops on free and open source LMS Moodle. It renews regularly, it has convenient interface and a lot of possibilities to work for students, teachers, teaching and methodical materials (TMM) developers [1, 2]. Bit by bit some books appear in different languages where procedures of distance courses creation, TMM elaboration and LMS administration are described with different levels of specification [3 – 5].

Significant difference of National University "Odessa Maritime Academy" (NU "OMA") [6] from a lot of different another universities is in presence of remote structured subdivisions in different parts of Ukraine: in the city of Izmail (Izmail faculty, IF) and in the city of Mariupol (Azov maritime institute, AMI). Moreover thousands of full time students, students by correspondence, postgraduate students, advanced training courses students and trainees every year pass many month naval training on different type of commercial vessels and need to have access to TMMs and teacher's consultations, being far from the home and NU "OMA". Before these possibilities could be realized by passing paper or electronic TMMs to vessels during crew members change (unexpectedly and unreliable), sending electronic TMMs via e-mail or downloading electronic TMMs from NU "OMA"'s web site [6] (these ways were realized during 13 years without any statistics, registration, efficiency analyzing, etc.). Using LMS Moodle (in test mode it has begun in September 2009, in full mode it has begun in September 2010) has significantly allowed to enhance quality of TMMs preparing, and also theirs quantity and actuality, and to prepare teachers and students step by step for regular using of Moodle possibilities wide spectrum.

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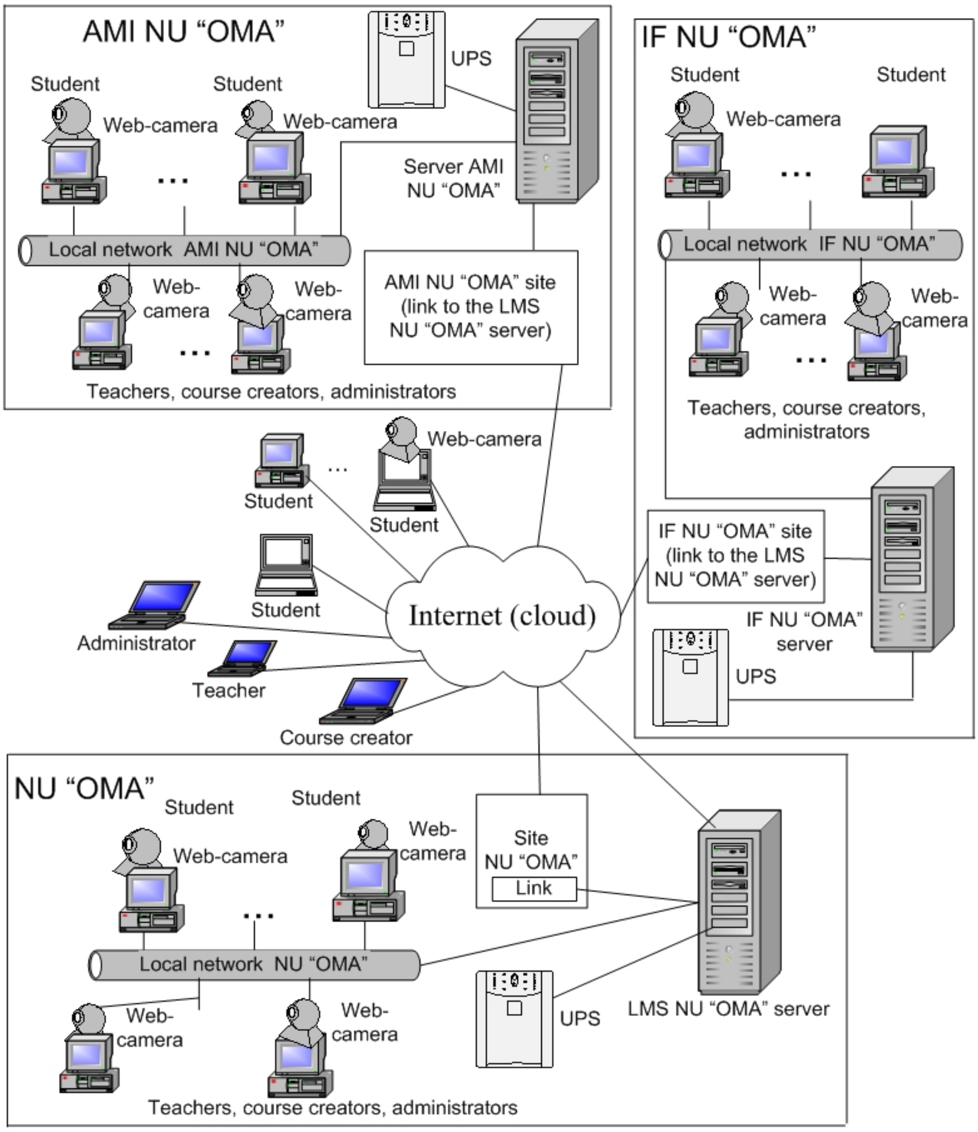
Scheme of distance information interaction between participants of educational process which is realized in NU "OMA" is presented on Figure 1.

It’s known that in most cases students begin studying of disciplines from school books, which are created by universities’ teachers, where they study. Precisely these school books much simpler (in comparing with books of another authors and franchisors) to place in LMS because by this way it’s possible to minimize problem of content piracy and another juridical aspects.

At present time distance learning system of NU "OMA" is based on Moodle 1.9.6 [5] software and provides work of more than 8900 users (including 320 teachers). For fast registration of big number of users special additional software is created. Using of LMS allows to get additional positive results in studying of interested students [1, 2]. Activity and interest of LMS using by students of different studying forms are growing permanently.



NU “OMA” - National University “Odessa Maritime Academy”

AMI - Azov Maritime Institute, city of Mariupol

IF - Izmail Faculty, city of Izmail

Figure 1. Structure of information interaction between NU "OMA" ’s subdivisions

METHODOLOGY

In any information system can happen some fault or failure that's why it's necessary to store backup copy of LMS folders structure with created distance courses and another materials and database of users. When moving LMS Moodle from one physical server to another one there is a possibility to export all data from previous server in SQL format (database dump) and to import all these data to new server. But during LMS exploitation server will store new distance courses with a lot of different methodical materials and tests in the frame of hundreds or even more than thousand disciplines, archive files which contain backup copies of each course will be added, new users will be added as well, thousands of users will upload different files, pictures and will take part in forums and so on. As a result the volume of stored data will grow very fast, the volume of export SQL file will grow very fast as well and will take place the problem of importing database dump at new server even from administrator's console on server computer without LAN using. Time of import will exceed network (browser) time out value and process of importing will be interrupted itself without finishing. Concurrently level of hardware utilization of quite modern typical computer configuration is very high (50-94 % of 2-cores CPU resources and 700-1200 MBytes of RAM). Also LMS Moodle uses CRON scenario (system job) which works in endless cycle checking and processing all new events in LMS and adds significant CPU and RAM loading.

Graphics of computer resources utilization with small, middle and high loading are shown at Figure 2, Figure 3 and Figure 4 accordingly. These graphics contain following information: CPU utilization (50, 76 and 94 % accordingly) and chronology of CPU utilization in the top part of graphics; swap file size (696, 941 MBytes and 1.21 GBytes accordingly) and chronology of swap file using.

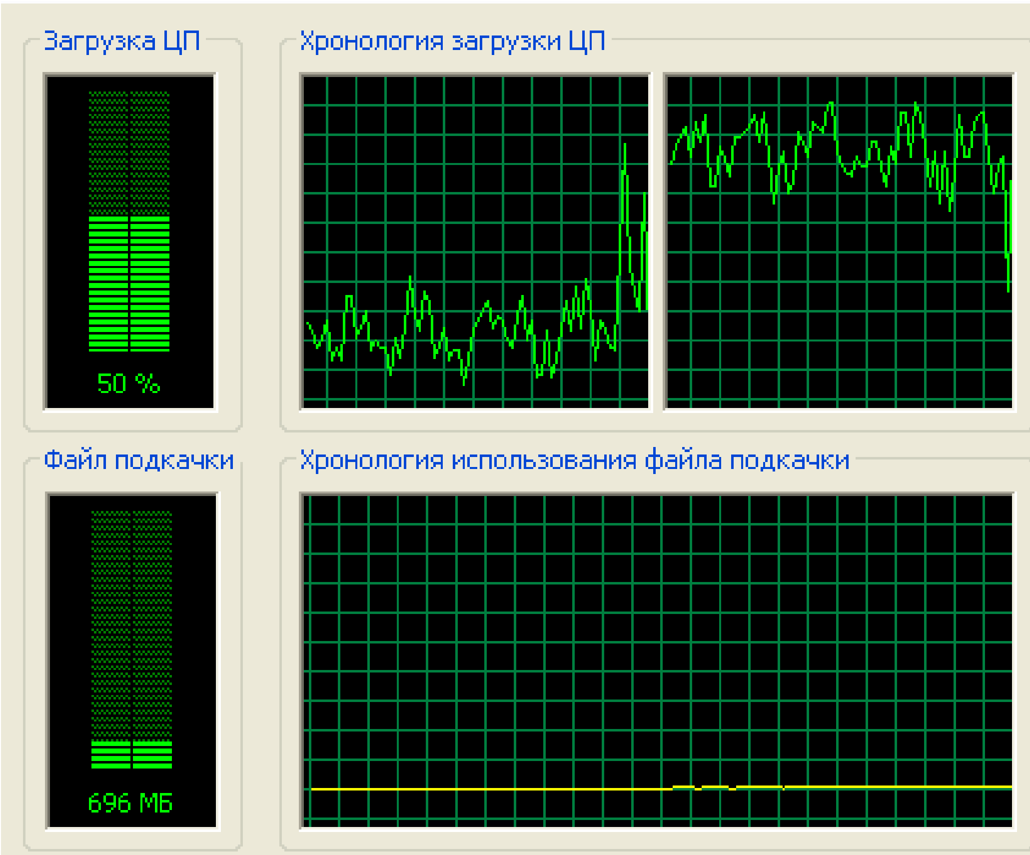


Figure 2. Minimal local computer loading during database dump importing

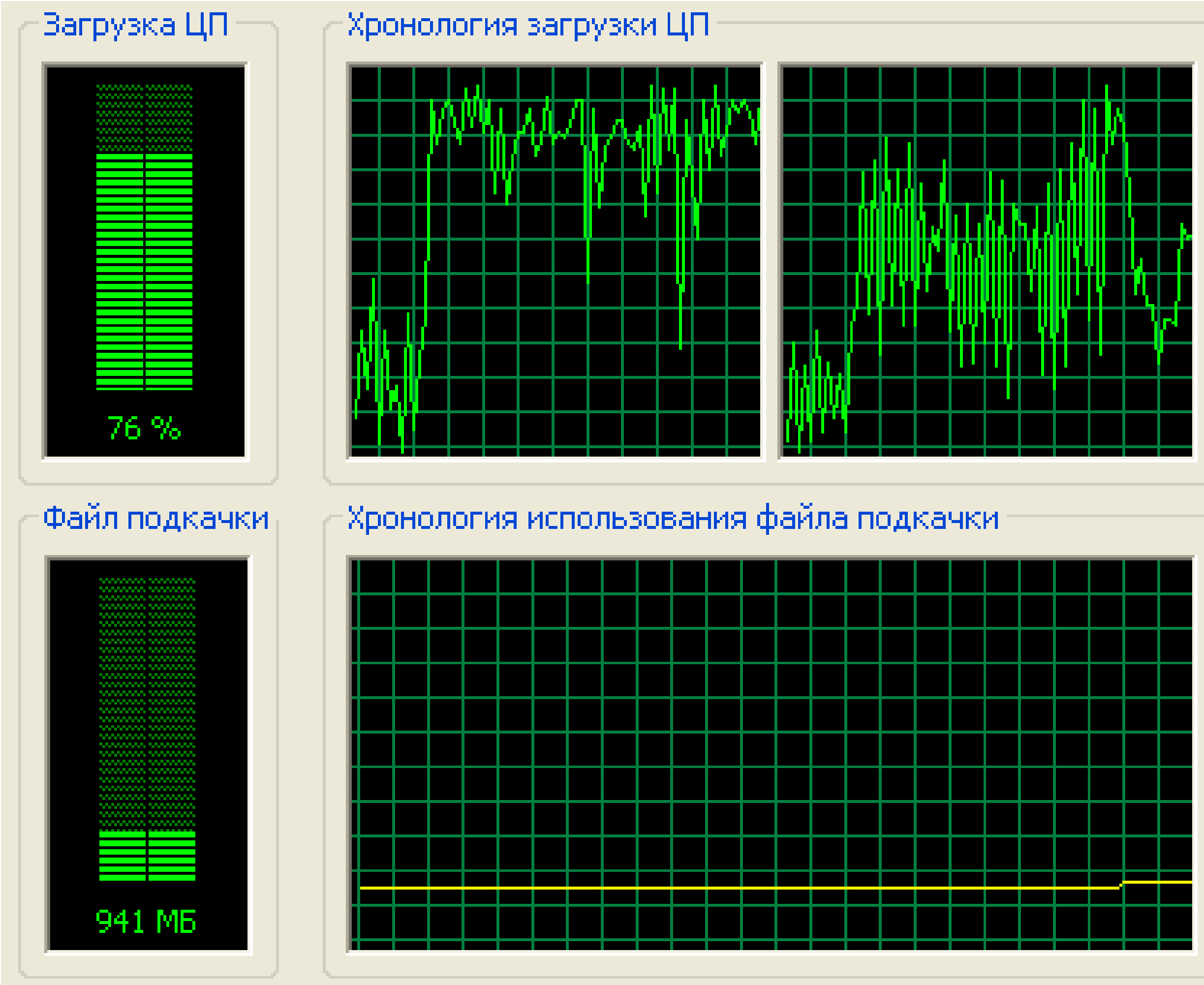


Figure 3. Middle local computer loading during database dump importing

In the same time repeated manual data input which is necessary to restore LMS is quite primitive, very boring, long and laborious process which can take between some days and some weeks of LMS administrator work depends on his qualification and experience. Herewith it's undesirable to attract any staff for execution of these works inside LMS in connection with necessity of full administrator rights granting to additional people and unpredictable results of further work because of human factor (fully unworking LMS in unexpected moment, appearance of faked users, plagiarism of different learning materials an so on).

Some tasks and problems which have to be solved in university information systems are described in [7].

It's necessary to formulate some recommendations for LMS Moodle administrators based on own 6 years long experience.

1. Not to add LMS users one by one manually even when number of these users is not too big. It's much preferably to create external text files with full list of user's data using special template, to add new users in the end of this file and to execute automatic procedure of importing by means of LMS Moodle, because file exported from LMS which contains the user's data will not contain user's passwords and in the case of LMS fault requires some additional manual processing of exported files

which requires additional time. Also this way involves the necessity of new passwords generation and user's informing about this situation with naturally arising dissatisfaction and mess, or searching and restoring of previous versions of passwords.

2. Before exporting of full database dump it's necessary to delete beforehand all archive copies of distance courses from the server, because presence of these files significantly increases database dump (sometimes even in times).

3. It's necessary to restrict file sizes (especially for graphical files), which will be uploaded on the server by users.

4. Not to import database dump to the server by LAN. Generally the most of Ukrainian universities use Fast Ethernet with 100 Mbps bandwidth as LANs. Just LAN data transfer speed will be as bottle neck because even bandwidth of old hard drive connection interface IDE is 100 MBps (theoretically 8 times faster), and modern SATA interface has at least 150 MBps. At the same time the same LAN will be used by another users which will take some part of bandwidth as well. So, during importing of database to the server directly from administrator console LAN will not become as restricting factor.

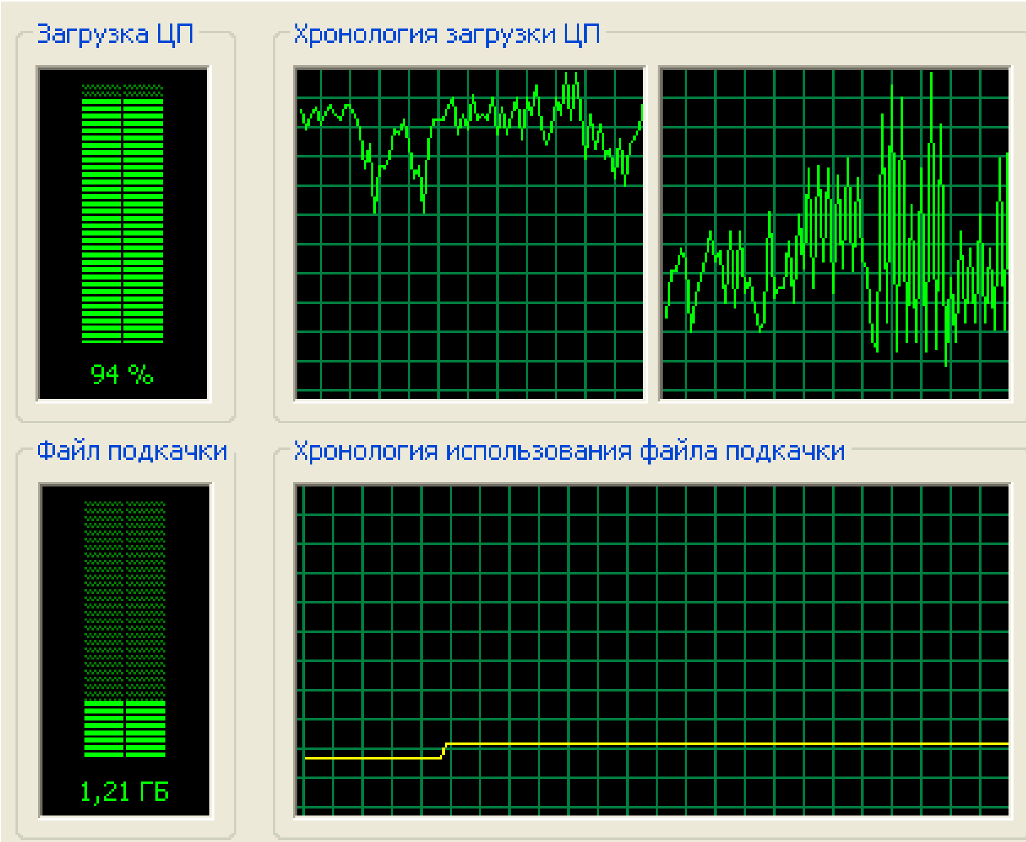


Figure 4. Maximal local computer loading during database dump importing

5. To store archive copies of each distance course on external hard, optical, flash drives, streamers and so on. It will make procedure of data restoring for separate distance courses or whole database much simpler and faster.

6. During database restoring on new server at first it's necessary to restore only categories and subcategories structure and to create empty distance courses without restoring of their content, and to make database dump. Such dump will have relatively small size and can be simple and fast restored, being the skeleton of LMS.

7. Before importing of big database dump it's necessary to enlarge values of following parameters: *max_execution_time*, *max_input_time*, *memory_limit*, *default_socket_timeout*, *mysql.connect_timeout*, *session.gc_maxlifetime* in configuration file *php.ini*.

CONCLUSIONS

In this paper some challenges and problems connected with modern university learning management systems software and hardware are touched on and some recommendations on exploitation of such systems are proposed. Currently learning management system is a part of more complex enterprise information systems, it can be combined with another software like ERP-, CRM-, BI-systems within the same computer network and hardware using virtualization technologies in particular. Inasmuch in present time learning and self-learning is life long process in any field of human activity and is very actual and will become much more dynamic, these recommendations may be useful not only for specialists in education system but for specialists which create and exploit different information systems as well.

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A REVIEW FOR EVALUATION OF MARINE SIMULATOR TRAINING PERFORMANCE

Ali Cem Kuzu[1]

ABSTRACT

Simulation is a practical training method that can be defined as learning by doing. Deck and engine cadets are tested by written examinations during licensing. This method may demonstrate a level of knowledge, but does not demonstrate sustained ability to perform the task or the job. Simulators may provide a practical method for measuring or testing levels of competence and proficiency and the ability to continue to prioritize tasks. However, evaluation of knowledge or performance is not easy compared with the traditional classroom teaching. The instructors have many challenges while following the progress of several trainees simultaneously for evaluation. Although evaluation criteria is defined by the code "Standards of Training, Certification & Watch keeping", evaluation method isn't certainly defined. That's why, evaluations of simulator training change according to instructor and also simulator training scores of trainees are objective results. In this study, a solution researched for standard evaluation method for simulator training. Academic studies about different evaluation methods of marine simulator training reviewed and shared.

Keywords – Simulator training, evaluation, maritime, assessment method

INTRODUCTION

Assessment can be defined as affirmation of competency of trainees. The assessment method varies with the diversified domains namely cognitive (what the trainee should know), psychomotor (what skills the trainee should be able to do), and affective (how the trainee feels or changes his/her attitudes). [1] Simulator trainings used for different domains such as medical, aviation, marine, road vehicles etc. All domains have different evaluation criteria and different evaluation methods for simulator trainings. In an evaluation system the aim of evaluation is to gather adequate information about trainee who can perform or behave to a specified requirement in a determined role. Marine simulator trainings also have evaluation criteria according to different objective task, but a standard evaluation method hasn't been defined certainly, so objective results of marine simulator training evaluations haven't been succeeded. Moreover, most of the marine simulator trainings are applied to a group of trainees simultaneously. The instructor have to evaluate the actions of each trainees, although they are working in groups while performing their objectives. Most ship simulator-based courses in which trainee performance is evaluated rely on instructor. Competence, knowledge, understanding and proficiency, methods for demonstrating competence, criteria for evaluating competence for deck and engine officers courses are defined by the code "Standards of Training, Certification and Watch keeping" in which there is a determined part that describes the use of simulators. Section A-1/12 of the code is mandatory section that incorporates standards governing the use of simulator. Section B-1/12 is guidance section that incorporates a guide regarding use of simulators. Types and criteria of marine simulators are described in the code. Although competence, knowledge, understanding and proficiency, methods for demonstrating competence, criteria for

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evaluating competence for deck and engine officers courses are defined by the code, a standard evaluation method for simulator training hasn't been defined in the code. That's why, simulator training evaluation method changes according to the lecturer and evaluations can't be objective. Evaluation has an important role to develop the learning process and assessment is crucial to approve the competence of the trainee.

LITERATUR REVIEW

Competence-based Training and Assessment System

Sub-committee of International Maritime Organization on standards of training and watchkeeping published a document named Validation of IMO Model Training Courses that incorporates a chapter about assessment and evaluation for marine simulator trainings. This document explains competence based training and assessment system as the standards of competence are related to functions and the basis of the training design is measurable standards of performance. The evaluation forms an essential part in a competence-based system and has crucial elements. Sub-committee of International Maritime Organization on standards of training and watchkeeping states that the competence-based standards form is defined as the framework for evaluation. Evidence of performance needs to be monitored and appropriately measured using clearly described evaluation criteria. The evaluation criteria should be relevant, valid, reliable, consistent and realistic. [1]

Studies about Different Marine Simulator Training Evaluation

There are different studies related to marine simulator training evaluation methods. One of them is structured instructor evaluation method. Instructor keeps score using some form of a checklist or rating scale with this evaluation method. [2] Another method of evaluation simulator training is the ship-handling performance measurement by using the evaluation indicators obtained from the ship's motion analysis. In this system, trainees conduct their berthing utilizing the standard factors of approaching angle to the berth, speed, lateral distance at the berth front, which are determined for each of vessel type and of the quay. Therefore, the instructors evaluate the ship-handling performance of each trainee by comparing the mean and standard deviation of each of their following indicators with those by instructors: speed, distance to the berth, approaching angle, lateral distance to the normal line of the berth at the designated points on the planned track. After finishing each ship maneuvering simulator session, the ship-handling analysis is performed automatically using the software developed by the authors. This makes it possible to evaluate the ship-handling performance of trainees quantitatively within the short period of time and the instructor can give necessary advice on their ship-handling. [3]

Committee on Ship-Bridge Simulation Training Marine Board Commission on Engineering and Technical Systems National Research Council states in Simulated Voyages that the primary methodology for evaluation in a marine training program has been observation and feedback from the instructors to trainees. In these cases, the instructor usually has the responsibility for both the input such as lectures, negotiations and the output. Generally, these two different roles are carried out by the same instructor. [4] As an alternative evaluation method, simulator trainings such as bridge team and bridge resource management trainings has been to assign to other training participants the role of observer and evaluator. This peer evaluation methodology relieves the instructor of the dual role and permits evaluation of instructional efforts based on the strength of the peer evaluation. [4]

Kongsberg, producer of Polaris bridge simulator has developed different computer based evaluation system that enables the instructor to make structured and objective assessment of trainee performance. Upon completion of an exercise it reports the trainee's performance. The system is under full instructor control. Relevant evaluation criteria can easily be defined. These criteria's are continuously monitored by the system throughout the exercise. If any variable goes outside pre-set limits, penalty points are accumulated. A normalized score for the exercise is calculated from the accumulated sum of penalty points. [5]

'The Development of Performance Assessment and Comparison Model for Mariners Utilizing a Ship Bridge Simulator' is a study involves the application of Analytic Hierarchy Process (AHP) to develop an evaluation system including job task analysis and implementation of simulation scenarios. The main aim of this study is to design a powerful and flexible assessment process to assist simulator instructors to set up priorities and make the reliable performance-based evaluation when both qualitative and quantitative aspects of a performance measure. [6]

Another study is about evaluation at berthing training for pilot trainees using a ship maneuvering simulator. The authors propose an evaluation method for the case of berthing the vessel using the turning maneuver. Since the index obtained by the method in which the vessel carries out a turn in front of the target quay before berthing, offers a single numerical benchmark, it is an easy to understand result of the training exercise. The authors carried out experiments using a ship maneuvering simulator and confirmed that the proposed evaluation method is effective and helpful to improve the effectiveness of ship maneuvering simulator training. . The method is based on defining an indicator, the discrete distance, obtained from the ship's motion analysis after ship maneuvering simulator training. Because it is easily measured from a figure of trail output, which is available promptly after the conclusion of the training exercise, the discrete distance was found to effective for trainee evaluation. [7]

An evaluation system of marine engine room simulator based on fuzzy comprehensive evaluation is a study that fuzzy judgment matrix which was constructed by using the fuzzy comprehensive evaluation method was used as objective evidence of assessment. This evaluation module was developed by using C# language on VS. Net 2010 development platform.[8]

Objectivity, reliability and validity were defined as three assessment elements of which would reflect the candidate competency level. Using simulators in assessing can be affected by the instructor as an individual, which may prevent the assessment objectivity. SEA system (Simulator Exercise Assessment) was introduced to avoid subjectivity in assessing performance in simulator training. It developed an automatic assessing method to assess performance against "hard parameters" inserted by the instructor, while leaving the "soft skills" to be assessed subjectively. [9]

Kongsberg introduced Neptune Instructor System in the maritime simulator newsletter. Through the system, it is possible that instructor can access to a tool that allows the assessment of trainees on all levels. This assessment system allows the instructor to monitor, and use for assessment alarms and lots of available variables in the simulation models. The Instructor can give credits or penalty points depending on student's performance. Moreover, instructor has the possibility to print out assessment reports for each individual student reflecting his performance, including pass or fail. [10]

Lindmark divided the assessment of competence into two parts as computer-assisted evaluation and subjective assessment made by the instructor in his master thesis. He stated that it would be beneficial to limit as much as possible the more subjective judgment made by the instructor for objective evaluation. He recommended developing computer-based system for succeeding objective evaluation. He claimed that the students met the demands that are required by Standards of Training, Certification and Watchkeeping together with the written examination and assessment of practical exercises. [11]

RECOMMENDATION

Sub-committee of International Maritime Organization on standards of training and watchkeeping can define subjective and standard evaluation methods for all marine simulator training. Thus, all seafarers that trained via simulators can be evaluated at the same and optimum standards. As a solution offer for objective evaluation, Simple Additive Weighting (SAW) method can be tried for simulator training evaluation. For trying this method, a simulator training scenario should be prepared and this scenario should be applied to dedicated number of trainees. After completion of this process, evaluation criteria and the data acquired from the computer based simulators should be assessed to determine the applicability and of this method for subjective evaluation of simulator training. Simple Additive Weighting (SAW) which is also known as weighted linear combination or scoring methods is a simple and most often used multi attribute decision technique. The method is based on the weighted average. An evaluation score is calculated for each alternative by multiplying the scaled value given to the alternative of that attribute with the weights of relative importance directly assigned by decision maker followed by summing of the products for all criteria. [12] Another option for objective evaluation of simulator training is to develop automatic assessment system which is provided via a software program. For achieving this evaluation, predetermined standard criteria, parameters and limitations will be specified for each of simulator trainings. And assessment score for each criteria, parameters and limitations will be appointed. Software program will assess outputs of simulation results according to parameters and records. In this way, trainees can be evaluated objectively with same criteria, parameters and limitations for each task. New developments are pointing to automatic assessment method for objective evaluation of marine simulator training.

CONCULUSION

Simulator training is an important part of maritime education training. Lots of seafarers are trained with the aid of simulators such as engine simulator, bridge simulator, radar simulator etc. Evaluation of trainees is one of the most important stages in period of their trainings. That’s why, an objective evaluation for marine simulator training is necessary for defining trainees’ performance correctly. Evaluation criteria defined in the code “Standards of Training, Certification and Watchkeeping”, but evaluation method hasn’t been clearly defined yet. That’s why, evaluations of simulator trainings change according to instructor and also simulator training scores of trainees are subjective results. In this study, a review for evaluation of marine simulator training performance carried out. Academic studies about marine simulator training evaluation researched. Different evaluation methods found, but none of them is assigned as standard evaluation system for all marine simulators. For objective evaluations of marine simulator training, an objective evaluation system should be determined and applied to all marine simulator trainings for enabling standard evaluations for all seafarers in scope of Standards of Training, Certification and Watchkeeping.

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FUTURE TRENDS IN MARITIME TRAINING SIMULATOR SYSTEMS

Murat YILDIZ[1], Ersoy KAÇMAZ[2], Gül Emecen KARA[3]

ABSTRACT

Human factor has been one of the elements that cause vulnerabilities which can be resulted with accidents in maritime transportation. When the roots of human factor based accidents are analyzed, gaps in performing cognitive abilities (perception, attention, memory…) are faced as the main reasons for the vulnerabilities in complex environment of maritime systems. Thus cognitive processes in maritime systems have become important subject that should be investigated comprehensively. At this point, neurocognitive tests have arisen as coherent tools that enable us to make valid assessments for cognitive status and functioning of the agents who are in charge of the performing tasks. In the foregoing circumstances, the aim of this study to introduce neurocognitive tests and their implications in maritime domain. After an extensive literature, how to apply these tests and use them in the education and selection of the seafarer will be introduced in separate chapters through the paper.

Keywords – *maritime training, maritime simulators, ship simulators,*

INTRODUCTION

Within the field of simulation, simulator manufactures have developed numerous efforts obtain and validate simulators as learning tools. The goal in this type of simulator is to recreate virtually and as accurately as possible real situation to train or convey certain knowledge to a group of people. There are many situations in which to practice and teach things in a real environment is not possible or too expensive or dangerous, as can be the case simulations of natural disasters [1,2] accidents [3] or mock plans emergency [4].

The use of simulation techniques becomes very valuable in these cases, as attached to economic savings, can recreate situations similar to real eliminating risks that they would impose. For the specific case of maritime simulators there a lack of real installations that simulate procedures rescue and it is not possible to recreate some emergencies in these facilities (As a leafy sea or fire on deck), with the additional disadvantage that displace a group of people from one city to another can be relatively expensive. They entering the field of marine simulators, in recent years have designed and implemented many simulators which aims to teach users handle different types of ships. In the first instance, these simulators which serve to make a first contact with the ship, and second, you have situations before which should show some cunning to successfully overcome them.

The most simulated vessels are usually large ships (the cost of putting them in operation for a practice is excessive), both merchant and of passengers. In fact, given its complicated implementation, there

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are companies such as PC Maritime dedicated exclusively to the creation of such simulators. An example of these simulators is the “Engine Room CBT” [5], which has

sensorised

completely a room that simulates the control room machines large ship merchant. Another field of marine simulators with great impact is the simulators to control underwater exploration probes remotely operated (ROV -Remotely Operated Vehicle). In this case, the risk incurred when performing actual training is purely economic. As in previous case, companies specializing in this type of simulator [6]. An easy way to comply with the symposium paper formatting requirements is to use this document as a template

International Maritime ORGANIZATION (IMO) and Maritime Training Simulators

The International Maritime Organization (IMO) is a specialized agency of the United Nations. Responsibility of the IMO is to establish standards to improve the safety of international shipping and to prevent ship-source pollution. Therefore, the IMO sets the basic requirements that all masters and watchkeeping officers must be well trained. Training should be taken ashore and before Watchkeeping Officers attend the ship to be qualified and competent to carry out their tasks. As a result of that, the level of security on board ships will increase. Furthermore, the IMO has decided to change the Standards of Training, Certification and Watchkeeping (STCW) Convention of 1978, to increase the safety at sea.

STCW Convention

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 was adopted on 7 July 1978, and entered into force 28th 1984 April Since then, many changes have been adopted, for example, in 1991,1994, 1995, 1997, 1998, 2004, 2006 and 2010. The 1995 amendments to the relevant seafarer training, certification and watchkeeping (STCW). In addition, in A and B parts of the STCW Code, there were to make recommendations to the parties, to make the provision of the Code service fulfillment and completeness. And then in 1998 further changes were the conventions and separate A of the Code for the training of seafarers and to certain types of ships such as passenger Ro-ro passenger ships. Moreover, the more changes were made in 2010 Convention and the Code by the Conference of STCW Parties in Manila, Philippines. The changes renew competency standards set especially in the use of modern technologies to improve the competence proposed sailors and also a new training and certification requirements and Methodology. For greater clarity and proper understanding of the STCW related requirements Based Training Simulator, it is important to discuss those Requirements under three titles as follows:

- The use of simulators
- Training and assessment
- Minimum standards of competence

STCW95 indicates the possibility of using simulators as an effective tool

Discussion of the training and assessment of seafarers under;

1- Regulation - I / 6 - training and assessment

2- section A- I / 6 - Training and Assessment

3- section B- I / 6 - Guidance regarding training and assessment

Maritime Training on International Safety Management (ISM)

The main objective of the International Safety Management (ISM) Code is, as stated in the introduction of the Code (ISM Code ,1994) to provide an international standard for the safe management and disposal operation of ships and for pollution prevention. Thus, by implementing Security Management System (SMS), the objectives of the ISM Cod are achieved.

The most important element in the shipping industry is the crew. For example, Rule 6 of the ISM Code, "resources and personnel”, emphasized on the; the ship-owner to enforced to ensure that the captain and crew of the ships had practiced training and are medically appropriate for their jobs on ship.

MARITIME TRAINING SIMULATOR SYSTEMS

Integrated Simulation Solutions in Maritime Training

Integrated Simulation solution enables simultaneous conduct large -scale training activities and inter connectedly with the participation of all equipment on board in one place, from one or more ships.

Integrated Simulation solutions comprise a series of functional simulators, including navigational bridges complete "full -mission " simulator(s) of engine room simulators and handling of liquid cargo, incorporating multiple types of platforms, which are integrated to work independently or as a single unit on a ship virtual. This solution provides an ideal platform training exercises on a large scale involving several participants’ different functions and roles within and through the shipboard environment.

Simulator full boat maneuver (Full Mission) is designs, builds and installs according to the requirements the " International Convention on Standards of Training, Certification and watchkeeping for Seafarers - STCW 100 " (International Convention for the Training, Certification and Watchkeeping for Seafarers) and is approved by DNV Standard Class A. This is a complete solution in training Seagoing for all necessary training related to navigation and ship management. Training is carried out in a convincing immersive atmosphere with all the visual elements, hearing and instruments available to students.

The complete simulator (Full Mission) is available in several types configuration, including, 180°, 240°, 270°, and 360° field visual. The customer can choose from a wide variety of systems based display screens and projectors.

Steering Simulator

Management Simulator is a simulation solution comprising cost-effective technology in terms software and hardware, to achieve a realistic integrating replica handling environment on board. Simulator can be used for effective and practical training of sailors at a level of support. this simulates Realistically the steering system on a ship, including simulation gyrocompass, magnetic compass, telegraph machines, autopilot, rudder angle indicator, direction NFU (non follow- up) as well as a wide range of alarms direction.

Bridge Team Management Simulator (BTM Simulator)

Simulator BTM is used to provide training in improving navigation skills and maneuver official navigation working in a team situation of bridge (bridge-team). The learners can participate in a full range of scenarios navigation normally found in the sea. All relevant external factors safety of navigation, including the state of visibility, weather, tides and currents can be set and modified to suit the specific training requirements.

The boat model behavior allows full 6DOF motion under the combined effect of internal, external forces and interactive.

The instructor is provided with an extensive library of failures and errors that can be introduced, including reduced functionality individual components to the complete breakdown of equipment of navigation aids (aids navigation), propulsion and steering.

The simulator is suitable for training in the company to improve efficiency, navigation and knowledge of sailors on board.

Simulator eBook - Electronic Chart Display Information System (ECDIS)

This is a complete system for training in understanding the operation of the Electronic Chart Display Information System (ECDIS).

Viewing the electronic charts (ECDIS),. the simulator allows students to gain skills to operations special involved in the use of ECDIS as charge cards, zooming and panning, tracking and checking of the route, monitoring, concealment and retrieval of information, correction of the letter, palettes, among others.

Applications for the training include the observation and understanding of correct several errors, restrictions and limitations associated with the use of ECDIS and recognition of the danger of over-reliance on ECDIS.

Simulator RADAR / Automatic Radar Plotting Aid (ARPA)

This simulator is used for training in navigation and collision avoidance routines related with RADAR / ARPA marine system. The simulator emulates the full functionality found in a system Modern marine RADAR provides complete control over traffic density, waterways, state sea and weather conditions. This simulator meets and exceeds existing international requirements, including those established by the STCW'100 and DNV. The instructor station has the ability to perform preparation, execution and reporting of training exercises.

Electronics Navigation System Simulators

Electronic Navigation System Simulator (ENS) is designed to train students in the use adequate and secure electronic navigation systems for fixing the position.

The simulator helps in the development of the following skills:

- Bridge work basics while officer navigating.
- Basic operations, capabilities, errors, limitations of navigating areas.
- Using RADAR, ARPA and other navigational aids.

Bridge Resource Management Simulator (BRM simulator)

Equipment Command-Bridge Simulator BRM is used to provide training in improving navigation skills and maneuver official navigation working in a team situation of bridge (bridge-team). The learners can participate in a full range of scenarios navigation normally found in the sea. All relevant external factors safety of navigation, including the state of visibility, weather, tides and currents can be set and modified to suit the specific training requirements.

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The simulator is suitable for training in the company to improve efficiency, navigation and knowledge of sailors on board.

- Teamwork bridge (bridge team)
- Ship Management
- Resource Management wheelhouse.

Simulator Vessel Traffic Service (VTS)

This is a versatile simulator that can be used for operator training and supervisor level, including refresher courses. The simulator can be customized to provide training in a port specific. Using this simulator is possible to train according to various models courses IALA (International Association of Lighthouse Authorities Maritime Fog - System) and carry out the evaluation of the 5 levels IALA recognized.

The simulator allows integration with the Full Navigation Simulator (Full Mission) to carry out realistic training together, including VTS operators and Navigation Officers.

Tow Truck Simulator (Tug)

Operation Simulator Tug (TUG) provides an excellent platform training for both new operators as experienced, improving their skills tug and management practices for maneuvers and emergency response.

Global Maritime Distress Safety System (GMDSS) Simulators

The GMDSS simulator provides training operating full GMDSS communication equipment using the same found in marine mobile units and high seas. The simulator meets the performance standards for simulators as defined in Section A- I / 12 and B -I / 12 of STCW'2010. The GMDSS Simulator follows the basic philosophy of providing an operation environment similar to the operation of a GMDSS station of a modern ship. Is suitable for training navigators at all levels to manage Communications routine and distress at sea.

The simulator replicates the transaction capabilities of everyone following teams in a modern station GMDSS on board:

- Inmarsat
- Inmarsat B
- Inmarsat C
- MF / HF DSC
- NBDP
- NAVTEX
- EPIRB
- SART
- Fleet 77

- Radar (for the use of SAR)

Full Mission Machines Simulator

Marine Engineers routinely monitor and manage large machines and power generation systems that are generally complex, highly sensitive to changes and with very little margin for error. While most operations in the engine room are performed smoothly, there is little common and accumulate errors occur which can result in incidents catastrophic proportions. A large number of these errors occur due to the inadequate experience of the operator (s). Adequate experience is costly and difficult (if not impossible) to get in real life.

Liquid Cargo Handling Simulators (LCHS)

Liquid cargo handling, pressurized gases, chemicals, oils and fuels in the marine environment has high risk of explosions, damage and pollution. He personnel involved in the management and administration of the load requires highly specialized training to prepare to carry out their responsibilities with the highest standards of safety and efficiency.

The simulator Liquid Cargo Handling is an advanced officer training solution levels operational and management. It is a scalable solution You can start from a computer to versions High of Mission Full range including consoles control position, instructor stations, mimicry duct panels and more.

Highly detailed models are delivered for ships LNG, oil tankers (crude and products), Vessels LPG, Chemical Tankers.

NEW TRENDS IN MARITIME TRAINING SIMULATION SYSTEMS

STCW Amendments

Reviews and Updates will be done every 5 and 10 years by STCW will be included standards of human elements in 2020. Human Element Vision is to improve safety significantly seas and the quality of the marine environment from human element issues addressing to improve performance.

Piracy Protection and Safety

• recent events have clearly shown that neither the naval operations nor the law Arrangements were sufficient to prevent piracy Experiments that not only hinder day maritime trade, but also make the A seaman less attractive to young People. Therefore, piracy response training is more demanded. • Focus on safety in the new global Environment leads the simulator to increase Applications, such as emergency situations Handling (fire, earth, collisions, etc.); Simulation of the FRB, patrol boats and RHIBs are becoming increasingly popular.

World Climate Change

Because of the global heating, North pole ices are melting year by year. Therefore, new opportunities will be on ship simulations:

• Ice Navigation Training

• Training for emission monitoring

• Ballast planning

• OIL SPILLS response plans preparation, response Training for management and for clean-up crews;

• Polar code and the related requirements Mandatory training will be added by 2015 Update of STCW

Offshore platforms

Number of offshore Wind farms, oil and gas mining platforms. will increase in the next decades. Therefore, risk of ship collision will increase navigating ships to offshore platforms This situation affects the maritime training and simulation systems like below:

• offshore platforms will impact on the coasts routing and navigation, as well as a necessity train staff for the use of surgery.

• modular Dynamic positioning and twisting slide

• Demand of the Dynamic positioning modules on shuttle tanker, Dynamic positioning PSV

• Remotely operated underwater vehicle operations simulators,

• Crane operations simulators

• Simulators of dredgers

• simulators floating cranes

E-Navigation

E-Navigation is an IMO initiative started in 2005 to increase the safety of navigation by modern technology. The scope of the e-Navigation project is defined as “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” (IMO MSC, 2009). E-Navigation foresees progress in the three fields of:

- On-board navigation systems,
- Shore side vessel traffic information management and
- Ship-to-ship-, ship-to-shore and shore-to-shore-communication infrastructure [7]

Distance Learning - e-Learning

Online training, e-Learning or distance learning is the future of education and training. It will allow to reach more students than size of auditoriums allow. Maritime Schools will create online training programs which involving a lot of different elements and a complex task. Simulators are able to run though the Cloud servers. Virtual Realism (VR) technologies will allow students to control the simulators from their homes.

Developments on the Technology

• 3D visualization realism and the is the one of the future trends on maritime simulation training.

Virtual reality makes the training easy past incidents to reconstruct learning experience for the future create. It also allows you to create realistic scenarios of vulnerabilities that are very industry specific. In this way, virtual reality allows to lay a solid foundation for the safety and situational awareness to vessels and platforms.

CONCLUSION

IMO-STCW standards emphasize the use of simulators in training, as well as the standards initiated worldwide by several classification societies and the growing number of marine industries, which are with maritime simulation to improve education in the skills and certification. Maritime Training Simulators provide to train to the maritime students, wachkeeping officers and engineers in dangerous and risky areas, emergency situations on board.

New technologies will affect the potential of simulators as a training tool. 3D visualization realism is the most important of the future trends on maritime simulation training.

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INNOVATION APPLICATION AT LOGISTICS INDUSTRY CASE STUDY FOR BORUSAN LOGISTICS

Gökçe TUĞDEMİR[1], Cansın ANGIN[2]

ABSTRACT

Since 1950s, logistics and logistics management have been standing out day by day. With globalization, importance of logistics and its management increased a lot. The logistics manages the flows of products, services and information between customers and suppliers, and plays an important role in supply chain. In this study, innovation concept, varieties, amenities and applications of this concept in logistics industry will be evaluated. Innovations in logistics, as in every industry, are important in terms of competitive power, effectiveness, efficiency and customer value. Reformed innovative movements should be required to efficiently manage product, service and information flow in logistics and to acquire competitive power. The aim of this study is to lay emphasis on innovation concept and to inform about what provide to firm. In addition, innovation concept that newly develops in our country will be presented through Borusan Logistics that pioneer of logistics sector in Turkey with innovative movements. Methodology of this project is planned to literature research, interview and online databases.

Keywords: innovations, innovations in logistics, logistics sector in Turkey, maritime logistics

INTRODUCTION: LOGISTICS

The term "logistics" has long been linked with the military. It was regarded as all the activities involved in wartime deployment and support of a nation's armies [1]. Over the years the meaning of the term has gradually generalized to cover business and services activities.

Logistics stands for all activities which provides the validity of correct product in the correct quantity to the correct clients at the correct time. Activities of logistics do a service like the connection between manufacture and consumption and basically ensure a relationship between manufacture and locations of market and suppliers distinguish by time and distance. It is necessary to focalize goods or physical products, people, and information about goods and people. Varied values are included to a good at several stage of life cycle [2].

Logistics is customer-focused. The customer is the key to all logistics activities- the various reason why things happen. The customer are included to all process until the end of all logistics activities [3].

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Logistics facilities mean the flow of products from of origin to point of consumption. Logistics activities can be sorted as transportation, warehousing and storage, industrial packaging, material handling, inventory control, order fulfillment, demand forecasting, production planning, procurement, customer service, facility location, return goods handling, parts and service support, salvage and scrap disposal [4].

Logistics has gained importance day by day. Some importance of logistics can be arrayed as changing in transportation cost, importance of efficiency and effective distribution channel, fundamental change in inventory, increased product line, development of technology and computer applications, using computer and mass production, reducement in economic regulation, expanding force of retailer merchant and globalization [5].

INNOVATION

When the world becomes increasingly globalized, it happens bigger innovation basically services areas, technology and exercises in order that the delivery of products and services are till speed reciprocatively rivalry [6].

Innovation is very important tools for enterprising for providing their competitiveness [7]. According to Drucker [8], innovation is the significant means of enterprising. Entrepreneurs take advantage of interchange as an occasion for a varied business or service. Porter [9] defined innovation in the way that businesses can succeed competitive superiority by way of innovation acts and they close innovation in its widest sensation, comprising both new technologies and new ways of doing things.

The significance and description of innovations can be clarified from various aspects. According to customers’ perspective, innovation is defined products with much better quality and services, which jointly add up a much better aspect of life. According to businesses’ perspective, innovations is defined sustainable expansion and development, recognition of major profit. From the aspect of employees, innovations is called as new and more attractive job, which is necessary to more mental sense, which comes up with result in superior salaries. For entire economy, innovations means a greater productivity and development [10].

As one of the fundamental drivers of industrial competition, XXI century is testimony to the growth of innovation and innovativeness. Innovation becomes ever-increasingly vital in generating and sustaining a competitive advantage of organization, alongside its additive to growth and wealth [11]. In a sense, innovation is a powerful competitive strategy to succeed world-class producing and servicing status and rival effectively in global markets [12].

According to areas of usage and degree of influence & size, innovations can be classified. According with definition of OECD Oslo Manual [13] for measuring innovation, there are four types of innovation. There are product, process, marketing, and organizational innovation. Sundbo and Gallouj [14] defined innovation in the service sector as incremental and radical innovation.

Kandampully [15] defined that three requirements for service innovation: technology, knowledge and relationship management. If the customer gains value added from new product or service and a new function with lower cost, an innovation will be in existence. [16]. Hesselbein [17] said that “Innovation is change that creates new dimensions of performance”.

LITERATURE REVIEW: LOGISTICS INNOVATION

With reference to logistics innovation, it mentions to service related logistics is in sight as new, better, and useful to a significance focal public. Innovations in logistics can be much simple to more complicate and can be implemented to internal transactions or services with partnerships [18]. According to customers, innovation should be new, better or development service. Firms have to permanently seek for innovative strategies to develop their competitive advantage in logistics for global competition [19].

Logistics innovation has been defined as " any logistics related service from the basic to the complex that is seen as new and helpful to a particular audience" Logistics innovation manages is process that consists of four main activities. These are setting the stage, customer clue gathering, and negotiating, clarifying, and reflecting, inter-organizational learning [18]. An innovation for Third Party Logistics Company has much better talent to gain competitive advantage and remain market share by way of a better ability to serve it with new better services [20].

Setting the stage activities are generating and changing environments and educating people to enhance innovation activities. **Customer clue gathering** is connecting with customers to search for hints for changing needs and to identify unfulfilled needs. **Negotiating, clarifying, and reflecting activities** are a continuous development approach to commenting, clarifying, and negotiating customer needs. **Inter-organizational learning** is engaging in joint learning and open innovation with customers [21].

Logistics innovation has both taken advantage of implementer in the logistics field and confirmed implementer in marketing, sales, finance, and as well end consumers. Logistics innovations examples which are used by logistics companies are containerization, cross-docking, EDI, RFID, and temperature-control technology [22]. As customer-related innovations, it is large possible to create value for the client loyalty and, at one and the same time, assist Logistics Service Providers make dissimilar themselves from their rivals [23]. Customer-related innovations must lead greater alteration program against eco-efficiency and they should be proactive [24].

Innovation in logistics was spurred with three trends. These are increase in the demand for high-technology goods, influencing logistics sector from globalization and internet & its applications [24]. Main components of logistics innovations are services, information, and product, technology and information systems, working process time and place, cost and price, customer, quality and people, distribution networks and warehousing, physical factors and transportation modes, value added services and integrations, research and development [25].

Lin [26] elucidates two types of innovation for logistics industry. Firstly, technical innovations belong to data acquisition technologies, information technology, warehouse management system, and transportation management system. The other type of innovation in logistics refers to administrative innovation. According to Lin [26], administrative innovation can be classified knowledge management, customer relationship management or supply chain management. According to Mena et al [35], administrative innovation is described as just-in-time; value added services, fourth party logistics, coo-petition and green logistics.

Technical Innovation

Technical innovation belongs to products, services, and production process technology; it is interested in main activities and can interest each goods or process [27]-[28]. According to the activities in logistics, the technical innovations for logistics can be categorized into four classification – data acquisition technology, information technology, warehousing management system, and transportation management system [26]-[29]-[30]-[32]. It is necessary the expanding knowledge about innovative technologies and applications with more flexible deployment [31].

Data acquisition technologies: Logistics service providers are mostly the object of a sleeve of products and data. Data collection and exchange are sensitive for logistics information management and control.
Well-quality in data acquisition can assist logistics service providers deliver customers' goods further rigorously and efficiently. The bar code system and radio frequency identification system (RFID) can be exemplified to data acquisition technologies [26]-[29]-[30]-[32].

Information technologies: A lot of logistics managers think the information technology as a main principle of enhance productivity and competition capacity [28]. Information technologies may remain organizational productivity, suppleness and competition capacity alongside trigger the improvement of inter-organizational networks [33]. Electronic data interchange (EDI), the internet, value added network (VAN), point of sales (POS), electronic ordering system (EOS), logistics information system, computer telephony integration, enterprise information portals and extensible markup language (XML) are included to the information technologies which are widely used in the logistics industry. In the knowledge-driven economy, information and communication technology plays an important role as it allow of innovation in product/service, process and organizations, especially in service companies [34].

Warehousing technologies: Warehousing performs a significant status in a logistics industry. The warehousing technologies are automated storage and retrieval system (AS/RS), automatic sorting system, computer-aided picking system and thermostat warehouse [26]-[29]-[30]-[32].

Transportation technologies: Transportation is very important of apparent logistics operations' factors. The main aim of a transportation management system is to transfer good from an source location to a detected destination by reducing costs and damage expenses. Transportation information system, global positioning system (GPS), and geographical information system (GIS), radio-frequency communication system, and transportation data recorder can be exemplified to the transportation technologies which are commonly used in the logistics industry [26]-[29]-[30]-[32].

Administrative Innovation

Administrative innovations are related knowledge management, customer relationship management or supply chain management [26]. Administrative is also a significant on the logistics industry. Undoubtedly, Just-in-Time have varies efficient. But a lot of different innovations are forming the industry. Some of the most important administrative innovation of recent years is described as just-in-time; value added services, fourth party logistics, coo-petition and green logistics [35].

Just-in-Time: It is a well-sample of administrative innovation in logistics which maintains to have an influence [35].

Value-added Services: such as warehousing, co-packing, co-manufacturing, labeling, postponement and mass-customization are expanding the role and importance of logistics provider in the supply chain [35].

Fourth Party Logistics: Fourth party logistics is an enlargement of Third Party Logistics which includes logistics outsourcing logistics services to a company that does not absolutely itself the asset and sources. These companies hold the computer systems and intellectual capital tend to suggest end-to-end logistics services on global-extent [35].

Coopetition: Important innovation in the industry which describe collaboration with customers, suppliers and competitors can help to minimize waste and increase responsiveness [35].

Green Logistics is the combination of various measure, action or object in the supply chain which impacts that supply chain in an environmentally way [36].

According to Lin [26], administrative innovation for logistics service providers into three topics which are Supply Chain Management (SCM), Customer Relationship Management (CRM), and knowledge management.

Supply chain management: The supply chain contains whole interactions between suppliers, manufacturers, distributors, and clients. The primary to influential supply chain management is to make the suppliers “partners” in the firm’s strategy to fulfil an ever-changing market-square [26]-[29]-[30]-[32].

Customer relationship management: Customer relationship management is a service notion which assist an enterprising administer customer relationships. Customer relationship management can ensure employees with information and process necessary to recognize their clients, find out their requirements, and effectively construct relationships between the company and its customers [26]-[29]-[30]-[32].

Knowledge management: Knowledge management is interested how knowledge is generated or obtained, propagated, and used within organizations. The process of knowledge management can be classified as knowledge acquisition and collection, knowledge storage and categorization, and knowledge diffusion and use. The acquisition and collection of knowledge can be attained by the ways of documents regulations and the technologies of essential societies. The storage and categorization of knowledge can be attained by the technologies of data mining and data warehousing. The expansion and implementation of knowledge can be attained by the technologies of enterprise information portal and e-learning [26]-[29]-[30]-[32].

All logistics innovations improved had the aim of demanding market needs and to gain competitive advantage [37]. Logistics is institutionally driven by operational demands. Therefore innovations are mainly leaned direct customer demand. However, logistics service providers (LSPs) have started to notice the importance of proactive innovation to gain competitive advantage [38].

CASE STUDY: BORUSAN LOGISTICS

This research is an exploratory study to evaluate innovations approaches of logistics companies and to determine logistics innovations which are important in terms of competitive power, effectiveness, efficiency and customer value. The **aim of this study** is lay emphasis on innovation concept and to inform about what provide to firm. In addition, innovation concept that newly develops in our country will be presented through Borusan Logistics that pioneer of logistics sector in Turkey with innovative movements.

Methodology of this project is literature research, interview and online databases such as company's websites, issues of Turuncu magazines and websites' news. The method of interview is used very extensively in every field of social research. In interview, a social scientist or someone authorized by him for the purpose meets individuals to interrogate them about various things. An interview is a direct method of enquiry. The purpose of interview, however, is not to collect superficial detail about the interviewee but is rather to probe into the inner life of the interviewee. Therefore, the method of interview is direct as well as in depth study [39].

As **data collection method**, semi-structured interview method that is one of the qualitative research method was selected and as data collection tool, semi structured interview form was prepared. In the creation of data collection tool, literature was taken as a basis. Open-ended questions were asked to the Planning and Delivery Manager and 6 Sigma Project Manager in Borusan Logistics companies by adhering to the literature in the context of logistics innovations and also issues Turuncu magazines and company website and websites' news were investigated deeply.

The **population of this research** is logistics companies. When it was researched literature review and realization of logistics innovation in Turkey, Borusan Logistics is the one of the most important and the most expensive innovation in Turkish logistics sector. So **research sample of this research** is Borusan Logistics. Face to face interviews with Mr. Koray AKINCI [40] who is planning and delivery manager of Borusan Logistics and Mrs. Gamze YAYLA [41] who is 6 Sigma project manager of Borusan Logistics were connected on 02.06.2016. This interview was conducted by being planned in the wake of pre-interview via mail.

Profile of Borusan Logistics

Borusan Logistics was founded in 1973 and reorganized as an integrated logistics service provider in 2000. Borusan Logistics become too specialized in four strategic business units: Turkey Domestic Logistics Services, Port Services, International Transportation Services, and Logistics Services Abroad [42].

Table 1. Innovative Work Cycle between 2008 and 2014

YEARS	MOVEMENTS
2008	- Managers of Special Project were appointed to work Special Projects
2009	- Innovations were started to discussed - Path Planning for 5 years
2010	- Notice of Innovation at company meeting - Notice of Cultural Conversion
2011	- Configuration of Logicube - First Committee Meeting - Progress of idea research and planning approach - Set up of Research and Development
2012	- Consultancy of Innosight - Logistics Business Development - Configuration and Deeping Innovation Process and Tasking
2013	- Innovation on the basis of company and business unit - Assignment of Innovation Management - Project of Innologi - Launching of ETA Project - Portfolio Management - Chase of trend at a level of Benchmark
2014	- Launching of Bukoli

Findings of Borusan Logistics' Innovations

Borusan innovation strategy is based on entrepreneurship. Management Systems of Borusan Logistics which are directly related to innovation and innovative movements can be collected under three titles as Customer Management System, Environment Management System, Employee Management System and Lean 6 Sigma [38].

Customer Management System includes Customer Relation Management (CRM), Voice of Customer (VOC), Customer Satisfaction & Complaints Handling (ISO10002), and Quality Management Standard (ISO9001). **Environment Management System** is related to 'Green' image from 'Brown' image. Carbon Footprint, Usage of Green Engine, Fuel Card, Usage of Electric Crane, Vehicle Maintenance, 1406 Greenhouse Gas Standard, and Temporary Waste Repository can be exemplified relevant to this system. **Employee Management System** is related to IIP (provides connection between employee participation and organizational goal) and OHSAS 18001 (Health and Safety Management Standard**). Lean 6 Sigma** is a management methodology which is designed to evaluate and improve all business systems. Benefits of this innovation defects rates, increase efficiency, improve all business processes and continually augment customer satisfaction [42].

Innovation strategy of Borusan Logistics is creating value new. "Value" refers more profit margin and more revenue, less cost and better use of resources. "New" refers new business, core business, and similar jobs. "Thing" refer product, services, proposal of customer value and others for Borusan Logistics. Borusan Logistics innovations can be examined into three groups. These are core, new, and others.

Core innovation of Borusan Logistics is energy logistics. Other innovation includes multimodal train and cold partial. This innovation is a green and innovative solution for logistics sector. Borusan

Logistics which has the first liner train Turkish company provides multimodal transportation service. It contributes to environmental sustainability by reducing land use, offers guaranteed delivery times with scheduled runs and provides integrated and safe delivery with door-to-door container transportation.

New innovations of Borusan Logistics include ETA, BUKOLI and Insurance Services Sale. ETA (Electronic Transportation Network) is the most important and expensive innovation for Borusan Logistics in Turkish Logistics Sector. This system is taken a chance to small and middle size company. ETA provides many advantages to Small and Medium-sized Enterprises (SMEs) (via Internet) and carriers (via Mobil Technology). ETA is not a simple meeting platform between cargo owner and truck driver, it is technologic fleet management system where thousands of vehicles are managed efficiently and created value to all sides. Properties of ETA are ease of use, efficiency, suitable price and safe system. It provides business continuity, cost advantages and efficiency to truck drivers.

ETA is very important savings and gains in our country such as increasing large tonnage transportation, decreasing usage of smuggled fuel and road damage, increasing efficiency, less usage of heavy vehicle, continuous mobility. As for smuggled fuel, special card is given to truck drivers and is seen types of used fuel. Therefore both environmental damage and governmental tax loss are prevented. As for efficiency, more transportation are done with number of same vehicle. The ETA is the first company to provide an online transportation service both transporters and possessors. Borusan said that “As transporters subscribed on the systems can reach business opportunities via mobile channels, good owners can obtain an insured transport service at market price, which can be always monitored, without paying any additional charges”.
ETA has active website. There are daily tender, types of vehicle, load time, place of load and discharge in website. Types of vehicle, properties of load, time of loading and similar data are logged in and demand are occurred. Price offer that calculated transiently and automatically is given by system. Market freight can be queried at portal system. With software of ETA, the nearest vehicles are found. Optimum transportation solution is used.

At the start, this project consist of 35 city such as Afyon, Ankara, Bursa, Aydın etc. Borusan Logistics is in cooperation with one Global System for Mobile Communications (GSM) operator for GSM assisted communication and tracking system. Then new mobile application is applied by Borusan Logistics. With this newness, business information are notified to truck driver's phone. Truck drivers can joint and offer without paying any commission with this application.

In addition to these, there is cooperation between IDO and ETA. This cooperation provides conveniences to semi-trailer truck user and truck user in line between Eskihisar - Topçular. Users benefit from many advantages. This innovation example can be evaluated as process innovation, radical innovation, technological soft innovation and information / transportation technology in technical innovations.

BUKOLI Project was developed by innovation team of Borusan Logistics for delivery problem. This project is next generation delivery model. Goal is generating solution for delivery problem. And now, BUKOLI delivery system is cooperate with important retailer firm. With cooperation, next generation delivery and alternatives will be provided with approximate 600 delivery points. This innovation will be both technical and administrative innovation. As a technical innovation, BUKOLI can be classified data acquisition technologies, as an administrative innovation, this project can be classified just-in-time and supply chain management.

All of these innovations of Borusan Logistics are based on entrepreneurship. Benefits of all innovations of Borusan Logistics are defecting rates, increasing efficiency, improving all business processes and continually augmenting customer satisfaction. Borusan Logistics attaches importance to green logistics. Therefore they provide innovations for providing green logistics. Benefits of these innovations ensure environmental sustainability, guaranteed delivery times, integrated and safe delivery. Thanks to ETA, Borusan Logistics provides ease of use, efficiency, suitable price, safe system, cost advantages, decreasing usage of smuggled fuel and road damage, increasing large tonnage transportation, less usage of heavy vehicles and continuous mobility for all logistics parties. BUKOLI project provides generating solution for delivery problems. Goals of innovative Borusan Logistics are to convert existing market by describing basic performance criteria and to occur new market thereby targeting non-consuming and Borusan Logistics is realizing all these goals by the virtue of its innovations.

CONCLUSION

Logistics gains importance day by day. Therefore logistics processes should be managed effectively and efficiently. Effective and efficient management in processes can be provided with innovations. Firm should make innovation to adapt dynamic and changing environment. Innovations in logistics can be grouped as technical and administrative. Technical innovations are related to data acquisitions, warehousing, and transportation and information management. As administrative innovations, it includes managerial movements, supply chain, customer relation and knowledge management.

Creating value new things are innovation. In light of this study and of the interview, innovations are necessary to increase efficiency, profitability, customer satisfaction, market share, to provide long – term sustainability, growth, and key to continue one's existence for firm. Before anything else, extended research & development work is required for innovation. Good infrastructure and preparations should be necessary. All employees from employee to top manager should be informed and adapted to innovation and innovation culture.

The major contribution of this study is to show and emphasize that practice and importance of innovations in logistics. Innovation concept is newly-emerging for logistics firm in our country. Innovation is required wide scale research and serious cost. Generally, large size company bear to wide scale research and serious cost in our country. Small and Middle Size Enterprises, called as SMEs, must be fallen to "innovation" and "be innovative". For example, ETA Project was actualized by Borusan Logistics to bear SMEs in the innovative system and innovative solutions. Because of that innovation and innovative solutions have a many contributions for firms and customers.

Borusan Logistics plays an important role in terms of innovative solutions in logistics sector. Confident steps taken related to matter. Various systems were developed. These systems contributes to firm in terms of customer value, profitability, efficiency, competition power, and growth. As mentioned above, "ETA" Project is important and first in terms of business model and SMEs in logistics sector in Turkey. When the place of Turkey in Logistics Performance Index is examined, progress of Turkey is seen. With innovation and innovative solutions, Turkey and logistics firm can be more and more developed.

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AN OWNERSHIP AND MANAGEMENT MODEL PROPOSAL FOR LOGISTICS CENTERS IN TURKEY

Seçil Gülmez[1], Çimen Karataş Çetin[2]

ABSTRACT

The requirement of submitting logistics operations performed from resources to ultimate consumers in supply chain, fastly, effectively and efficiently for low costs, draws interest on nodal points ashore along with seaports. Logistics centers have been operating for long time in Europe but have become a current issue only since last 10 years in Turkey. There are logistics centers established and planned to be established by TCDD and planned to be established by private sector in Turkey. But, success of the logistics centers, no matter how to be established, is parallel to a successful management model. The aim of the study is submitting a proposal for the ownership and management model for logistics centers in Turkey. Accordingly, ownership and management models of logistics centers are investigated and delphi method is used to receive opinions of the experts on logistics centers among both private sector and government experts. Ultimately a model proposal for the ownership and management of logistics centers in Turkey is submitted in light of the information reached by experts' opinion.

Keywords - Delphi Method, Logistics Centers, Management, Ownership, PPP

INTRODUCTION

Continuous changes of trade dynamics in the global market force logistics industry, as well as all sectors, to provide services faster, more efficient and at lower costs. Firms are interested in finding new logistics solutions due to increase in cargo flow and requirements of adaption to possible future changes and solving problems in supply chain owing to globalization. Hence, in competitive market logistics centers have become more important because of the fact that it provides faster, efficient and low cost logistics services.

Success of logistics centers depends on many factors that, service quality, efficiency of hinterland connections, corridor development, location selection, market analysis, trimodal connections, common user and neutral management, policy and regulatory regime, institutional barriers, economies of scale etc. [1]-[2]-[3]-[4]-[5]-[6]-[7]. Additionally efficient and effective operations of logistics centers depend on a good organization and management structure. Synergy and collaboration of firms lead

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logistics centers to success. Once a research done on examples of logistics centers worldwide it is seen, especially in Europe, that organization structure of logistics centers rely on good service quality and succeed by means of good coordination of logistics service providers. Entire framework of logistics center organization is composed of tri-partition. These are independent business units, transport companies and added value services. Despite the competition in the market, the companies grouped into tri-partition have synergy due to complementing each other in logistics center. By the means of win/win situation, both logistics center increases its effectiveness [6]. As it seen the German GVZ, governing of centers are based on the collaboration of the companies located in the center and companies get benefits by the achieving synergy. Therefore new companies get encourages benefits as well as the companies located in center have the advantages of development [8]. As well as organizational structure, management of logistics centers have an importance to development of logistics centers. However, heavy bureaucracy, management procedures and regulation issues lead to obstacles to build a logistics center. Accordingly logistics centers should supported by institutions with fewer regulations in order to achieve high degree of development [9].

Logistics sector has gained acceleration in Turkey with the world development as well [10]. Investment in transport infrastructure has increased from 3 billion EUR in 2006 to 15.5 billion EUR in 2013 [11]. Additionally international trade flows of Turkey has increased from 128,9 million EUR in 2004 to 291,7 million EUR in 2014 [12]. In parallel with the development of transportation and trade in Turkey, building logistics centers have become a requirement [13]. Logistics center projects are mostly planned by TCDD (Turkish National Railway), as well as private sector has logistics centers projects. However there has not been determined management and ownership model that could be applicable in logistics centers. In addition to that defining the responsibility of logistics centers under 4 different ministries (Ministry of Science, Industry and Technology, Ministry of Economy, Ministry of Customs and Trade and Ministry of Transport, Maritime Affairs and Communications) creates authority complication.

The study primarily aims to submit an ownership and management model proposal which could be applicable in Turkey considering the regional and commercial dynamics. Also clarifying the parties, involved in management and ownership model, and their duties and responsibilities.

In the study, first section explains organization, ownership and management of logistics centers and explains each types of management models. Second section examines that logistics centers projects in Turkey. Third section explains the methodology and how delphi method used in the study as well as states findings and results of delphi survey. In the light of third section, final section submits an ownership and management model proposal for Turkey and specifies related parties and their duties.

ORGANIZATION, MANAGEMENT AND OWNERSHIP OF LOGISTICS CENTERS

According to the Europlatforms logistics center is “the hub of a specific area where all the activities relating to transport, logistics and goods distribution – both for national and international transit – are carried out, on a commercial basis, by various operators” [14]. Logistics centers are extensive structuring in terms of organization and management. Despite many actors in logistics centers and each of actors have their own strategy based on companies’ main activity the collaboration among transport and logistics companies within organized logistics centers can enhance optimization of transportation equipment and opportunities of planning international transport [15]-[6]. Analysing logistics center concept, main concern operational aspects that emphasis on services, infrastructure, and functionality. Organization structure and business development has a significant importance that generating trade and cargo [16].

Ownership Model of Logistics Centers

Ownership model of logistics centers may categorize as follows:

- Publicly owned
- Privately owned
- Chamber of industry and commerce or local government partnerships or PPP Model (Public-Private Partnerships).

The **Figure 1** below is illustrating the ownership, management and operation structure of logistics centers. According to the **Figure 1**, if public manages and operates the logistics center and if logistics center is owned by public, the model is public governance; if management and operation activities performed under private sector control and also logistics centers owned by private sector, the model is private governance; if logistics center is owned by public, but management and operations are performed under private sector control or if logistics center is owned by both public and private sector and management and operations are performed under both two sector, the model is PPP.

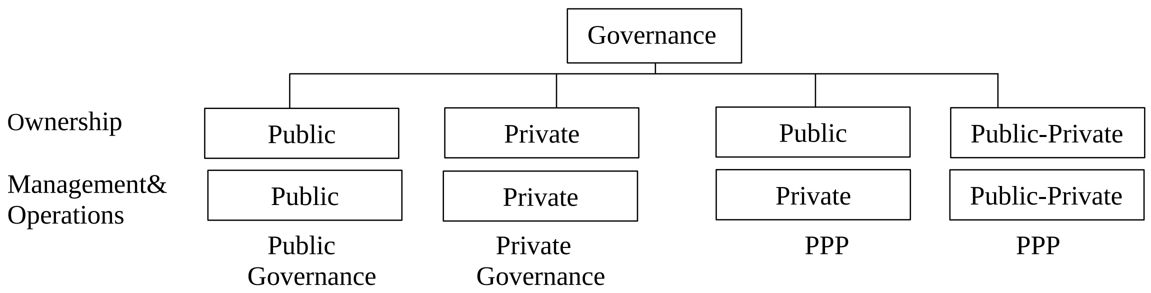

Figure 1: Types of Ownership and Management Model of Logistics Centers
Source: [17]

Ownership determines possession of terminal sites and facilities (including equipment) [17]. Operators of logistics centers can be owner or tenants of warehouses, storage areas, offices, distribution centers and truck services etc. which have been built in logistics centers. In compliance with the free competition rules, logistics centers must be open to access all companies involved in these activities. In addition that logistics centers must be equipped with public facilities in order to perform logistics activities [6].

The setting up of inland ports (or the labeling of existing facilities) often involves private and public interests. The aim of the private investor is that increasing investment returns while the public intervention is fulfill two types of goals related to development and planning objectives. As the first public aims to develop local economy (employment, income, taxes) through supporting logistics activities. The second goal is planning and regulation objectives which are related with the promoting railway usage, sustainability and reducing traffic congestion etc. [15]-[18].

Management Models of Logistics Centers

According to the Europlatform (2004), it is vital that a Logistics Centre be managed as a single and neutral legal body [14]. In addition it is also crucial that along with suitable government structure and strong management plan, professional and competent management body is also basic service characteristics of logistics centers [19]-[6]. Management structure of logistics centers should provide following features [20]-[21]:

- Takes measures for improve logistics activities
- Value added services and suitable infrastructure for intermodal transportation
- Coordination of different service providers and
- Efficient use of resources

Ownership and management models cannot be classified clearly for logistics centers. Different types of relation may enable for governance and operation of logistics centers that only private venture, projects, affected by public policies, and public private partnership [15]. Consequently in parallel with ownership structure the management models of logistics centers are;

- Public Management Model
- Private Management Model
- Public-Private Partnership Management Model

Public Management Model

Governments around the world are investing significant resources in the development of new and the expansion of existing logistics clusters, all of whom are central nodes of the global freight transportation network [22]. Public has two aims to setting up logistics centers that development and planning objectives. Development objective is related to developing local economy by means of attracting logistics activities. Planning objective is associated with the regulation objectives which promote to using rail and river transport, minimizing traffic congestion and reorganizing freight distribution which comply with its local characteristics [15].

In this type of management model, developing the infrastructure and financing are fulfilled by public sector (Railway organization in general). Establishment of logistics centers infrastructure development is financed by public sector. Private sector is not concluded in operating and management [23]. Public sector has control over operations, income and transportation modes. The control means that public sector procures handling equipment, operations and employees who are employ in logistics centers. In case private sector is unwilling or unable in order to capital intensive investment, investments are performed by public sector [24]. Public sector may retain direct control over operations, transportation and revenues, but it can offer the equality treatment among all users. However some disadvantages based upon public sector such as allocation of resources ineffectively or national priorities and public impressions etc. [25].

Private Management Model

In this type of management model, operation and management are controlled by private sector In case logistics centers are established by private funds, the greatest advantage is mobilization of private resources for national transport infrastructure and direct benefits for the national economy. Private management implied by private investment can be more flexible to trade and operations and considers daily changes in global market [25].

Public-Private Partnership Management Model

The most common and ideal management organization model applied in logistics centers is PPP [26]. Financial, planning and infrastructure issues are considered as main subject for public-private partnership. These large investments are not only mean that construction of large warehouses but also provide services for public interest such as transportation infrastructures, large scale regional planning and policy for public interest [19]- [26]. Two combination of PPP model which may applicable in logistics centers are as follows [25]:

- Public sector provides railheads, container handling equipment and some facilities, private sector provides other facilities e.g. CFS facilities.
- Public and private sector provides funds for joint operation under single body with unified control.

First option offers that railhead and handling equipments are capital intensive and long term investments. It is advantage for private sector that public sector undertakes the investments. Public authorities have to ensure that eliminate financial risks and provide finance for logistics centers. Second option offers that logistics centers functions develop in a coherent manner [25]- [21]. From the point of view of public sector PPP means that benefit from private sector experience and meets customer needs. From the point of view of private sector PPP provides risk sharing, increases long term revenues, safeguards acceptable return on investment and supports growth [26].

LOGISTICS CENTER PROJECTS IN TURKEY

Publicly owned logistics centers, privately owned logistics centers and PPP logistics centers examples can be found in Turkey. For instance Ankara Logistics Base is established by private sector investment. Ankara Investment and Fuel Trade Inc. is founded by 45 international transport companies which mostly located in Ankara [27]. Some logistics centers are established by public sector investment (TCDD-national railway organization which is unit of Ministry of Transport, Maritime Affairs and Communications). Management and infrastructure investments are made by TCDD.

Logistics centers are under responsibility of 4 ministries. These ministries are Ministry of Science, Industry and Technology, Ministry of Economy, Ministry of Customs and Trade and Ministry of Transport, Maritime Affairs and Communications. Logistics center projects under 4 ministries responsibility are explained as follows:

Specialized Organized Industrial Zone (Specialized OIZ): This type of logistics centers Ministry of Science, Industry and Technology is responsible and authorized to all permissions. It is suitable for PPP due to allowing for participation both public and private sector. First formal application has been made by Mersin Specialized OIZ, patterned Zaragoza Logistics Center, to the ministry [28]-[29].

Logistics Free Zone: Ministry of Economy is responsible for logistics free zones, but legislation details have not determined clearly yet [29]. Once logistics centers are compared with free zones, these implementations cannot be considered similar [30]. Furthermore free zone legislation brings government intervention. Logistics centers should have a flexible management structure but with the government intervention bureaucratic obstacles will be occur.

Ministry of Customs and Trade Logistics Centers: In the process of adaptation to the European Union, Ministry of Customs and Trade takes some measures of developing logistics centers. The ministry plans to establish “Specialized Logistics Customs Office” and “Customs Warehouses” in all logistics centers [31]. Ministry of Customs and Trade must participate in establishment of logistics centers for arranging of customs areas, implementing customs clearances and applying customs procedures [30].

TCDD Logistics Centers: These logistics centers are the same with transshipment terminal. TCDD logistics centers services provide consolidation and deconsolidation services for cargoes carried by railways [32]. Ministry of Transport, Maritime Affairs and Communications is responsible for TCDD logistics centers. TCDD has 19 logistics centers projects. Samsun (Gelemen), Uşak, Denizli (Kaklık), İzmit (Köseköy), Eskişehir (Hasanbey) and Halkalı logistics centers have been started to services. The other logistics centers projects are in the process of construction, bidding and expropriation [33].

Roadway Logistics Centers (Karayolu Lojistik Merkezleri): These types of logistics centers provide consolidation and deconsolidation services for road transportation. These logistics centers are established by international transport companies, located near to the city center and main highways [29]. Ankara Logistics Base is an example of roadway logistics centers.

As in the examples of logistics centers in the world, in order to achieve success, logistics centers has to be built up within an efficient management, ownership and organization structure. In the study, ownership and management model proposal has submitted in view of the fact that Turkey's regional and commercial dynamics in order to apply best practicable.

RESEARCH METHODOLOGY

Definition of the Sample

Considering the management and ownership model examples of logistics centers can be seen in different spectrum from solely public model to private model including public-private partnership model. For instance to that Ankara Logistics Base is established by private investment. As public investment logistics centers are established by TCDD (Turkish National Railway which is unit of Ministry of Transport, Maritime Affairs and Communications). However many projects are expected to be performed on the basis of PPP. The fact remains that logistics centers are under responsibility of 4 ministries (Ministry of Science, Industry and Technology, Ministry of Economy, Ministry of Customs and Trade and Ministry of Transport, Maritime Affairs and Communication).

Purpose of the Research

Purpose of the research is to develop proposal for ownership and management model for logistics centers in Turkey thereby investigate ownership and management model applied in logistics centers and using expert opinion through delphi research technique. In addition, sub-purpose of the study is determining roles of public and private sector in the process of establishment and operation of logistics centers.

Method of the Research

Delphi research technique is used in the study owing to limited expert quantity having knowledge about ownership and management of logistics centers, allowing to creative ideas with different viewpoint (Şahin, 2001), collecting systematic information and benefitting from experts' opinion in order to develop an ownership and management model for logistics centers.

Selection of Delphi Panelist

Delphi panelists consist of stakeholders who are university members, public institutions, logistics service providers, chamber of commerce's, local authorities, person and firms given services by logistics centers and firms which operate logistics centers. The stakeholders of logistics centers are logistics service providers (private companies), logistics center operators, TCDD officers, academicians, logistics advisors and development agency officers are included in this study as delphi panelists. Due to the limited numbers of panelists informed about logistics centers, size of delphi panel is limited. At first, connected with experts after the literature review and got some advices from panel members and academicians who support this study in order to increase number of panel members. After all, 1st round of delphi survey is started with 21 panel members. 7 of them are academicians, 3 of them are TCDD officers from different departments, 2 of them are association managers, 5 of them are managers at private sector company, 2 of them are chamber of commerce personnel, 1 of them is development agency personnel and 1 of them is logistics advisor.

Generation of Delphi Statements and Collecting Data

3 rounds are determined in this study. The 1st round of classic delphi technique includes open-ended questions which can be answered without any constraints [34]-[35]. In this study, 1st round delphi questionnaire is composed of 4 open-ended questions, but 2nd and 3rd round delphi questionnaires, "Agree", "Disagree" and "No Comment" options are offered to each statements. In case panel members choose "Agree" or "Disagree", "Your Comment" option is offered for explain the reasons.

Interviews are made by telephone, e-mail and face-to-face technique. Face to face technique only used for panelists who live in İzmir. 4 open-ended questions which are generated through literature review are prompted to 21 panelists. At the end of the first round, the results are analyzed and 33 new statements are generated for second round of delphi survey. 19 of 21 panelists responded to statements for second round of delphi survey. At the end of the second round, the results are analyzed and 13 of 33 statements have not reached consensus. The answers for 13 statements have been used to draw up third round of delphi survey and generated 21 statements. 17 of 19 panelists responded to statements.

Consensus Measurement of Delphi Survey

APMO (The Average Percentage of Majority Opinion) formula is used in this study as consensus measurement. At first number of majority agreements and disagreements have to be calculated by expressing the participants' comments "Agree", "Disagree" and "No Comment" in percentages per statements [36]. Number of majority "Agree" and "Disagree" are summed up, than sums are divided by total number of opinions expressed. The formula:

[Majority Agreements + Majority Disagreements]÷[Total Opinions Expressed] has been used in this study.

Results of First Round of Delphi Survey

In first round of delphi survey 4 open-ended questions are conducted to panel members for getting general opinions as commonly used in delphi survey [34]-[37]-[35]. These 4 open-ended questions are stated below:

- What do you think about the importance of logistics centers for Turkey?
- What do you think about ownership model and establishment of logistics centers?
- What do you think about management of logistics centers?
- What do you think about the roles of public and private sectors for establishment and operation of logistics centers?

Table 1 shows answers that responded by panelists:

Table 1: Answers Given by Panelists

Comments
1. Logistics centers are important for Turkey owing to turning location advantage into competitive advantage.
2. Logistics centers enhance quality of services through enabling warehousing, handling, packaging services together.
3. Logistics centers are important for reducing environmental pollution and traffic congestion through shifting logistics activities to the country.
4. Logistics center should establish considering transportation corridors.
5. Logistics centers should allow for shifting between transportation modes in Turkey.
6. Transportation infrastructures (especially railway) are not qualified enough for establishing logistics centers.
7. Current regulations are enough for establishing logistics centers in Turkey.
8. New regulation studies must be done for logistics centers in Turkey.

9. Ministry of Transport, Maritime Affairs and Communications must participate in logistics centers establishment process.
10. Ministry of Science, Industry and Technology must participate in logistics centers establishment process.
11. Ministry of Economy must participate in logistics centers establishment process.
12. Ministry of Customs and Trade must participate in logistics centers establishment process.
13. Local authorities must participate in logistics centers establishment process.
14. Private companies must have ownership of logistics centers.
15. Publicly owned model must be considered as an ownership model for logistics centers in Turkey.
16. PPP model must be considered as an ownership model for logistics centers in Turkey.
17. Logistics centers must be found as corporation in Turkey.
18. Logistics centers must be found as limited company in Turkey.
19. Logistics centers should found within the structure of TCDD
20. Logistics centers can be found as Specialized OIZ.
21. Logistics centers can be found as free zones.
22. Logistics centers must have experienced, professional management structures and can easily adapt to market changes and improvements.
23. The management structures of logistics centers must be equal and neutral to companies which offered services.
24. Management of logistics centers should be fulfilled by public sector in Turkey
25. Management of logistics centers should be fulfilled by private sector in Turkey.
26. Public and private sector should participate in management of logistics centers.
27. Ministry of Transport, Maritime Affairs and Communications should participate in logistics centers’ management.
28. Ministry of Science, Industry and Technology should participate in logistics centers’ management.
29. Ministry of Economy should participate in logistics centers’ management.
30. Ministry of Customs and Trade should participate in logistics centers’ management.
31. Municipalities, provincial private administrations, governorships and sub-governorships should participate in logistics centers’ management.
32. There is need for an association in order to control and provide coordination among logistics centers in Turkey.
33. In order to provide the coordination among ministries an upper unit required for logistics centers projects in Turkey.

These comments are also used to draw up second round of delphi survey’s questionnaire.

Panelists especially emphasis on logistics centers are important for Turkey owing to turning location advantage into competitive advantage. Panelists are suggested different combinations of ownership model e.g. publicly owned, privately owned and PPP model. Some comments are related with departments and units In the process of establishment according to public, private and PPP model will be applied for logistics centers as management of logistics centers.

Results of Second Round of Delphi Survey

Questionnaires are sent to 21 panelists, but 19 panelists have responded in this stage. APMO cut-off rate is calculated as 87,8%. Statements, under 87,8%, are re-evaluated as regards panelists’ comments are revised for following third round of delphi survey. Consensus is reached for each of first 8 statements about importance of logistics centers. Besides, statements related to ownership and establishment (10th, 11th, 12th, 14th, 20th, 21th) and management and roles of public and private sector (25th, 26th, 27th, 28th, 29th, 30th and 31th) are not reached consensus. 6th, 7th, 15th, 18th, 19th and 24th statements are reached consensus on “Disagree” whereas remained statements are reached consensus on “Agree” option.

Results of Second Round of Delphi Survey

In third round of delphi survey, the questionnaires are sent to 19 panelists, but 17 of panelists are responded. APMO cut-off rate has been found as 87%. The statements which are not reached consensus in second round of delphi survey are evaluated and generated 21 new statements for this stage. **Table 2** shows third round of delphi statements as follows:

Table 2: Third Round of Delphi Statements

Number		Statements
10*	1.1.	Ministry of Science, Industry and Technology should not participate in establishing process in order to reducing bureaucracy. However it should be in coordination with Ministry of Transport, Maritime Affairs and Communications
	1.2.**	Ministry of Science, Industry and Technology should provide services and legislative supports
11*	2.1.	Ministry of Economy should not participate in establishing process in order to reducing bureaucracy. However it should be in coordination with Ministry of Transport, Maritime Affairs and Communications
	2.2.**	Ministry of Science, Industry and Technology should provide services and legislative supports
12*	3.1.	Ministry of Customs and Trade should not participate in establishing process in order to reducing bureaucracy. However it should be in coordination with Ministry of Transport, Maritime Affairs and Communications
	3.2.**	Ministry of Customs and Trade should provide services and legislative supports
14*	4.1.	Ownership of logistics centers should not have been controlled by only private sector due to commercial dynamics in Turkey, profitless etc.
	4.2.**	The ownership of logistics centers may have been controlled by public sector and logistics centers facilities can be rent out in long term contract.
	4.3.	The ownerships of infrastructure and superstructures of logistics centers should have been controlled by only private sector.
20*	5.1.	Considering the commercial dynamics, logistics centers can establish as Specialized OIZ.
	5.2.	If logistics centers are managed by PPP model, logistics centers could establish as specialized OIZ.
21*	6.1.	Logistics centers should have not established as logistics free zones due to the free zone procedures are not qualified enough for logistics centers and free zones are not suitable for logistics centers.
	6.2.	Free zones can be established in logistics centers.
25* **26***	7.1.**	Establishing, controlling and planning must have been performed by only public sector.
	7.2.	Controlling of logistics centers should be fulfilled by public and private sectors.
	7.3.**	Management of logistics centers must have been performed by only private sector.
	7.4.	Management of logistics centers should have been performed by public and private sectors.
27* **28*** **29*** **30***	8.1.	Related ministries should provide legislative supports.
	8.2.**	Related ministries should not participate in management directly.
31*	9.1.	Municipalities, provincial private administrations, governorships and sub-governorships should participate in management but not intervene directly to the decisions with the purpose of providing only such services security, maintenance and repair etc.

*Second Round of Delphi Survey Statement
**Statements which are not reached consensus in third round of delphi survey

Only 4.3th statement is reached consensus on “Disagree” option. The other statements which are reached consensus are reached consensus on “Agree” option. Comments for 4.3th statements show that ownership of logistics centers is not only controlled by private sector but also public sector should participate in sharing risks due to commercial dynamics (crisis, profitless etc.) in Turkey. 1.2th, 2.2th, 3.2th, 4.2th, 7.1th, 7.3th and 8.2th statements have not been reached consensus but saturation is achieved. Related ministries should only provide services and legislative support, besides logistics centers are not within the province of Ministry of Science, Industry and Technology and Ministry of

Economy (1.2 and 2.2). Some panelists stated Ministry of Customs and Trade should only provide services related with customs area. Other panelists stated that customs legislations related to logistics centers directly. Thus Ministry of Customs and Trade should provide services and legislative supports for logistic centers (3.2). Panelists who choose “Agree” option refer that considering the economic structure in Turkey, it is difficult to invest in large scale logistics centers by a single private company as in Europe and return on investments needs long period. The other panelists concern about problems during or end of the term of tenancy and possibility of failure to provide sustainable logistics services. Therefore the ownership of infrastructure and superstructure of logistics centers should not be controlled by only public sector (4.2). Planning of logistics centers could have been performed by public sector in addition to this establishment of logistics centers could be performed by public-private partnership or public and private sector separately in order to determine optimum requirements and deployment of resources for logistics centers (7.1). The statements which consensus is reached 7.2 and 7.4 Planning, establishing and controlling should not have performed by only public sector is supported by 7.2th and 7.4th statements.

Some panelists stated that logistics centers should be managed by professional management structure which provides high efficiency and less bureaucracy. Thereby management of logistics centers must be performed by only private sector whereas some other specialists stated that public sector should participate in management partially (7.3). Also some panelists implied that neither of ministries should participate in management structure of logistics centers, but some other panelists implied that only Ministry of Transport, Maritime Affairs and Communications should be participate in logistics centers management as authorized department.

AN OWNERSHIP AND MANAGEMENT MODEL PROPOSAL FOR LOGISTICS CENTERS IN TURKEY

A model proposal for the ownership and management of logistics centers in Turkey is submitted in the light of information reached by experts’ opinion and examples of logistics centers and model is planned to determine the roles, duties and responsibilities of public and private sectors. The model details are stated as follows:

Before Establishment of Logistics Centers

In order to provide the coordination among ministries an upper unit must be set up for logistics centers project. Additionally owing to the fact that logistics centers are under the responsibility and authority more than one ministry, an upper unit must be set up and Ministry of Transport, Maritime Affairs and Communications must lead to the unit.

There is need for an association in order to control and provide coordination among logistics centers in Turkey.

Table 3: Related Parties and Their Duties

Parties	Establishment	Ownership	Management	Controlling
MCT	In case logistics centers establish within the related ministry, perform the duties determined by law. Working in a coordinated manner with Ministry of Transport, Maritime Affairs and Communication during establishment process due to customs departments in logistics centers. In addition to this controlling the departments.			Controlling the customs areas
MTMC	Enhancing railway infrastructure and building new road links up Executing public intervention needed transactions e.g. supplying suitable land and expropriation	The ministry should construct infrastructure of logistics centers e.g. roadway, railway and port connections Considering the regional dynamics, the ministry should construct facilities located in logistics centers and rent out in a long period. The other option is facilities can be built by private sector within the scope of PPP. Supplying suitable land		Following up the new constructions will be built in logistics centers
MSIT	Instead of taking part in establishment process, working in a coordinated manner with Ministry of Transport, Maritime Affairs and Communication In case logistics centers establish as Specialized OIZ, perform the duties determined by law.			In case logistics centers establish as Specialized OIZ, the ministry should control logistics centers within law.
ME	In case logistics centers establish as Logistics Free Zone, perform the duties determined by law. In case free zone may establish in logistics centers, perform the duties determined by law and work in coordinated manner with Ministry of Transport, Maritime Affairs and Communication during establishment process			In case logistics centers establish as free zone, the ministry should control logistics centers within law.

Table 3: Related Parties and Their Duties (Continue)

Parties	Establishment	Ownership	Management	Controlling
ALSP/ LSP/ CCI	Participating in establishment of logistics centers directly within the scope of law (CCI). Considering members' interests and participating in establishment process in order to build sustainability in logistics centers by the virtue of know-how (ALSP)	Participating in operation and developments of logistics centers directly and taking responsibility for superstructures of logistics centers. Taking responsibility of new investments maintenance and repair and modernizations of facilities constructed under "build-operate-transfer" contract terms Supplying superstructure equipments	Management of logistics centers Taking measures and decisions to operations of logistics centers Taking decisions to build new facilities Preparing budget and accounting reports to be submitted to control. Preparing annual report	Controlling budget execution Controlling balance sheet and account Controlling of activities and transactions performed in logistics centers.
LA	Supplying water and electricity, planning environment and site selection		Participating in management with the purpose of providing only services e.g. security, maintenance and repair etc. but not intervene directly to the decisions	

MCT (Ministry of Customs and Trade)

MTMC (Ministry of Transport, Maritime Affairs and Communication)

MSIT (Ministry of Science, Industry and Technology)

ME (Ministry of Economy)

ALSP/LSP/CCI (Association of Logistics Service Providers/Logistics Service Providers (Private Company)/Chamber of Commerce and Trade)

LA (Local Authorities (Municipalities, Provincial Private Administrations, Governorships and Sub-Governorships)

In addition to Table 3 that, logistics centers should be established as corporation and private and public sector must participate in management of logistics centers.

In briefly, instead of participating in establishment of logistics centers directly, related ministries should be coordinated with Ministry of Transport, Maritime Affairs and Communication as only authorized unit in order to reduce bureaucracy. Related ministries except Ministry of Transport, Maritime Affairs and Communication should fulfill their duties and responsibilities, in case logistics centers establish within the structure of ministries.

The ownership model should be public private partnerships. Ministry of Transport, Maritime Affairs and Communication should supply suitable land and construct transportation infrastructures in establishment process. Private sector should participate in operation and development of superstructures directly. Moreover considering the regional dynamics, private sector should undertake responsibility of construction, maintenance and repair, modernization and new investments and supply superstructure equipments.

Local authorities should participate in management with the aim of providing required services but not intervene to decisions. Chamber of commerce and trade, logistics service providers and associations should manage logistics centers.

If logistic centers are established as Specialized OIZ, free zone etc. related ministries should control logistics centers under the determined by regulations. Ministry of Customs and Trade should control customs areas located in logistics centers. Ministry of Transportation, Maritime Affairs and Communication should follow and control new constructions built in logistics centers.

Table 4 shows management structures and ownership model of logistics centers. Private management and public management model have already applied in Turkey. Within the context of the study, PPP management and ownership models (1) and (2) are suggested for logistics centers.

Table 4: Management and Ownership Model of Logistics Centers

Model	**Management**	**Land**	**Operations**	**Infrastructure (Transportation Links)**	**Superstructure (Equipments)**		**Superstructure (Building)**	
					Ownership	**Operation**	**Ownership**	**Operation**
Private Management Model	Private [1]	Private [1]	Private [1]	Public [2]	Private [1]	Private [1]	Private [1]	Private [1]
Public Management Model	Public [2]	Public [2]	Public [2]	Public [2]	Public [2]	Public [2]	Public [2]	Public [2]
PPP Model (1)	Private [3]	Public [2]	Private [1]	Public [2]	Private [1]	Private [1]	Public [2]	Private [1]
PPP Model (2)	Private [3]	Public [2]	Private [1]	Public [2]	Private [1]	Private [1]	Public [4] (BOT)	Private [4] (BOT)

[1]Logistics Service Providers (Private Companies, Chamber of Commerce and Trade, Associations
[2] Under responsibility of Ministry of Transportation, Maritime Affairs and Communication
[3] Logistics service providers (Private companies), Chamber of Commerce and Trade, Associations and Local Authorities
[4]BOT (Build-Operate-Transfer) model is used

In private management model management, land, operation and superstructure (equipments and buildings) are under the responsibility of private sector. Because of railway still under the responsibility of TCDD, development of infrastructure is under responsibility of Ministry of Transportation, Maritime Affairs and Communication. Management, land, operation, infrastructure and superstructure of logistics centers are under responsibility of Ministry of Transportation, Maritime Affairs and Communication in public management model as is seen TCDD logistics centers project.

In this study different 2 models are suggested for applying in logistics centers. Once analyzing PPP, private companies, associations, chamber of trade and commerce and local authorities should participate in management. As mentioned before, local authorities should not intervene to management directly. Due to bureaucracy Ministry of Transport, Maritime Affairs and Communication should not be in management. Logistics centers should establish in a wide area. Thus, Ministry of Transport, Maritime Affairs and Communication should meet the expropriation, land cost and supplying a suitable land needs for logistics centers. Operation and ownership of superstructure equipments belong to private sector.

In PPP (1) model, Ministry of Transport, Maritime Affairs and Communication can construct the superstructures (buildings) with its own investments and rent out private sector in long term contract.

In PPP (2), different from PPP (1) model, private sector can build logistics centers superstructure under the BOT contracts. Ownership of logistics centers belongs to Ministry of Transport, Maritime Affairs and Communication. Within the BOT contracts, private sector operates logistics centers in a given time.

CONCLUSIONS

Legal infrastructure related to logistics centers is inadequate in Turkey. Therefore, new regulations are required to determine establishment, operations, structures and roles of parties and affiliated with authorized ministry.

New road construction and road maintenance works have gained pace. In order to provide one of the most important functions of logistics centers (integration of different transportation mode) railway infrastructure and new routes must be improved urgently.

Logistics centers need dynamics and debureaucratized structure. Among ministries, Ministry of Transport, Maritime Affairs and Communication must be only authorized ministry from public side. Owing to logistics centers are under the responsibility of 4 ministries, there is need to establish new upper unit for provide coordination and control among ministries. Ministry of Transportation, Maritime Affairs and Communication must be coordinate the upper unit. Additionally there is need to an organization in order to provide coordination between logistics centers and control. This organization must composed of private and public sectors.

The development of public structures is very difficult but public has a critical role in creating resources for construction of infrastructure and superstructure. Determining optimum requirements of logistics centers and extending the business volume, private sector must be in participate establishment process.

Management model of logistics centers should be PPP management model. Local authorities can participate in management of logistics centers from public side. Local authorities should not be intervene to management directly, but provide required services for logistic centers. Due to increasing bureaucracy, public institutions should not be in management. Private sector should be in charge of management.

Controlling of logistics centers must be performed by public and private sector. Responsibility of public sector is to follow up new constructions which will be built in logistics centers whereas responsibility of private sector is control budget, balance sheet and accounting transactions.

LIMITATIONS AND RECOMMENDATIONS FURTHER STUDIES

Once the logistics centers examples are analysed, it has been obviously seen that logistics centers are established in wide area which interlinked to railway, seaway and roadway connections; operated by various operators and conducted many logistics activities. However, some concepts such as dry ports, intermodal terminals, distribution centers etc. are comprehended as logistics centers in Turkey. For this reason, the term “logistics center” is used within the study.

In the study, we are reached limited number of specialists due to limited persons and institutions interested in management and ownership issues of logistics centers.

Specialists were reluctant to participate the study owing to the fact that delphi method takes long time. Some contacted specialists did not participated or participated to only 1st round or 2nd round of delphi survey. Owing to presence of different people from different sectors, means different viewpoint, achieving consensus also became difficult.

Logistics centers investment can be studied as further research in the view of the fact that logistics centers management is under the responsibilities of investor parties as in different examples all over the world.

There are many logistics centers projects in Turkey. Therefore after starting to operation of that logistics centers, new panel can be fulfilled with authorized persons who assigned to logistics centers.

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BRIDGING CUSTOMER VALUE AND INNOVATION IN CONTAINER SHIPPING

Gökçay BALCI[1]

ABSTRACT

The invention of containers was a radical innovation that has changed the transportation system and has enabled development of advanced logistics systems such as just-in-time. The container shipping has shown a spectacular growth performance in recent decades. However, competition between container carriers is keen. Carriers need to create value for their customers to achieve competitive advantage. Creating customer value can be accomplished by understanding customer needs and wants and then creating an innovation. Hence, the purpose of this study is to discuss customer value and innovation concepts in container shipping. Upon revealing customer value and innovation concepts, a literature review on supplier selection criteria, carrier selection criteria, service attributes of shippers is conducted. This study proposes that innovation in container shipping should be carried out by understanding the real needs and wants of customers in container shipping rather than the current needs stated in carrier selection criteria literature.

Keywords: Customer value, innovation, container shipping

INTRODUCTION

The competition between container lines has been escalating due to recent developments in the market. Understanding, creating and delivering customer value is inevitable for container lines to be competitive and survive in the market. Creating and delivering customer value can be implemented through effective innovation. In fact, customer value and innovation are in the reciprocal interaction that innovation can also be implemented through understanding customer value. Understanding customer value by which creation of innovation is achieved by perceiving the real needs and wants of customers.

Container shipping is actually a fascinating innovation by itself that helped shippers – the customers of container shipping – to obtain a faster, safer, cheaper and more reliable transportation [1]. This innovation has met the needs and wants of shippers so that it has replaced general cargo vessel for many types of cargo vessels. Today, even some dry bulks that had been conventionally carried by bulk vessels are transported in containers [2]. However, innovation must be sustainable for container

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lines to be competitive and survive in a market. Thus, container lines should constantly strive for understanding the real needs and wants of customers.

However, understanding the customer value by perceiving the real needs and wants of shippers is a difficult task for creating innovation in container shipping. Thus, the aim of this study is to discuss real needs and wants of shippers and innovation in container shipping by bridging the customer value and innovation concepts. A brief literature review is done for carrier selection criteria and service attributes in container shipping and supplier selection criteria in a general context.

CUSTOMER VALUE AND INNOVATION

Creating value for customers is a prerequisite for firms to achieve a sustainable competitive advantage [3] . Suppliers need to understand, create and deliver value to customers to sustain competitive advantage. Especially in business markets, growth and competitive advantage can be gained through value creation. [4]. Understanding customer value is also critical to provide customer satisfaction which helps to receive loyalty of customers, positive word of mouth and higher market share [5].

Value concept is used in many different areas such as economics, finance, ethics, accounting, strategy, justice and marketing [6], [7]. In this study, we consider the value concept in the marketing perspective. Value concept is stressed in many definitions of marketing. For instance, American Marketing Association defines it as "*Marketing is the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large*". However, customer value concept has been approached by different authors with diverse interpretations in the literature [8].

Woodruff [3] defines customer value as "*customer's perceived preference for and evaluation of those product attributes, attribute performances, and consequences arising from use that facilitate (or block) achieving the customer's goals and purposes in use situations*". In business-to-business (B2B) marketing domain, Anderson et al. [9] defines customer value as "*perceived worth in monetary units of set of economics, technical, service, and social benefits received by a customer firm in exchange for the price paid for a product offering, taking into consideration the available suppliers' offering and prices*". Both definitions stress a trade-off between all the benefits received from a product or service and all the costs to receive the product or service. Our focus in this study is at the benefits side of customer value rather than the costs side.

One of the major focuses of customer value literature is to how to create and deliver the value to the customers [8]. In fact, prior to creating and deliver value, companies need to understand what their existing and potential customers value for as shown in Figure 1. Analysis of needs and wants of customers is essential to understand customer value.

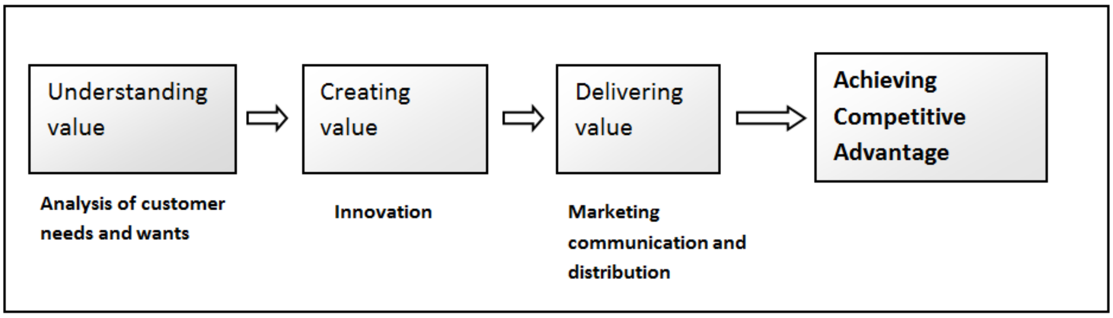

Figure 1 Customer value process
Source: Drawn by the author

Analysis of customer needs and wants or in other words what they value for is a challenging and significantly important issue. In his pioneering article of named "marketing myopia", Levitt [10] states that most firms actually do not perceive real needs and wants of customers. He provides examples from several industries to illustrate how firms might have myopia in terms of the customer needs and wants. Levitt states that railway companies did not understand that what customers needed and wanted was fast, frequent and reliable transportation, not necessarily the railways. Therefore, railway companies lost their market share to road transportation which gained a significant competitive advantage against railway transportation. Railway companies should have promoted intermodal transportation to compete and survive in the market. Porter (1985) also suggested that one of the ways to achieve competitive advantage is differentiation and successful differentiation does not only need to be unique but also valuable for the customer.

Upon successfully defining the needs and wants of customers, the next step is to create value for customers. Berghman et al. [4] state that value creation can be achieved by having "*fundamentally different and/or new business model*". In parallel, O'Cass & Ngo [12] suggests that innovation is essential to create value. Matthyssens & Vandenbempt [13] found out in their qualitative study that innovation is a key contributor of achieving competitive advantage in industrial services. Slater [14] also stated that firms can achieve value creation and competitive advantage through a commitment to customer value-focused innovation. Thus, it is safe to say that creation of value can be obtained by innovation as illustrated in Figure 1.

Innovation is a concept that is used in many different industries and organizations. Different types of innovations exist. Rogers [15] defines innovation as "Innovation is an idea, practice, or object that is perceived as new by an individual or another unit of adoption". Gopalikrishnan & Damanpour [16] suggests three types of perspectives in terms of the type of innovation. Damanpour et al. [17] suggest that administrative and technical innovations are two types. Administrative innovations are the ones affecting the social system of an organization including management rules, procedures and structures. Technical innovations on the other hand are any new ideas related to new product and service development.

Another perspective on types of innovation is the distinctions between radical and incremental innovations. Radical innovations are significant and revolutionary changes in an existing product or technology. Incremental innovations on the other hand are minor changes in the product or technology [18], [19]. The third perspective on innovation type is whether it is a product or process innovation [16]. The innovation does not necessarily need to generate a new product or service but can be a new idea in the production process.

The success of an innovation, either radical or incremental, depends on several factors. Read [20] revealed that together with a cultural change in management which is supported by top management, market/customer focus is very important for the success of innovation. Romijn & Albaladejo [21] investigated the innovative capabilities of electronic and software firms in England and found that education, prior work and R&D effort are important internal sources of innovation while the intensity of external relations and proximity in network relations are key external sources of innovation. Hauser [22] one of the most important requirements of a successful innovation is whether customer accepts the innovation or not. Though many other determinants of a successful innovation exist, our study focuses on being customer oriented.

It is not surprising to see how customer or market focus is important for the success of innovation. After all, the ultimate purpose of innovation for firms is to achieve competitive advantage among competitors by creating and delivering value to customers. Thus, focus on customer needs is a prerequisite for a successful innovation. The customer value and innovation, therefore, is in a reciprocal relationship to be successful and effective. However, being customer focused does not always bring successful innovation. Berghman et al. [4] focusing on current customer needs may actually hamper innovation rather than support it. They suggest that being customer driving is key for a sustainable innovation and value creation rather than customer driven. Flint et al. [23] also support this view by indicating that perceived value of customers may change over time due to current development in the industrial markets. Thus, it is critical to understand real needs and wants of the customer as Levitt suggested instead of currently stated needs and wants.

NEEDS AND WANTS OF SHIPPERS IN CONTAINER SHIPPING

Carrier selection and carrier service attribute studies are selected to understand the needs and wants of shippers. Carrier selection criteria or service attributes of carriers in container shipping were studied by several authors [24]–[28]. Brooks studied ocean selection criteria both in 1982 and 1989 and compared if any difference existed in 7 years by evaluating total 16 criteria. According to the results of 1989 study, the 5 most important criteria are the cost of services, frequency of sailings, transit time, directness of sailings and on time pick and delivery. Collison [27] evaluated total 24 carrier service attribute criteria for finding out segments. Compliance with specific instructions, overall average transit time, schedule reliability, ability to serve outbound and inbound port that meets shipper’s requirements, shipping requirement understanding, the responsiveness of management to meeting requirements, the absence of loss and damage and frequency of sailings are the most important criteria among the 24.

Kannan et al. [24] used 45 variables to investigate ocean carrier selection criteria of Indian shippers. Low freight, pricing flexibility, flexibility, equipment availability, safety, convenient schedules, competitive charges, on-time pick-up, the condition of containers are the most important criteria in order. Wong et al. [26] considered total 50 variables for carrier selection.

Although too many variables are stated by some authors in the literature to assess carrier selection criteria in container shipping, the basic concerns of shippers seem to be cost, time, reliability, safety, customer service, timeliness, availability of service and relationships. To better understand needs and wants of shippers, we should also evaluate supplier selection criteria of shippers or consignees. Since shipping is a derived demand [29], understanding exact needs and wants of shippers would be better achieved by searching selection criteria of their basic product, semi-product or raw material suppliers. These studies illustrate what shippers or their customers pay attention when buying from their suppliers.

Cheron and Kleinschmidt [30] investigated 9 supplier selection criteria studies between 1966 and 1979. According to their table, the most common supplier selection criteria are quality, price, delivery, production capacity, technical capacity and reputation. However, price, quality and delivery are the three common criteria existing in all 9 studies. Xia and Wu [31] applied Analytic Hierarchical Process method for supplier selection and evaluated price, quality (technical level, defects, and reliability) and service (on-time delivery, supply capacity, repair turnaround time and warranty period). Verma & Pullman [32] investigated selection criteria of manufacturers in the United States and considered quality, on-time delivery, cost, lead-time and flexibility. Hirakubo & Kublin [33] studied supplier selection criteria of electronic manufacturers and considered price, quality, cost reduction capability, delivery, design, technical capability and manufacturing as selection criteria. Kannan & Tan [34] ability to meet delivery due dates, commitment to quality, technical expertise, the price of materials, honest and frequent communications are the top 5 most important criteria that buyers evaluate when selecting a supplier.

In parallel to a literature review of [30], our literature review of supplier selection criteria also suggests that price, delivery and quality are the three most common and important criteria that buyers consider when selecting a supplier. First of all, the importance of delivery indicates how shipping service is actually important for customers. Shipping, in fact, directly affects cost, quality and delivery of goods and raw materials. We can also conclude that ocean carrier selection criteria of shippers are actually related to supplier selection criteria. Freight rate, price discounts, free demurrage time etc. are related to cost. Transit time, the frequency of sailings, availability of cargo space and directness of sailings may be evaluated as related to delivery. Safety record of carriers, the condition of containers and good care of cargo handling can also be related to quality.

As it can be noticed in the literature of ocean carrier selection, there are too many criteria to understand needs and wants of shippers. The literature actually focuses on current needs and wants of shippers and aims to be customer or market driven. However, the creation of value through innovation requires being market driving. Having market driving approach requires understanding real needs and wants of customers as Levitt suggests. For instance, Kannan et al. [24] found that condition of containers is an important criterion for selection of carriers. However, is it real need and want of shippers or is it the quality of goods inside the containers that shipper concern? Frequency of sailings, transit time, availability of cargo space and number of containers are all important for shippers because these affect the delivery on time performance of goods. Thus, the real “needs and wants” of shippers is actually delivery of goods on time or as early as possible. In other words, frequency of sailings does not have any meaning for shippers without having available containers or cargo space on board of container vessel. We propose that innovation in container shipping market can be effectively accomplished by determining these real needs and wants of shippers. Following section will explain how this can be achieved.

INNOVATION IN CONTAINER SHIPPING INDUSTRY

Shipping industry has been the backbone of international trade for many decades. The industry is quite complex since numerous private, governmental and non-governmental organizations (NGO) are involved both in local and international context. Shipping companies, mainly carriers, are subject to many challenging demands from these organizations. For instance, carriers need to reduce the emission due to regulations of International Maritime Organization as well as pressure from NGOs. Besides, there is a growing competition between shipping companies as liner conferences are not allowed in some countries including the European Union. As global supply chain systems has become widespread in recent decades and advanced logistics systems has arisen such as just-in-time, expectations of shippers have also increased [35]. All these regulations and competitive pressures stimulate shipping companies to innovate.

Liner shipping industry has witnessed some significant innovation examples. The invention of containers by McLean, for instance, is a game-changing radical innovation example. It has provided safer, more reliable and faster transportation of goods from origin to final destination. First containers were carried by converted tanker Ideal-X and the first regular container shipping service started in 1961 between East Cost of US and Central and South America [36]. The containerization has enabled production and trade to be globalized [37]. The rapid development of containerized trade is illustrated in Figure 2. Containerized world seaborne trade has increased from 102 million tons in 1980 to 1.6 billion tons in 2014 (UNCTAD 2015).

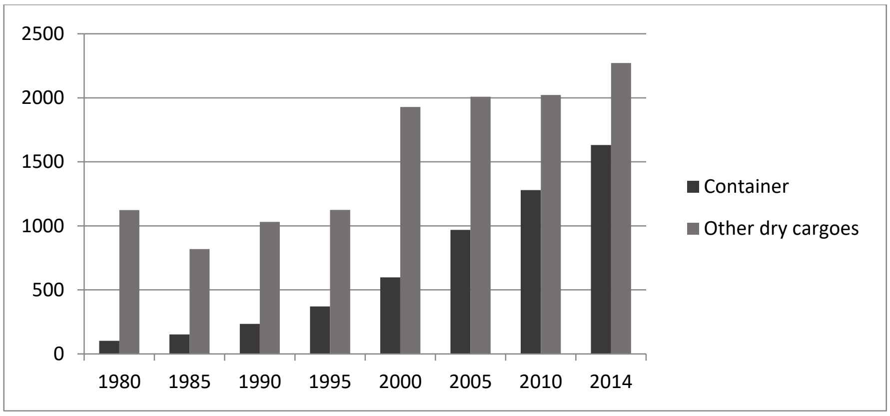

Figure 2 World seaborne containerized and other dry cargo (dry cargoes other than 5 major bulks) trade in million tons.
Source: Derived from UNCTAD

Mega size vessels may be evaluated as another innovation in container shipping. This innovation can be considered to be an incremental innovation. Larger container vessels enable carriers to utilize economies of scale [39]. Maersk announced its Triple-E class 18.000TEU vessels as an innovation that which provides energy efficiency and reduces the cost and CO2 per TEU. Many other container firms also followed mega vessel trend. Container shipping industry takes advantage of information systems to offer innovation for their customers. Online cargo tracking availabilities are good examples which do not only bring convenience for customers but also for container line personnel. It may also help to reduce the number of customer inquiries. Another innovation of container lines is door-to-door shipment service. This process innovation allows customers to receive benefits of one-stop shopping. A simple but very effective innovation for carrying non-hazardous liquid in bulks is flexitank. A flexible plastic tank is placed in a standard dry container and liquid cargo is pumped into the flexible tank. By this ways, shippers are not dependent on tanker vessels or special tank containers designed for only carrying liquid cargo.

Ports have also witnessed several innovations in parallel to developments in containerization. Nowadays Automated Guided Vehicles (AGV) are started to be used for movement of container at container terminals. There are many other incremental innovations regarding the process and product of container shipping services. However, Notteeboom & Rodrigue [37] indicated that the market has become mature and no radical innovation is witnessed recently. Especially ports are not able to achieve competitive advantage through existing equipment and system [37].

As discussed in the previous part, competitive advantage can be achieved through creating value for customers that can also be gained by innovation. An effective innovation, on the other hand, can be accomplished by first understanding the need and wants of customers. However, as [4] suggests, value creating innovation can be obtained through not current needs and wants of customers. For instance, McLean found out the real needs and wants of shippers when inventing the containers. Instead of focusing the current needs of shippers at that time such as speed of vessel, frequency of services, number of gangs at the port or better stuffing of cargoes in general cargoes, McLean thought that what shippers need was faster, more reliable and safer transportation. This perspective allowed him to create a major radical innovation in the shipping industry.

Another important innovation is the invention of reefer containers. Many of the refrigerated cargoes are transported by reefer containers instead of reefer vessels.

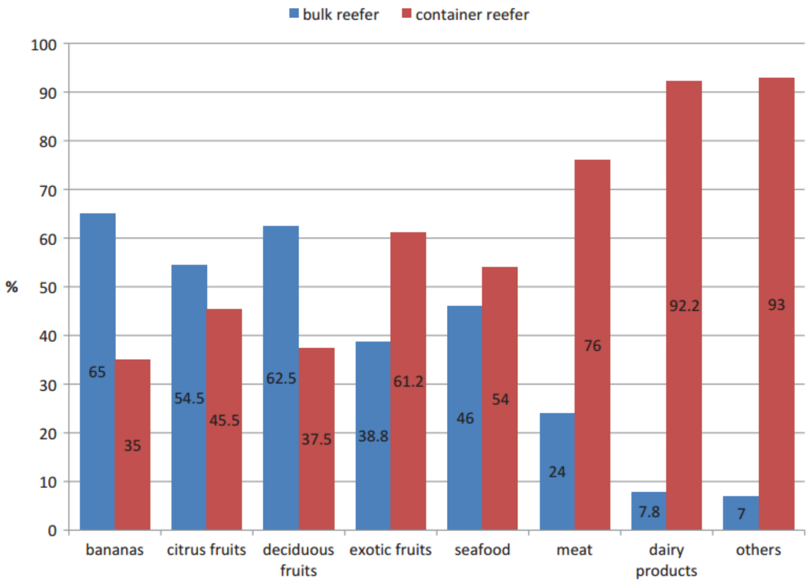

Figure 3: Reefer cargo trade by commodity and mode in 2011
Source: [40]

Many of the refrigerated shippers started to transport their goods by reefer containers due to their advantages in terms of reliability, frequency and smooth operations. For these shippers, the real needs and wants were not transporting the vessel by reefer vessel but transporting their goods in good condition with previously mentioned advantages. The innovators of reefer cargo containers realized well that the real need and want of a reefer shipper was not a well-conditioned reefer cargo vessel but a fast, safe and reliable transportation of their cargoes. This situation is very similar to railway operator example of Levitt. However, the question we need to ask for innovation and creating value for customers is if reefer containers are real needs and wants of shippers?

Many of the research papers state that shippers consider the availability of special equipment when selecting a carrier. A carrier which has enough reefer containers and capacity space on board is considered to be a market driven company. However, what a reefer shipper wants is to deliver or receive goods at a stable cool temperature on time, not reefer containers. Hence, for instance, if special reefer pallets with long battery life or a special packaging system that preserves the temperature is invented, there is no meaning for a number of reefer containers. Refrigerated cargoes can be transported in usual dry containers even together with other usual dry cargoes. This kind of innovation would allow carriers to be market driving just like the invention of reefer containers and leads to achieving competitive advantage.

Understanding the real needs and wants of customers and creating innovation enable carriers to achieve competitive advantage. Analysis of customer needs and wants, however, is quite a tricky matter. For instance, another concern of shippers that have sensitive cargo is cleanliness of containers. Both machine producers and tobacco producers are concerned about cleanliness of container but definition of “clean” might be different for these two types of shippers. It is for sure they both don’t want any contamination due to the previous shipment but machine producers might not be very sensitive to average degree of smell in the container while tobacco shipper is extremely sensitive to even very little degree of smell. Thus, detailed analysis of needs and wants of shippers is also necessary. A market segmentation program can be helpful for carriers to detect industry specific needs and wants of shippers. By this way, more effective innovations can be accomplished.

CONCLUSION

Innovation is necessary for firms to create delivery to customers to compete successfully. Container shipping market is no exception, and carriers also need to create value for their customers. In fact, container shipping is a spectacular innovation itself that the market has shown great growth. However, the competition in the market is getting fierce as the industry becomes more mature and carriers cannot rely on the growth of the industry. Carriers need to seek for sustainable innovation. A successful innovation depends on the thorough perception of customer needs and wants. However, container shipping lines should find out real needs and wants of their customers instead of current needs and wants to be stated by their customers or in the academic literature. By this way, container lines can be market driving as McLean accomplished with the invention of containers.

Being market driving is not as easy as it sounds and it requires experience, research and high management skills including innovation capabilities. Nevertheless, an effective and continuous research of needs and wants of customers may lead carriers to successful innovation. This study revealed in the literature that three basic needs and wants of shippers are cost, quality and delivery of the raw material and manufactured goods. Too many factors may affect these three basic factors. Besides, new expectations of shippers may also emerge depending on the expectation of consumers who are actually the final customers in the trade system. For instance, as consumers are getting more concerned about the environment, shippers are likely to pay attention to their carbon footprint in the supply chain system. Transportation constitutes an important portion of the air polluting gasses. Hence, carriers, who are able to offer a much cleaner total door-to-door transportation of goods through innovation both in transportation vehicles and processes, are likely to achieve competitive advantage.

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ASSESSMENT OF VIABLE PORTS FOR ANTARCTICA TRANSPORTATION VIA NAVIGATIONAL PERSPECTIVE

Alper Seyhan[1], Ibrahim Kilic

ABSTRACT

In recent years, large number of countries have established research stations in Antarctica. Scientific researchs can be made in the research stations but the natural resources of Antarctica shall not be extracted in regard to the 1991 Antarctic Protocol of Environment Protection. In the future, the world will be in danger of exhausting supply of natural sources such as about oil and some minerals. Therefore, the investigation about natural source reserves in Antarctica has gained importance considerably. The transportation to Antarctica is being made via only Chile and New Zeland now. The aims of this study are to open a new window looking to Antarctica from the different view point and evaluate Antarctica as a logistic area. This study views the current Antarctica ports and calculates distances between these ports and some important points in the world using the great circle sailing routes. Finally, it represents viable ports in Antarctica by navigational distance perspective.

Keywords:Antarctica, Ports, Great Circle Sailing

INTRODUCTION

Antarctica is a continent located in south of Africa, America and Australia. The distance to the nearest continent South America is 540 nm and to the Africa is 1620 nm and Australia is 2106 nm. Antarctica was explored in 1820 and is not under the domination of any country. It is the unique area which has not native population in the whole world. In 1961, Antarctic Treaty System (ATS) entered into force and it aims protect the continent from military actions and only permitted scientific investigations (2016, June 3).

30 countries have 76 research stations in Antarctica. Scientific researches revealed the continent has noble minerals: gold, silver, cobalt, copper, chromium, iron, molybdenum, manganase, nickel, lead, titanium, uranium, zinc and oil. Governments take the action about that minerals and Convention on the Regulation of Antarctic Mineral Resource Activities (CRAMRA) was opened for signature in 1988. This convention increased international interest for Antarctica due to importance of mineral resources. ATS signatories rapidly increase 25 to 38 during CRAMRA process. World needs a new agreement about environment in Antarctica and Protocol on Enviromental Protection to the Antarctic Treaty (Madrid Protocol) which is part of Antarctic Treaty System came into force in 1998. These

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changes which are arised from CRAMRA, show the fragility of the ATS consensus (2016, June 4).

In the future, it will be required to benefit from minerals. Transportation of minerals and logistic in Antarctica will come into prominence such as viable ports for transportation of minerals especially oil. The continent have 7 ports in using of scientific research stations' logistic. In the future, some of them might be used for transportation of underground resources. None of them has a dry dock and all of harbour coastal natural. All of ports position are located in south of South America except Mcmurdo, it is in south of Australia and New Zelland.

This study investigates Antarctica by an original approach, estimates the most efficient port from navigational perspective. In comparison of Antarctica ports, distances to significant maritime transportation points are based. These points are Panama Canal, Gibraltar, Cape of Good Hope, Malacca Strait and approach point to Gulf of Aden and Hormuz Strait. This study calculates distances between Antarctica Ports and significant maritime points by utilizing Great Circle Sailing. The Great Circle Sailing method considers the spherical structure of the World and can calculate true distances between different points. It is anticipated that ATS will be cancelled by the governments due to mineral scarcity and they will decide to enter into force new agreements which allow the usage and transportation of Antarctic resources. They have to consider viable ports and seaways to relocate that minerals and oil to their countries. This study will be first guide in assessment of Antarctic ports.

METHODOLOGY

Spherical trigonometry were basically generated for astronomy and navigation. The haversine formula is an equation which is used in calculation of great circle navigation. It calculates distance between two points on a sphere. In the literature, there exist studies which are based on haversine formula. (Mwemezi and Huang, 2011) utilise great circle distance calculation in optimal facility location for sea include oil rigs, mobile drilling units and dynamically positioned units. Besides, Ratsameethammawong et al., 2010, Cassa et al., 2005 and Nordin et al., 2012 apply haversine formula in different areas: biomedical cell phone GPS and ambulance routing.

Firstly José de Mendoza y Ríos and then Florian Cajori who are mathematicians, introduced and worked on spherical navigation and haversine. However the term of haversine was used by James Inman.

Haversine function:

$$haver\sin(\varphi) = \sin^2(\varphi/2)$$

$$\sin^2(\varphi/2) = \frac{1-\cos(\varphi)}{2}$$

For arrival and departure points on a sphere, the haversine of the central angle between these positions is formulated by

$$hav(\theta) = hav(dlat) + \cos(lat_A)\cos(lat_B)hav(dlong)$$

$$hav(d/r) = hav(\alpha_2 - \alpha_1) + \cos(\alpha_1)\cos(\alpha_2)hav(\beta_2 - \beta_1)$$

(Goodwin, 1910), (Brown, 2003), (Earl et al., 1983) and (Frost, 1988)

Where,

- d is the spherical distance between two points on great circle
- θ is the central angle
- r is the radius of the sphere
- α_1 , β_1 are respectively latitude and longitude of departure position
- α_2 , β_2 are respectively latitude and longitude of arrival position
- dlat is difference in latitude
- dlong is difference in longitude

By applying inverse haversine,

$$d = 2r.\arcsin(\sqrt{hav(\alpha_2 - \alpha_1) + \cos(\alpha_1)\cos(\alpha_2)hav(\beta_2 - \beta_1)})$$

$$= 2r.\arcsin(\sqrt{\sin^2(\frac{\alpha_2 - \alpha_1}{2}) + \cos(\alpha_1)\cos(\alpha_2)\sin^2(\frac{\beta_2 - \beta_1}{2})})$$

APPLICATION

There are 7 ports in Antarctica, they are clustered around two areas (south of Australia and south of South America). Six of them take place in islands which are located in south of South America. They have closeness advantage to Argentina and Chile. We considered Ellefsen Port from this area in great circle distance calculations due to closeness each other. Other Antarctica port is McMurdo which is located in south of Australia.

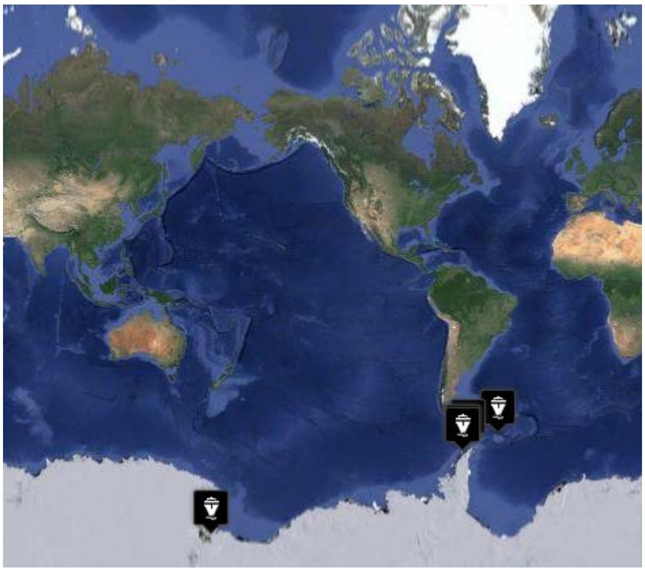

Figure 1. Antarctica Ports

We calculated the spherical distances between these two ports and five important maritime transportation points (Malacca Strait, Panama Canal, Gulf of Aden, Cape of Good Hope and Gibraltar). Latitude and Longitude of the two Antarctic ports and six maritime transportation points are given below in Table 1.

Table 1. Positions of Arrival and Departure Points

Sea Area	Lat	Long
Ellefsen Port	60° 44' 00" S	045° 03' 00" W
McMurdo Port	77° 00' 00" S	170° 00' 00" E
Panama Canal	08° 47' 00" N	079° 30' 00" W
Cape of Good Hope	34° 21' 29" S	018° 28' 19" E
Mallacca Strait	05° 04' 00" N	093° 42' 00" E
Gibraltar	35° 54' 00" N	006° 02' 00" W
Gulf of Aden	12° 20' 00" N	051° 18' 00" E

Table 2. indicates Great circle distances between Ellefsen and McMurdo Ports and important maritime transportation points

Table2. Distance Calculation with Great Circle Navigation (nautical miles)

	Malacca Strait	Panama Canal	Gulf of Aden	Cape of Good Hope	Gibraltar
Ellefsen port	6981.6	5091.3	6581	2867.7	6409.2
McMurdo port	6221.9	6759.7	7815.8		

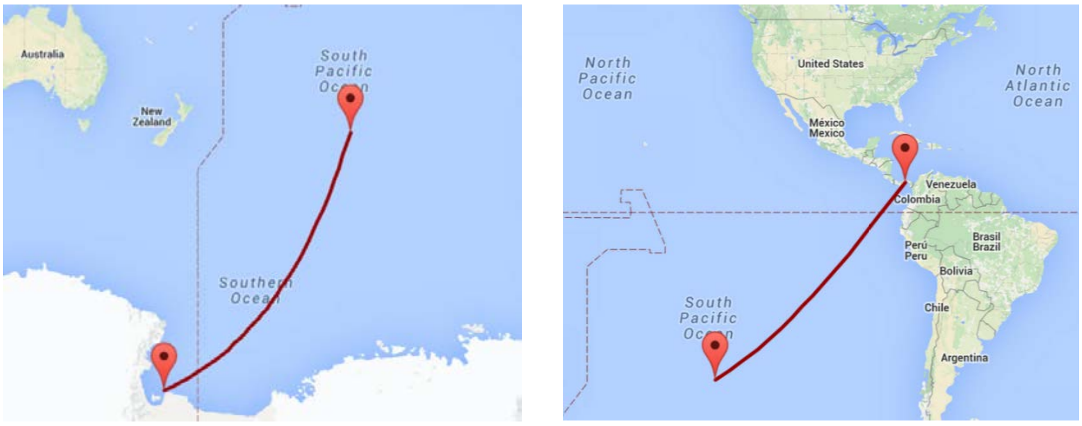

Figure 2. Great Circle Route from McMurdo to Panama Canal South Approach

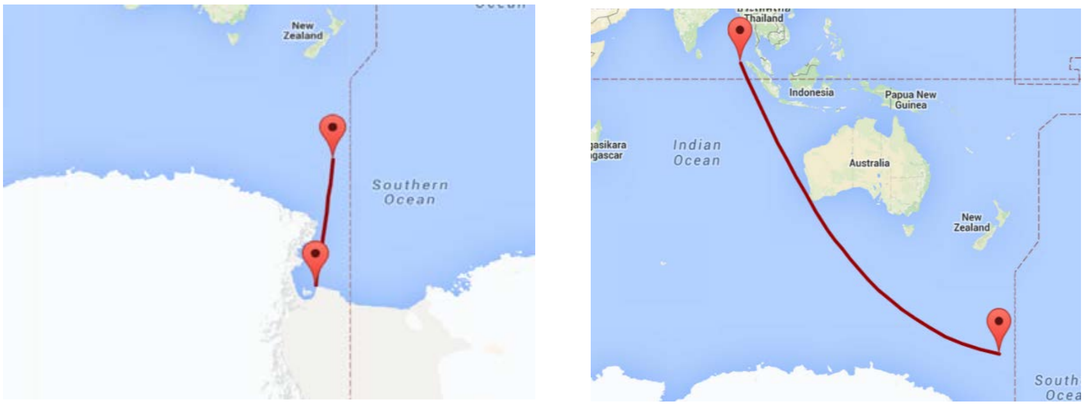

Figure 3. Great Circle Route from McMurdo to Malacca Strait West Approach

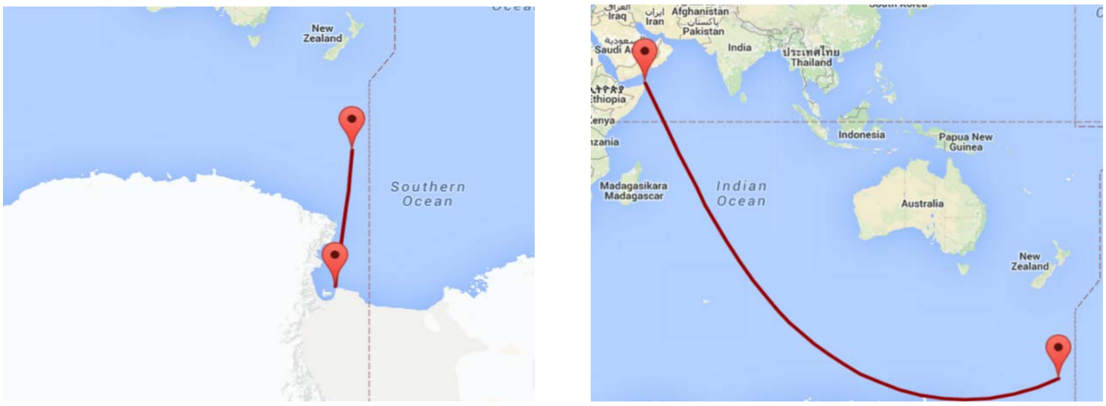

Figure 4. Great Circle Route from McMurdo to Gulf of Aden

Figure 5. Great Circle Route from Ellefsen to Gibraltar

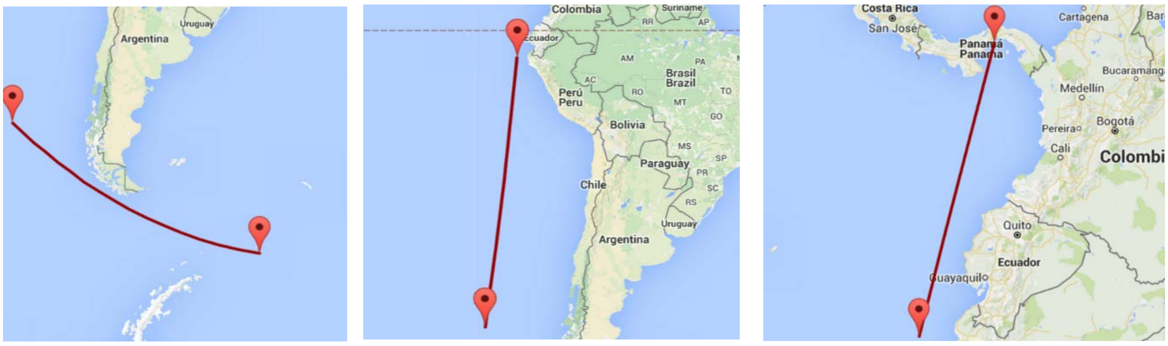

Figure 6. Great Circle Route from Ellefsen to Panama Canal

Figure 7. Great Circle Route from Ellefsen to Malacca Strait

Figure 8. Great Circle Route from Ellefsen to Gulf of Aden

Figure 9. Great Circle Route from Ellefsen to Gulf of Good Hope

DISCUSSION

Antarctica is an increasingly important land and a trend research area for the whole world. We looked at Antarctica from navigation perspective. We analysed navigation distances between some intense maritime trade point and Antarctica ports by utilising Haversine Formula- Great Circle Navigation. This study considered Antarctica as a logistic area, this approach is not supported by international agreement and protocols. However the world trade needs to use underground resources of Antarctica. Because resources in the world are limited and transportation sector focuses decrease in cost. This study broadens academic researches' horizon and estimates that antarctic minerals will be extracted.

In the international economics, it is required to trade that the world market price is lower than the domestic price or there exist lack resources. Market prices include transportation costs so transport distance gains ground in economics. Therefore, spherical distances are crucial in decreasing transportation costs of some goods in the market. We estimate that underground resources of Antarctica will be extracted and it is required to determine viable ports for Antarctic logistics for the future.

In this study, it is observed that there is no excessive difference between Ellefsen port and McMurdo port. Extracted mineral type and destination port are important factors to choose viable port. For instance, Ellefsen port is recommended for transportation of copper. However, McMurdo is more viable for transportation of iron resources. If arrival port is Gulf of Aden, Ellefsen port should be chosen due to its closeness to destination. On the other hand, McMurdo is more profitable in order to transport mineral to Malacca Strait. This study approached to Antarctica from an original aspect and cosidered mines of Antarctica as an important source. We believe that this study will pionner other studies about Antarctica mine resources.

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THE DANGEROUS GOODS TRANSPORTATION AND HANDLING ACTIVITIES IN LOGISTICS CENTER: THE CASE STUDY OF BANDIRMA

Umut AYDIN[1], Ustun ATAK[2], Serap INCAZ [3], Alper KILIC[4]

ABSTRACT

Multimodal transport is a combination of two or more types of transportation modal such as between sea-air, road-sea, railway-sea etc. Bandırma area, where sealine, railway and road are linked in located at Southern Marmara, is a strategic location in terms of transportation systems. Bandırma is on the junction of different transport modes such as sea port (Celebi Port), airport (Kocaseyit), railway to Izmir mega city and main route of highway in Southern Marmara Region. A logistic center is a hub that exchange and distribution can be placed in between different types of transport options with regard to both international and national. In national and international transport, dangerous goods has a great marketing share and financial profit. Dangerous goods can be transported by any kind of transportation modal in accordance with ADR, IMDG, DGR etc. regarding which type of used as transportation modal. A logistic center is a must for multimodal transport in order to transport proper and effectively any kind of dangerous goods. In this study , Bandırma is researched whether it is applicable to establish a logistic center especially to service dangerous goods transportation.

Keywords: Dangerous Goods, Logistics, Multimodal Transport, Logistics Center

DEFINITIONS AND CHARACTERISTICS OF MULTIMODAL TRANSPORTATION

Multimodal transportation is made using more than one type of transportation with different transportion units or vehicles. A multimodal transportation is a combination of two or more kind of transportation modal such as between sea-air, road-sea, railway-sea etc. There are several different definitions from several sources below.

Multimodal transportation is a term that used to define cargo movement from origin to destination. According to United Nations Multimodal Transportation Handbook (1995) Multimodal Transportation: The multimodal transportation is a shipping activity that products are carried from manufacturer to its end user, therefore which is also called door-to-door service by using of at least two modes of transportation.
In accordance with the United Nations Convention on International Multimodal Transportation of Goods, “international multimodal transportation” is defined (in Article 1) as ‘the carriage of goods by at least two different types of transportation [1].

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The key features of the multimodal transportation are listed below:
(A) The first key feature is that it includes service contract
(B) The third key feature is that it includes commercial activity.
(C) The third main feature is that it includes international activities. [3].
With all these definitions and characteristics of multimodal transportation, it has a great importance in international transportation of especially cargo. While globalization and industrialization are having importance day by day, all members of transportation systems are gaining importance too.
Bandırma is located along the Marmara Sea is the third largest county and has approximately 150,000 population. Beside Bandırma far from about 200 km Çanakkale, Bursa, Balıkesir, it has airports that could be used both civilian and military (Balıkesir Airport, Balıkesir Koca Seyit Airport) , a port that could be used as a substitute port for Marmara, a railway passing through center towards to Bandırma port and a freeway enough to handle regional traffic.

A CONCEPT OF THE DANGEROUS GOODS TRANSPORTATION

Due to the velocity of industrialization, type of freight and mode of transportation are changing day by day and global companies make an effort to raise their profit share in this industry. In developed European countries rely on the importance of dangerous goods transportations which is inevitably for the supply of basic industry products and services e.g. energy (petrol, diesel, heating oil etc.) and that increases constantly[4]. 'Dangerous goods' are materials or items with hazardous properties which, if not properly controlled, present a potential hazard to human health and safety, infrastructure and/ or their means of transportation.The transportation of dangerous goods is controlled and governed by a variety of different regulatory regimes, operating at both the national and international levels. Prominent regulatory frameworks for the transportation of dangerous goods include the United Nations Recommendations on the Transportation of Dangerous Goods, ICAO's Technical Instructions, IATA's Dangerous Goods Regulations, ADR Euorpean Agreement
Concerning the International Carriage of Dangerous Goods by Road and the IMO's International Maritime Dangerous Goods Code. Collectively, these regulatory regimes mandate the means by which dangerous goods are to be handled, packaged, labeled and transportationed [5].
Classification of dangerous goods is divided into nine classes in accordance with the type of danger materials or items present [5];

1. Explosives
2. Gases
3. Flammable Liquids
4. Flammable Solids
5. Oxidizing Substances
6. Toxic & Infectious Substances
7. Radioactive Material
8. Corrosives
9. Miscellaneous Dangerous Goods.

The Dangerous Goods Transportation in Accordance with International Regulations

The Dangerous Goods Transportation should be performed according to international regulations due to its high risk. All modes of transportation system have own regulations to perform the Dangerous Goods Transportation operations and it is aimed to explain which manuals are being used in and how the Dangerous Freights operations should be performed in accordance with modes of transportations system below;

Aerial Transportation of Dangerous Goods

On all commercial air transport, the shipper and the operator need procedures which provide safe transport and shipping. For this reason The IATA Dangerous Goods Regulations are published due to this reason. In 1953, the airlines of IATA members recognized the growing need to transport by air, articles and substances having hazardous properties which, if uncontrolled, could adversely affect the safety of the passengers, crew and/or aircraft on which they are carried. Experience in other modes of transport had demonstrated that most such articles and substances could be carried safely provided that the article or substance was properly packed and the quantities in each package were properly limited. Using this experience together with the industry's knowledge of the specialized characteristics of air transport, IATA developed the first regulations for the transport of dangerous goods by air. The first edition of the IATA Dangerous Goods Regulations was published in 1956 as the IATA Restricted Articles Regulations [6].

Concept of the International Maritime Dangerous Goods (IMDG) Code

The International Maritime Dangerous Goods (IMDG) Code contains provisions for the safe carriage of dangerous goods by sea. The key objectives are to: protect human life, prevent marine pollution, facilitate the free movement of dangerous goods [7].

The International Maritime Organization (IMO)

The IMDG Code is produced by the International Maritime Organization (IMO), a specialist United Nations (UN) agency responsible for developing and maintaining regulatory frameworks for sea transport. The UN develops recommendations that cover the Code’s provisions. These are published in the UN ‘Recommendations on the Transport of Dangerous Goods’, known as the ‘Model Regulations’ because the document provides a framework of rules for the safe transport of dangerous goods by all modes – air, road and rail as well as sea. The UN Model Regulations provide a uniform set of safety procedures covering consignment and transport issues such as classification, identification, packing, marking and labelling, documentation, security and training[7].

European Agreement Concerning The International Carriage of Dangerous Goods By Road

This agreement was signed in Geneva at 30 September 1957 under the auspices of Unted Nations the Economic Commission for Europe. The European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) is entered into force on 29 January 1968. Annexes have been published as ECE/TRANS/242 Volume I and Volume II [8].
Some dangerous goods are subject to a different process than others in road transport. These are listed below.

- Annex A is also included conditions related to packaging and labeling.; and
- Annex B is also related construction, equipment and operation of the vehicle carrying the goods [8].

Annexes A and B have been regularly amended and updated since the entry into force of ADR. ").
The following contracts are concerned on the basis of regulations on dangerous goods:
* the United Nations Recommendations on the Transport of Dangerous Goods, Model Regulations,
* the International Maritime Dangerous Goods Code (of the International Maritime Organization),
* the Technical Instructions for the Safe Transport of Dangerous Goods by Air (of the International Civil Aviation Organization) and

* the Regulations concerning the International Carriage of Dangerous Goods by Rail (of the Intergovernmental Organisation for International Carriage by Rail).
The common lay-out of all conventions is as follows [8]:

Annex A: General provisions and provisions concerning dangerous articles and substances

Part 1: General provisions
Part 2: Classification
Part 3: Dangerous goods list, special provisions and exemptions related to limited and excepted quantities
Part 4: Packing and tank provisions
Part 5: Consignment procedures
Part 6: Requirements for the construction and testing of packagings, intermediate bulk containers (IBCs), large packagings and tanks
Part 7 : Provisions concerning the conditions of carriage, loading, unloading and handling
Annex B: Provisions concerning transport equipment and transport operations
Part 8 : Requirements for vehicle crews, equipment, operation and documentation
Part 9: Requirements concerning the construction and approval of vehicles.

FIATA Documents and Trade Logistics Standardization

The content of FIATA documents The objective of FIATA is to help freight forwarders to extent their business worldwide. Freight forwarders are faced with multiple challenges, and one of them is that their services are subject to different jurisdictions. Different legal systems vary and therefore add to the uncertainty of freight forwarders' liabilities. In order to unite the documents standards used by freight forwarders worldwide, FIATA has developed the following 8 documents [9].

1. Negotiable FIATA Multimodal Transport Bill of Lading (FIATA FBL)
2. Non-negotiable FIATA Multimodal Transport Waybill (FIATA FWB)
3. Forwarders Certificate of Receipt (FIATA FCR)
4. Forwarders Certificate of Transport (FIATA FCT)
5. FIATA Warehouse Receipt (FIATA FWR)
6. Shippers Declaration for the Transport of Dangerous Goods (FIATA SDT)
7.Forwarding Instructions (FIATA FFI) 8. Shippers Intermodal Weight Certificate (FIATA SIC).

Convention Concerning International Carriage by Rail (COTIF)
Appendıx C – Regulations Concerning the International Carriage of Dangerous Goods By Rail (RID)

In application of Articles 6 and 19 § 2 of the Convention concerning International Carriage by Rail, signed at Berne on 9 May 1980, herein after called “COTIF 1980”, the fifth General Assembly of the Intergovernmental Organisation for International Carriage by Rail (OTIF) was held at Vilnius from 26 May to 3 June 1999.

In application of Articles 6 and 19 § 2 of the Convention concerning International Carriage by Rail, signed at Berne on 9 May 1980, hereinafter called “COTIF 1980”, the fifth General Assembly of the Intergovernmental Organisation for International Carriage by Rail (OTIF) was held at Vilnius from 26 May to 3 June 1999.
– Convention related with all aspects of international carriage by rail at the State level,

– Application of COTIF 1980 by 39 states and their railways by businesses has been recognized as the best convention.
– Taking into account the necessity of COTIF 1980, in particular the CIV Uniform Rules and the CIM Uniform Rules must be in harmony with international rail demand.
– The traffic demands the transformation of RID and a contract of carriage subject to the CIM Uniform Rules should be considered in the transportation of hazardous materials by rail.
– Convention has been an important step in order to establish a common politic, economic and legal space.
– International rail traffic should take effective measures in favor of public interest.
– All contracts for the railway to be adapted into existing contracts.[10].

When it comes to chemical industry, besides Bandırma has organized industrial zone located in distance 25 km away city center and there are several corporations serving in the chemical industry in this zone. Beside corporations in organized industrial zone Etimaden Bandirma Boron Works Bandırma - Balikesir on the way to the center of town 4 km away from the factory site in Borax Penta, boric acid, amorphous Boroksit, glassy Boroksit - anhydrous borax, Agricultural Boron (Etidot-67) is continuing its production activities [11]. Also Bandırma Gübre Fabrikaları A.Ş. called BAGFAS is serving in the chemical industry.
Handling dangerous goods requires more awareness, preparation and education due to any mistake that may result in disaster. Dangerous goods industry needs warehouses appropriate standards where handling process can be performed effectively. The presence of at least two different modes of transportation is the most important factor for logistics centers and Bandırma has four type of effectvie transport modes and these modes are being used to transport dangerous goods densely.

THE DEFINITON OF LOGISTICS CENTER AND ITS MOST IMPORTANT ELEMENTS

The multimodal transportation system has a great impact on especially logistic centers. The term of "logistics center" is dated back to old times. The term "logistics center" which refers to all operations such as packaging, customs clearance, storage, shipping and the other many"activities [12] from [13].
The facilities which performing different functions are described by many authors as a logistic center. This can be considered as a definition of all system. A logistics center is also the focal point for the flow of goods. Thus it performs extensive logistics network to use different transport modes. It gives users a wide range of services and presents information technology solutions (Medute 2005 and Europlatfroms 2004). Logistics centers will accelerate the economic development and business life. Businesses must implement to the latest support technologies and management skills. Logistics centers offer these services without the added risk or infrastructure costs. Since not all companies are able to build their own logistics centers [12] from[14].

Logistics Centers Most Important Elements

The main activities of logistics centers can be listed as follows; customer service, transportation, storage, inventory, cross-docking, handling, packaging, demand planning, insurance, distribution, consolidation, distribution network management/vehicle routing, delivery and package tracking. It is useful to explain some of them.

Storage : The traditional function of warehouses is sort of storage. Storage of goods request arised due to various reasons, associated with different types of inventory. The following functions of warehouses, although not necessarily new, have been developed in more recent times, and it will be seen that they are not necessarily associated with storage of inventory. Indeed, they are often designed to reduce or even eliminate storage. Modern logistics approaches emphasize flow (in distribution to markets the approach is called flow-through distribution) rather than storage of inventory [15] from [16].

Transportation: The transport system consists of a sum of the specific input and output. Inputs of transportation system are transportation demands, resources and constraints and transport policies and strategies.

Distribution: Distribution is the process from production center to consumption process. Distribution channel is the flow of industrial buyers of consumer goods from a manufacturer.
Assembly and kitting: Logistics centers can have assembly capability to supply made-to-order products with a short lead time. Made-to-stock products can be kitted at logistics centers with engineered-to-order products to form assembly packages. In addition, logistics centers can be used to adjust assemblies facing design changes thus, reducing the adverse impact of changes that are ubiquitous in construction [12].

Consolidation: Smaller consignments are consolidated at a warehouse and subsequently dispatched as a volume shipment. Consolidation may be in-house or provided by a third party. Freight forwarders offer consolidated services, particularly in international shipping. There is usually an element of storage in consolidation, whilst awaiting departure of the consolidated consignment. The main advantage of consolidation is the saving of transport costs by sending volume or full-load shipments [15]from[17].

Break Bulk: Break bulk cargo ,which is called as general cargo as well, is loaded into ships as individual pieces or unitised on pallets, in bundles and is not containerised nor in the form of dry or liquid bulk consignments in whole or part shiploads [18].

Cross-docking: Goods enter the warehouse from various suppliers, and are (ideally immediately) transferred to vehicles in the required combinations for shipment to customers (or to a production plant). Cross docking is therefore associated with product assortment or product mixing. In this case, the warehouse is not really used as a storage point but as a transfer location. The term cross-docking refers to the fact that goods move directly across from the receiving dock to the dispatch dock in the warehouse [15] from [19].

Distribution network management/vehicle routing: A logistics center can be designed to handle and optimize material distribution by assigning material packages to vehicles and choosing the best route. Vehicle routes can use milk runs or direct shipment based on project needs [12].

Delivery and package tracking: Using information systems (e.g., radio frequency identification or RFID), a logistics center can track the status of material and vehicles throughout the supply chain. This can increase delivery reliability when it comes to correct material orders and timely deliveries [12].

BANDIRMA AREA IN ACCORDANCE WITH A LOGISTICS CENTER IDEA

Besides taking place among the country's most important ports due to its location, the Port of Bandırma is capable of handling all types of cargoes in combined transportation owing to its connection to the national railway. As a logistic center, Bandırma Port, after Istanbul, is the second largest port in the Marmara Sea. Depth of 12 meters, the port has a capacity of 20 thousand gross tons up to 15 ships berthing at the same time will make loading and unloading [20]. In view of the fact that Bandırma port has strategic location, it is capable of handling different types of cargoes in combined transportation. When it comes to port capacity Port of Bandırma has 268.348m^2 total port area, 215.596m^2 total storage area, 268.348m^2 customs area, 1.500m^2 equipment parking area, 8.000 m^2 container freight station. Port of Bandırma cargo capacity is analized; Containers 350.000 TEUs/year capacity, Bulk 10.000.000 tons/year capacity, General 1.000.000 tons/year capacity and Liquid Bulk 1.000.000 tons/year capacity [21]. When we evaluate in terms of connections with other transport models, the biggest competitive factor of logistics centers, Bandirma port has rail and road networks are linked Anatolia.
BAGFAS has two jetties capable of accommodating three vessels, thus, simultaneous cargo operations are possible. Maximum allowable ship tonnage is 40.000 GT with a loading/discharging capacity of 400 tons per hour for dry bulk and 500 m3 per hour for liquid cargoes. Raw materials discharged are carried directly to the warehouses or tanks by conveyor belts and pipelines [22].
Bandırma, when evaluated in terms of Etimaden Bandirma Boron Works, BAGFAS and other chemical enterprises serving in the chemical industry, has about 1.300.000 tons dangerous goods production capacity. As a logistics center ; Port of Bandırma and BAGFAS will not meet the demand due to their limited area so Bandırma will need a logistics center and this center should include zones where especially dangerous substances could be handled and other establishments accelerated the process for instance banks, bonded area etc. This center should be located the best point where all modes of transportation system could be linked. In Bandırma especially three modes could be used; road, sea and railway. There are two airports located in Balıkesir and by using road it takes maximum two hours to get to these two civilian airports and by this way, fourth mode of transportation system could be used in this center.

CONCLUSION

Developments on logistics, different types of cargoes, and demand of high profit push companies to become different and due to this reasons, logistic operators began to prefer logistic center where all operation can be run. In respect to developments, logistic center was began to found and following foundation this center has become widespread. Logistics centers are named differently in view of purposes and activities, such as Logistics Center, Freight Village, Logistics Base. It is clear that there is no differences between different named logistic centers in view of purposes and activities. That's why, 'Logistics Center' used as common word in this study.
Generally speaking about basics of logistics centers, besides that there is a place that all logistics operation steps could handle, also an area that a center has enough background to meet all technical and social necessities. Logistics center has to be founded on vast lands and an join point that meets effectively railways, seaways and roads. Besides stores and facilities dedicated different purposes, there should be bank offices, postal offices, insurance companies, hotels, restaurants, etc. like a place for recreational activities. By foundation this facilities, both logistic process can be effective and with scale economy companies can profit higher.

When the area of Bandırma is researched in respect to mentioned logistics center's characteristics, in the area, Port of Bandırma and one dock belongs to BAGFAS are in use as logistics center.

Bandırma has a potential of attraction center owing to the fact that Bandırma has railway and roads connected to Anatolia, is a place located beside Sea of Marmara, is far away form only 2-3 hours to Bursa, Canakkale, Istanbul cities. At a place that railways, seaways and roads meet perfectly, where all logistics operation could be handled, a center could be founded and also this center could provide training facilities. And If this center is linked with Airport of Balıkesir and Koca Seyit where four different type of transport modes can be used, Bandırma will be an attraction center in regard to logistic. Capasity of Bandırma Port and due to location of city center, there is a possibility that port cannot be enough to handle all cargoes, and this supports to idea of new logistics center.

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SHIPBROKER SELECTION CRITERIA OF CHARTERERS IN DRY BULK SHIPPING

Gökçay BALCI[1]

ABSTRACT

The competition between shipbrokers has been getting fiercer due to information technologies and increasing expectations from their clients. In such a competitive and challenging market, shipbrokers need to thoroughly understand selection criteria of their clients. Thus, this study attempts to explore charterers' shipbroker selection criteria in dry bulk chartering. The study also discusses the role and services of shipbrokers in chartering market. Based on a qualitative study model, semi-structured interviews were conducted with charterers and shipbrokers. According to results, charterers consider total nine criteria when selecting a shipbroker. These are trustworthiness and reputation, ability to find lower freight rates, ability to find suitable vessel in due time, negotiation skills, service quality during post-fixture, information and advisory services, cargo expertise, geographical expertise, communication availability. The results suggest that trustworthiness and reputation is a pre-condition that charterers attach the most importance. Shipbrokers should constantly improve their network and information and advisory services to perform better on selection criteria of charterers. The information technologies are not necessarily a threat for future of shipbrokers but instead can be a competitive advantage

Keywords: Dry bulk shipping, chartering, broker selection criteria

Note: This study is a revised version of the unpublished master thesis of author.

INTRODUCTION

Shipbrokers have been traditionally playing a significant role in shipping business for many decades. Shipbrokers contribute a lot to shipping business through expediting searching and matching process, achieving favorable prices and handling asymmetric information [1]. Different types of shipbrokers exist i.e. sales and purchase or chartering brokers in distinct segments of shipping business [2]. In ship chartering, for instance, the very basic and traditional role of shipbroking is to bring charterers and owners together to sign a chartering agreement. This role used to be especially critical before advanced information technology (IT) era. It was indeed time consuming and expensive for ship owners to reach charterers or for charterers to find a suitable vessel. However, in today's IT era, owners and charterers can reach each other very conveniently even through smart phone applications.

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There has been a concern in the market that rapid development in IT puts shipbroking business at stake as charterers and owners can easily reach each other. Indeed, some charterers and owners bypass ship brokers and sign chartering agreement directly after a negotiation process. Yet, many shipbrokers still exist in shipping market all around the World. One reason behind why charterers and owners still work with shipbrokers may be due to advantages of outsourcing [3]. Charterers and owners can focus on their core businesses and let shipbrokers to handle chartering process. Another strong rationale is that shipbrokers do not only bring charterers and owners together but also provide other services that add value to business of their clients. As a result, many charterers and owners keep working through their brokers.

Nonetheless, the market environment of shipbrokers has become more competitive recently. First reason, number of ship brokers has been increasing due to more interest from individuals. Great number of private shipbroking courses exists in many countries but especially in the UK. Second, the developments in IT enable new comers to easily develop their network and enter to the market. Moreover, more informed clients with their in-house chartering department demand more from shipbrokers in addition to just finding a vessel or cargo. Thus, brokers need to understand what their customers need and want and which criteria the customers evaluate for selecting a broker. To knowledge of author, no academic paper has attempted to find out shipbroker selection criteria. Therefore, the purpose of this study is to explore shipbroker selection criteria of clients.

The paper focuses on shipbroker selection criteria in voyage chartering in dry bulk shipping with the viewpoint of charterers. Following sections provide information about dry bulk shipping, role of shipbrokers, methodology, results and discussion of the study.

LITERATURE REVIEW

According to the classification of Stopford [4], shipping market is divided into four as newbuilding market, second hand market, freight market and demolition market. Freight market can be basically divided into two as liner shipping and tramp shipping. Liner shipping refers to scheduled regular services between certain ports. Container, Roll-on Roll-off (Ro-Ro) and passenger traffics are examples of liner shipping industry. In liner shipping, rules of carriage are standard and shippers are not able to negotiate the terms of agreement except some discounts on freight [5], [6]. In tramp shipping, or bulk shipping in other words, many of the terms of carriage such as freight, loading and discharging terms, risks, time, laycan, demurrage are subject to negotiation [7].

Three types of basic chartering agreement exist in bulk shipping: Voyage chartering, time chartering and bareboat chartering. Gorton et al. [7] defines bareboat chartering as a leasing the vessel for a time period by which charterer is responsible for all commercial and technical responsibilities except the capital costs. In time chartering, charterer hires a vessel for a time period to trade specified cargoes. Charterer is responsible for voyage costs including bunkers, port charges, canal and strait dues and loading and discharging costs in time chartering. Time charterers are not responsible of technical costs such as Hull and Machinery insurance, maintenance, classification and manning of vessel. In voyage chartering, the charterer occupies a part or whole carrying capacity of the vessel with a specified type and volume of cargo which is loaded and discharged at a determined port(s) [8].

Dry bulk freight market reflects the characteristics of a free market structure where freight rates are highly rely on supply and demand equilibrium [9]. Dry bulk shipping has a high volatility in terms of freight rates which are significantly affected by world trade, global economy and political issues [10]. In dry bulk, commodities transported include five major bulks (iron ore, coal, grain, aluminum bauxite and phosphate), steel, scrap, cement, forest products, fertilizers, copper and metallic minerals. In 2013, total 9.5 billion tons of total cargo were transported by sea and dry bulks generate around 4.3 billion tons of this amount [11]. Considering the great number of owners, variability of cargo types and number of charterers, this paper focuses on voyage chartering in dry bulk shipping.

Brokers act as an intermediary in all those 4 shipping market segments mentioned in previous part. In dry bulk shipping, shipbroking activities commonly appear in voyage chartering. Shipbrokers can be exclusive, by which they are the sole representative of charterers, semi-exclusive and competitive [12]. A written contract is not necessary for an exclusive or semi-exclusive business relation between a charterer and shipbroker [1].

The very basic function of a shipbroker is to bring charterer and ship owner together and act as an agent. Pisanias and Wilcocks [12] states that apart from matching charterers and owners for a chartering agreement, shipbrokers have 4 different tasks:

1) Information acquisition and dissemination
2) Advisory role through knowledge of the market
3) Negotiations and representation
4) Informal arbitration

Pisanias and Wilcocks also indicate that job of shipbroking is actually an information network but the quality of information is rather important than quantity of information. Colins [8] lists the role of brokers as "*information, market advice, strategic advice, negotiation buffer, administration of charter and assistance in resolution of disputes*". Coulson [13] indicates the services given by brokers as processing the fixture upon initial contract, solving disputes, supporting the client with statistical information and services such as freight and demurrage calculations. Gorton et al. [7] stress the importance of confidentiality and loyalty of shipbrokers against their principals. Shipbrokers should not disclose the business secrets or interests of the charterers. Any misleading information given by shipbrokers may also deteriorate the business relation between the broker and charterer.

The literature review indicates that shipbrokers play a crucial role before, during and after the chartering agreement. Shipbrokers add significant value to charterers during negotiation process and also provide general information about the market. However, the limited literature on the role of shipbroker suggests that role of shipbrokers remains to be an area that should be explored. In addition to find out shipbroker selection criteria in dry bulk shipping, this paper also aims to explore the role of shipbrokers.

METHODOLOGY

Since the purpose of this study is to explore shipbroker selection criteria and have deeper understanding of business of shipbrokers, this paper is designed as exploratory qualitative study [14]. Data collection method should be chosen by considering what kind of data is necessary for a research [15]. Semi-structured interview is chosen as data collection method since it allows researcher to understand preferences and opinions of industry experts with a deeper insight [16].

The interviewees were chosen based on non-probabilistic judgmental sampling [14]. Total 5 semi-structured interviews were conducted with industry experts in dry bulk shipping in 2011. An initial interview was performed with two shipbrokers to discuss if such a research is needed in practice as well as and formulate the interview questions. Though the number of interviews may not seem to be satisfactory at first glance, experience and competencies of interviewees are quite satisfactory. Besides, theoretical saturation, as suggested by [17], was also achieved in the first three interviews. The details of the interviewees are illustrated in Table 1.

Table 1. Profile of interviewees

Name	**Company**	**Experience**	**Position**	**Fixtures per year**
Charterer1	Iron and steel (Turkey)	11 years	Chartering manager	100 vessels
Charterer2	Coal importer (Turkey)	10 years	Chartering manager	20 vessels
Shipbroker1	Dry bulk broking (Sweden)	27 years (Co-author of a shipbroking book)	Partner (also lectures at university)	350 vessels
Shipbroker2	Dry bulk broking (Sweden)	37 years	Partner	350 vessels
Shipbroker3	Dry bulk broking (Turkey)	12 years	Founder	50 vessels

All the interviewees are quite experienced in chartering business. Among the interviewees, Shipbroker1 is especially noteworthy as he does not only have a long experience in shipbroking and chartering but also he is the co-author of a famous international shipbroking book and he teaches at master degree level at a university in Sweden.

Three of the interviews were conducted face-to-face in the offices of interviewees while remaining two interviews were done through Skype program. The interviews with Shipbroker1 and Shipbroker2 lasted 1 hour and 30 minutes while rest of the interviewees took around 1 hour. Detailed notes were taken during the interviewees. As [18] suggests, first general questions about the business of the interviewees were asked and then more specific questions were probed. Language of the interviews with brokers in Sweden was in English while it was Turkish with the other interviewees located in Turkey.

FINDINGS

Shipbroker Selection Criteria of Charterers in Dry Bulk Shipping

Total nine criteria that charterers may consider when selecting a shipbroker were explored. All interviewees agree on classification and definition of the criteria. Although measuring the importance level of these criteria is not possible with a qualitative study, interviewees were also asked to categorize the criteria under most important, very important, important and preferred. Table 2 illustrates the criteria explored in this study.

Table 2. Shipbroker selection criteria

Criterion	Explanation	Prioritization
1. Trustworthiness and reputation		Most Important
2. Ability to find lower freight rate	Lower than market average	Very Important
3. Ability to find a suitable vessel in due time		Very Important
4. Negotiation skills	Inserting advantageous clauses to C/P.	Very Important
5. Service quality during post-fixture	Includes documentation, dispute resolving, follow-up of the operation.	Very Important
6. Information and advisory services		Important
7. Cargo expertise	Specific details of cargo	Important
8. Geographical expertise	Knowledge of ports and procedures in a region, aware of business culture.	Preferred
9. Communication advantage	Same native language, face-to face availability	Preferred

Most important criterion found in this study was trustworthiness and good reputation of shipbrokers. Charterers strongly express that no matter how shipbrokers are proficient and skillful in the other services or how competitive freight rate they can find, they never consider working with brokers whom they do not trust.

Negotiation skills mean that shipbroker is experienced and skillful to insert favorable clauses for charterers and warn charterers about some clauses which may put charterers into difficult situations later. Both charterers believe that it is very important for them and brokers who have this skill would be more attractive.

Ability of a charterer to find a suitable vessel in short time is very important for both charterers as they stated they need to find the vessel sometimes in a very short time period due to the sales agreement between the buyer and seller. However, brokers indicated that the right wording of this criterion should be in “due time” as it is not always an obligation to find the vessel in short time.

The interviews indicate that lower freight rates always attract charterers and would be a preference reason. However, shipbroker in the second interview stated that some charterers, who have high valued or risky cargo, might focus on quality and performance of vessel rather than the freight rate. Nevertheless, all interviewees agreed that lower freight rate is always appealing for charterers.

One of the most common complaints of charterers mentioned before was “*fix and forget brokers*”. All interviewees agreed that service quality during fixture is a very vital criterion. Charterers clearly expressed that fixing a vessel with favorable freight rate and charter party clauses is important, but not enough to select a broker. They said that they want assistance from shipbrokers during the post-fixture stage which includes follow-up documentation like bill of lading, laytime calculation, dispute resolving and payments. Charterers and broker particularly underlined that dispute resolving may provide a lot of benefits for charterers.

The interviews suggest that information and advisory services is also an important criterion. Charterer2 stated that he always seeks for market information about his business. He wants to be updated about current developments in the market even when no chartering agreement occurs at that moment. Shipbrokers also confirmed that some charterers demand information services when they are not practicing a chartering operation.

Cargo expertise might be interpreted in many different ways but here it means that shipbroker knows specific details of some particular cargoes. Both charterers and brokers believe that it is an important matter but does not have a vital importance. However, especially the charterer in coal trade stressed the importance of this knowledge level of a broker as he believes coal is a sensitive and flammable cargo which may require extra attention.

Geographical expertise stands for knowledge of shipbroker in loading and discharging ports. It also includes awareness of business culture in those regions. Though charterers pointed out that this might be important in some cases, it is not a critical issue when selecting a broker.

Since chartering is a very much risky business that a small mistake can lead big financial losses, speaking the same native language and eliminating any possible communication problem is very important. However, he believes it is not a significant concern if both parties are proficient in English. Shipbroker3 specified that though they never have a face-to-face contact or never meet each other, some charterers are still willing to use broker whom they can meet face-to-face.

Interviewees almost have same opinions regarding the importance of criteria although they could not prioritize them in a precise order. The reason they explained is that priority of each criterion may change case by case and charterer by charterer. However they are all agreed that the most important criterion is trustworthiness and reputation. Beside the criteria indicated here, interviewees pointed out that there might be some other factors that can affect charterer's decision. Charterer1 specified that close relations can also be a reason for working with a broker. Same politic views, membership to same organizations and family connections etc. may be a reason for selection depending on the culture and country of charterers.

Services and Role of Shipbrokers in Dry Bulk Shipping

According to the interviewees, services that shipbrokers are supposed to provide are similar to literature part under the role of shipbrokers heading. Shipbrokers believe that delivering the information accurately between parties and drawing up the charter party after fixture are the legal obligations. However, they also believe that solely complying with legal rules is not enough and they have to help charterers until the file is closed. Shipbroker3 indicated that service of shipbrokers even may start from opening letter of credit stage for charterers who are not very experienced.

Charterer2 stated that "*A broker has to deliver all the information about the vessel and shipowner accurately, on time and in detail which necessary for us, act trustworthy and follow up the fixture from offer stage until the vessel completes discharging and departures port*". Charterers pointed out that they sometimes bypass brokers and work with owners directly to achieve lower freight rates.

Most important reason why they are willing to work via shipbrokers is that they can sometimes get much lower freight rates in a shorter time period.

Brokers in Sweden think that most explicit difference of services between twenty years ago and today are advisory and information services. They believe advisory services have become much more important than the past.

Both charterers and shipbrokers agreed on that services given after fixture, which is called as post-fixture, are quite important. All interviewees stressed the significance of especially dispute resolving. Interviewees believe an experienced and erudite shipbroker can help charterers to save or earn more money from disputes arising during post-fixture stage. The important role of broker in disputes and arbitrations was especially underlined by the interviewees. They stated broker must be able to help parties to solve the problem without applying to legal arbitrations and courts.

According to interviews, expectations of charterers from shipbrokers depend on the experience and shipping knowledge of charterers. Experienced charterers, who have their own professional chartering department, expect a broker to find suitable vessel in due time with competitive freight rate, act honestly and carry out necessary documentation while inexperienced charterers demand shipbrokers to give an entire service. Shipbroker3 stated that some charterers ask for help regarding shipping clauses of sales agreement which is not related to shipbroking and it has been becoming a usual practice.

There are also some differences between charterers regarding their expectations depending on their culture and country. Shipbroker in Turkey stated that some charterers in Turkey expect brokers to inform them about every small details of the operation which are sometimes not necessary at all either for chartering or for ship operation. However, charterers for instance in North Europe, require to be informed only for critical matters.

Another important matter is that some brokers do not pay adequate attention the services after fixing the cargo. This problem was also touched upon by brokers and they are also quite unhappy with this kind of brokers in the sector. Shipbrokers named this problem as "*fix and forget brokers*". Other kind of broker that charterers usually do not like very much is "*quote and quote broker*". It means they do not like brokers who are just receiving and delivering messages without any suggestion. Charterers also sometimes face with brokers that make firm offer and then just disappear. This situation wastes charterers' time and annoys them pretty much.

Shipbrokers state that their business is going tougher day by day. They asserted that number of shipbrokers is increasing and some of the charterers which have professional chartering department are creating their own network. Despite this, they believe that shipbrokers are going to exist though the number will probably be less than now. Charterers said that they sometimes make a chartering practice by skipping shipbrokers but they also clarified that to find most competitive freight offer and suitable vessel they are always willing to work with reputable brokers who assist them from offer stage till the file of that fixture is closed. Shipbroker also enriched his opinion as "*I believe shipbroking will disappear when teleportation technology is launched. Even then there may be special brokers*".

On the other hand, Charterer1 remarked that they bypass brokers more than half of their chartering practice nowadays. He said that the only reason why he wants to work with a broker is for finding lower freight rates. He stated that he can get 1USD per ton lower freight rates from ship owners when he bypasses the broker. He believes he can handle other chartering procedure as their chartering team has become very professional. Following question was asked to charterers upon this data. "*In which condition would you like to still work via a broker though s/he cannot find lower freights than you*?" The answer was "*if shipbroker is able to provide critical information which is vital for our future decisions and investments*".

All shipbrokers in the interviews stated that shipbrokers should create a good reputation and recognition to keep their business live. They believe that shipbrokers must have their long term visions and missions to survive. They should generate an idea in the mind of charterers such as trustable, loyal, good at negotiation and specialized in a cargo so that they would be preferred among other brokers.

DISCUSSION

The interviewees have similar opinions in terms of services that should be given by shipbrokers and shipbroker selection criteria of charterers. However, slightly differences occur regarding the services that shipbrokers are supposed to supply. The services that shipbrokers must provide are usually not defined clearly with an agreement. Although brokers believe that they should assist charterers during negotiations, handle the post-fixture operations and follow-up the entire chartering process, they think breach of agreement occurs only when they misinform charterers or make a deliberate mistake. On the other hand, most common complaint of charterers about brokers is "fix and forget" style of business. Therefore, there is an uncertainty over the level of "adequate service" in shipbroking business.

Despite the lack of consensus in terms of adequate service, findings of this paper are parallel with the literature. Interviewees are quite sensitive regarding trustworthiness as [7] stresses the importance of confidentiality and loyalty of brokers towards their principals. Information and advisory services, post-fixture services, assistance in negotiation and dispute resolution were all mentioned as the role of shipbrokers in literature [8], [12], [13]. However, expectation of charterers and charterers' selection criteria may depend very on business scale, preference or strategy of charterers.

The most important criterion when charterers select a broker is trustworthiness and good reputation of shipbrokers. The reason behind may be because shipping is a risky business and charterers are sensitive about the confidentiality of their business. As small mistakes or misinformation can lead a huge financial burden for parties, charterers can be very sensitive for trustworthiness and reputation of shipbrokers.

Charterers must find a vessel within a certain period of time to comply with sale agreement and it is really vital to find a vessel to start loading on time. The vessel must be also suitable for the cargo, loading and discharging port, age restrictions due to insurance and flag due to political reasons. For these reasons, it is very understandable that charterers find this ability of shipbrokers very important. It is not also possible to take other criteria into consideration if there is not a suitable vessel to carry the cargo.

It is obvious that charterers would be willing to work with a broker who can find more competitive freight rates. The reason why a charterer also wants to work with a few different brokers or with competitive brokers is to find more favorable freight rates by using their different networks. Therefore, a broker should have a very wide network to be able to find a competitive freight rates.

This was pointed out by shipbrokers that one of their critical assets is the network they have and also was mentioned in literature review.

Having a broad network may also enable a broker to find a suitable vessel in a short time, which is a very significant criterion of charterers as well. We should also keep in mind that network of brokers was the reason why charterers want to work with them. In addition to the network, shipbrokers must have experience and skill to be able to match the right cargo with the right vessel for a competitive freight rate.

It is quite understandable that a shipbroker who has strong negotiation skills is one of the most critical characteristics that charterers are seeking for because all the important rules and clauses of the voyage chartering agreement are negotiated and decided during the negotiation stage. If charterer manages to insert advantageous clauses into the contract, he might minimize his responsibilities by transferring them to ship owner such as making ship owner liable to check restrictions at loading and discharging ports or condition Bill of Ladings to be signed as clean so that he can reduce financial and legal risk that he might face with. Shipbrokers also stated that this is the area where they can create many benefits for the charterer. This criterion actually requires having a great knowledge of maritime law and shipping business.

The necessity of international trade and maritime law knowledge has also vital importance for dispute resolving which takes place in post-fixture part. In addition to experience and being wise, charterers want brokers to dedicate themselves to operation and documentation during the post-fixture and be loyal to charterers. Therefore, we can interpret that charterers are willing to work with experienced and professional brokers who do not “fix and forget” the fixture as well as brokers who can find a suitable vessel in due time for lower freights. Charterers make their decisions case by case with a cautious assessment.

Charterers also want to work with brokers who are already familiar with their trading cargoes instead of explaining details of the transportation to a broker who does not have experience in those cargoes. Each different commodity has its own traits there are special conditions for loading/discharging and also transportation of that particular cargo. Knowledge and experience of shipbrokers in loading and/or discharging ports are important too as when a problem occurs during loading and discharging, shipbroker can solve the problem with his/her close contacts in the region. Broker also knows performance of ports, local rules and business culture which are considerable for charterers.

Communication availability might be a preference reason to eliminate the possible communication misunderstanding since the market is too risky and small details may lead significant outcomes. This criterion was the least important one among others so we can comment that charterers do not suffer from any communication problem though they feel more comfortable with same native language speaking brokers.

Although information technologies can be evaluated as a threat for the future of shipbroking business, they can actually help shipbrokers to achieve competitive advantage for some of the selection criteria including ability to find lower freight rate, ability to find suitable vessel in due time and information and advisory services. We should consider that the reason of a working with shipbroker for a charterer in this study is only if the charterer receives information and advisory services.

CONCLUSION

The main purpose of this study was to explore shipbroker selection criteria of charterers in dry bulk voyage chartering. The study also aimed to discuss the role of shipbrokers and services given by them in dry bulk chartering. Charterers consider nine criteria when selecting a broker: trustworthiness and reputation, ability to find lower freight rates, ability to find suitable vessel in due time, negotiation skills, service quality during post-fixture, information and advisory services, cargo expertise, geographical expertise, communication availability. The criteria indicate that charterers evaluate several factors when selecting a broker. The importance level of each criterion may change depending on cargo, preferences of charterers and urgency but trustworthiness and reputation of brokers seems to be the first concern of charterers in every case.

The criteria found out in the study suggest that shipbrokers should constantly enhance their services, develop their network and focus more on information and advisory services to gain a significant differentiation against other brokers. The results of the study also propose that information technologies are not necessarily a threat for shipbrokers but instead can be used as a competitive advantage for developing their network and offering information and advisory services. Specialization in some particular cargoes may also help brokers to create a strong positioning in the mind of charterers. The results also indicate that a disagreement about the level of service shipbrokers exists in the market. Although competition is getting tougher in the market, important opportunities for broker still exist.

The results of this study can be a useful base for future studies. Future studies may perform quantitative analyses such as AHP or a multivariate analysis to investigate this topic. A quantitative study with a sample including different cargo types, charterers from different geographies and different sizes can be performed.

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ANALYSIS OF LOGISTICS ACTIVITIES IN THE FURNITURE INDUSTRY: A CASE STUDY FOR İNEGÖL

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ABSTRACT

Furniture industry is one of the few sectors that are in the process of rapid development in the last decade and do not have foreign trade deficit. In this study, İnegöl furniture sector logistics activities which perform fifteen percent of Turkey's total furniture exports were analyzed. The aim of this study is to analyze logistics activities of furniture companies which are operating in İnegöl, reveal their functions and identify their logistics business profiles. For that reason, 62 furniture businesses from İnegöl were interviewed. After analyzing data, it has been reached that, first businesses logistics activities' current situation and the functioning of basic logistics activities were revealed. Second, 9 hypotheses validity that were formed under these data in early stages of this study were tested. The most striking results from the study are; inadequacy of logistics companies that are serving in İnegöl and necessity of increase the quality of the employee working in logistics or furniture companies in İnegöl.

Keywords – Logistics, Furniture Logistics, Maritime Logistics, Logistics Activities

INTRODUCTION

The successful implementation of logistics management is an important advantage in intense competition both national and international markets that is main aim is deliver products and services from manufacturer to the end user with cost-effective way, at the right time and with the right way. Logistics management is a movement chain that is most important activity is transportation. Despite good progress with the impact of globalization, formed the majority of small and medium-sized family businesses Turkey's furniture sector, remains connected to the road transport which is the most expensive form of transport. When analyzed current study's findings and very little number of academic studies conducted on the logistics activities on the furniture sector, it is encountered that the sector has been experiencing significant difficulties while implementing other logistics activities. The aim of the research is; examine the current status of logistics activities, to reveal the applied basic logistics activities of furniture businesses operating in İnegöl and define the logistics based profiles of furniture businesses according to the variables that discussed in the following sections. The objective of the research is to develop new alternatives instead of implemented logistics activities of furniture businesses in İnegöl and to contribute all practitioners in the furniture industry based on İnegöl example.

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FURNITURE INDUSTRY AROUND THE WORLD

Furniture production is one of the major economic sectors in the world and the sector produces $ 376 billion average annual worth with main, auxiliary and side elements [7]. Furniture sector grew about 100% in the last twenty years [16]. According to 2010 statistics world furniture market value is about $ 376 billion, it is estimated that it will pass $ 1 trillion in 2050 [14]. The first reason of this growth is the opening of new markets and the second reason is the increase in world consumption particularly affecting developing countries [16]. With exceeding $ 20 billion amount furniture trade deficit in the USA, EU countries with exceeding $ 50 billion amount exports and Chinese with the furniture trade surplus exceeding $ 16 billion are the important actors of world furniture industry [12]. In the world furniture sector China is the leader in production and USA is the leader in consumption area. However when analyzing the per capita consumption data, Canada became the leader in consumption area according to per capita consumption data [13]. Turkey has a rate of 1% in terms of production and potentially tends to exceed this ratio [7].

The largest share of furniture exports in 2013, has taken from China. China has followed by Germany, Italy and Poland in terms of world furniture export share. Turkey has become fifteenth country in terms of world furniture export ranking out of 228 countries [11]. The largest share of furniture imports in 2013, has taken from USA. USA has followed by Germany, France and England [11].

EUROPEAN UNION FURNITURE INDUSTRY

Furniture industry is one of the largest manufacturing industries in the European Union [1]. Both commercial aspects and style and technology aspects EU countries has a great power around the world [3]. EU furniture industry meets nearly 20% of world furniture exports [2]. According to the European industry representatives, 27 countries of EU provisions %27 of world furniture production, %28 of world furniture consumption, %45 of world furniture export and %46 of world furniture import [2]. 50% of world furniture imports are carried out by the EU. Among the top five importing countries in the world there are three (Germany, France, England) EU countries. In addition to being largest producer, Germany also has a great share in import area and that makes Germany the biggest furniture market in EU [3].

FURNITURE INDUSTRY IN TURKEY

Due to the geographical proximity to countries that have big shares in the world furniture trade, furniture sector in Turkey has strategic importance [9]. Because of using mainly domestic resources in exports and has a minor dependence imported products furniture industry provides high contribution to the national economy [13]. The furniture sector in Turkey gathered places where the market is concentrated and/or certain regions where forest products concentrated. According to their total employment shares important furniture production regions in Turkey are; İstanbul, Ankara, Bursa (İnegöl), Kayseri, İzmir and Adana [10]. Value of $ 6 billion furniture production capacity of Turkey composes %2 of total world furniture production and takes %1 share of world furniture export [16]. In 2013Turkey’s total furniture production value has been $ 19 billion and total furniture consumption value has been $ 14 billion [11]. Turkish furniture sector is a unique sector because it did not give foreign trade deficit during last 12 years [14]. Turkey's furniture export, except for a small decline in 2009 due to the economic crisis, has increased steadily in the last five years [16]. Turkish furniture industry is one of the least affected sectors from 2009 world economic crisis with the %13,4 decline [9]. In 2012 Turkey exported furniture to 209 countries. By export volume, top 5 countries have been respectively Iraq, Libya, Germany, Azerbaijan and France. By the end of 2012 the serious export increasing observed in Libya with the increase of %880 [15]. In 2012, 115 countries were made about 817 million dollars worth of furniture imports [15].

FURNITURE INDUSTRY IN İNEGÖL

İnegöl furniture sector is a sector that attracts attention with foreign trade surplus and high level of employment. İnegöl furniture industry is an important input for the furniture industry in Turkey because of its added value. İnegöl furniture industry is one of the largest industrial zones in the region [6]. When analyze the value of import and export of this county, İnegöl's furniture production volume is seen to be larger than 60 cities in Turkey [6]. Bursa-İnegöl furniture sector comes after Ankara with a level of employment [14]. 47% of the total labor force is employed in furniture industry [4]. İnegöl's share of Turkey's total furniture exports is seen that 15% [5]. The success achieved in exports shows that Bursa-İnegöl is becoming a major international furniture center [14].

In 2013, İnegöl made $ 913.022.081,75 export with 626 businesses, $ 327.678.705,66 import with 48 businesses. The foreign trade volume has increased $1.240.700.787,41 and have $ 585.343.376,09 foreign trade surplus [5].

METHODOLOGY

The aim of the research is, a) examine the current status of logistics activities; b) to reveal the applied basic logistics activities of furniture businesses operating in İnegöl and c) define the logistics based profiles of furniture businesses according to the variables that discussed in the following sections. The research model is based on research and identification. In the study, qualitative and quantitative research methods and exploratory research design was used. The study's sample consisted of 62 furniture businesses serving in Bursa-İnegöl, selected by convenience sampling method.

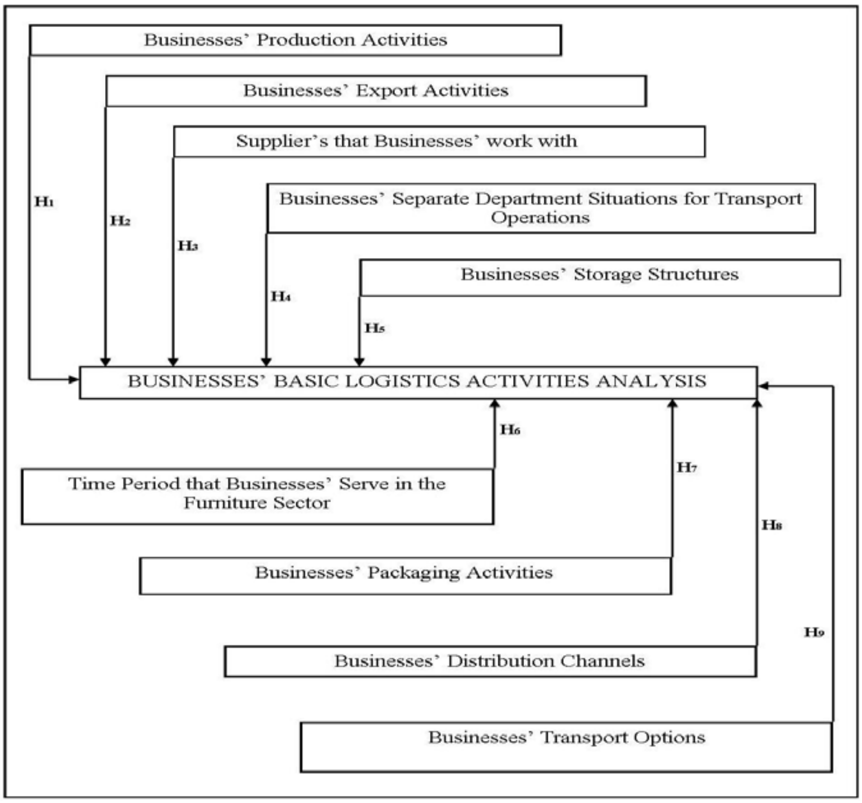

Figure 1. Research Conceptual Model

Hypotheses of Research

H1: The distribution of variables related to the basic logistics activities of businesses, vary according to production activities.

H2: The distribution of variables related to the basic logistics activities of businesses, vary according to export activities.

H3: There is a significant difference between the numbers of suppliers that businesses' work with and the average rating of the variable distribution of the basic logistics activities.

H4: The distribution of variables related to the basic logistics activities of businesses, vary according to whether they have separate department for transport operations.

H5: The distribution of variables related to the basic logistics activities of businesses, vary according to the storage structure.

H6: There is a significant difference between the time period that businesses serve in the furniture sector and the average rating of the variable distribution of the basic logistics activities.

H7: The distribution of variables related to the basic logistics activities of businesses; vary according to whether use the special packing material.

H8: There is a significant difference between the distribution channels of business and the average rating of the variable distribution of the basic logistics activities.

H9: There is a significant difference between the transport options used by the businesses and the average rating of the variable distribution of the basic logistics activities.

FINDINGS

In the reliability test, performed to determine the reliability and validity of the datum, Cronbach's Alpha value was measured as 0.682.

Table 1. Analysis on the Business Profile

	Frequency	Percent		Frequency	Percent
Active Times in Sector			**Titles**		
0-9 Years	24	39,3	Owner	37	63,8
10-19 Years	18	29,5	Marketing Manager	5	8,6
20-29 Years	10	16,4	General Manager	4	6,9
More than 30 Years	9	14,8	Accountant	3	5,2
Total	61	100	Transport Manager	3	5,2
Production Activities			Business Manager	3	5,2
Available	59	95,2	Foreign Trade Specialist	2	3,4
Absent	3	4,8	Sales Manager	1	1,7
Total	62	100	**Total**	58	100

Table 2. Analysis to Identify Logistics Activities of Businesses'

	Frequency	Percent		Frequency	Percent
Transport Department			**Export**		
Available	16	26,2	Available	52	83,9
Absent	45	73,8	Absent	10	16,1
Total	61	100	**Total**	62	100

Storage Activities			**Import**		
Absent	15	24,2	Available	8	12,9
Storages of Company	38	61,3	Absent	54	87,1
Storages for Rent	4	6,5	**Total**	62	100
Both Company and Rent	5	8,1	**Suppliers**		
Total	62	100	1 to 5	14	22,6
Packaging			6 to 10	21	33,9
Available	59	95,2	11 to 15	9	14,5
Absent	3	4,8	16 to 20	6	9,7
Total	62	100	More than 21	12	19,4
			Total	62	100
Distribution Channels					
Production- Sale				32	51,6
Production-Storage- Sale				15	24,2
Production/Purchase- Storage-Sale				6	9,7
Production- Sale/ Purchase- Storage- Sale				3	4,8
Purchase- Storage- Sale				3	4,8
Production-Storage- Sale/ Purchase- Sale				2	3,2
Purchase- Sale				1	1,6
Total				62	100
Transport Options					
Transport Company				26	41,9
Transport Company-Logistics Company				11	17,7
Transport Company- Business' Own Assets				10	16,1
Transport Company- Logistics Company- Business' Own Assets				6	9,7
Business' Own Assets				4	6,5
Transport Company- Business' Own Assets- Cargo Company				3	4,8
Transport Company- Cargo Company- Other				1	1,6
Cargo Company				1	1,6
Total				62	100

Table 3. Factor Analysis

	Variance%	**Average**	**1**	**2**	**3**	**4**
Effect of Transport Operations in Logistics Process						
Product damages during transportation process	7,670	3,6429	,749			
Delays during transportation process and before	6,608	3,1250	,736			
Loss of customers due to transportation problems	5,719	2,9107	,681			
Delays in customs	2,568	2,0893	,661			
Negative impacts of business' workers illiteracy on logistics process	3,198	2,8750	,553			
Evaluation of Basic Logistics Activities						
Performing of marketing activities as smoothly	14,123	4,2857		,894		
Performing of purchasing activities as smoothly	18,341	4,5357		,835		
The negative effect of urban transport entry-exit time applications	,905	2,1250		-,675		
Performing of transportation activities as	11,824	4,2857		,525		

smoothly						
Status of the Difficulties Encountered during Transport Operations						
Stowage faults while the vehicle loading process	1,948	2,7321			,830	
Cost increasing because of regulations about tonnage limits	1,413	3,9464			,634	
Thought that transport companies work with high profit margins	4,759	3,3929			,579	
Performing of storage activities	10,549	4,3036			-,517	
Having sensitive products that is vulnerable to damage while transportation	1,799	4,4464			,495	
Evaluation of Transportation Companies						
Negative impacts of logistics company's workers illiteracy on logistics process	3,665	3,4286				,819
Adequacy of transport company that work with	3,822	3,7321				-,510
Disassembled vehicle loading	1,089	4,1429				,470
Total	**69,115**					

According to factor analysis results, conducted to measure the participation degree of basic logistics activities of surveyed furniture companies, variables were collected in four factor groups. The variance explained by that 4 factor groups is % 69,115.

Hypotheses Results

H1: The distribution of variables related to the basic logistics activities of businesses, vary according to production activities.

Table 4. H1 Test Result

Variables Related to the Basic Logistics Activities	**Levene Test**	**P Value (sig 2 tailed)**
Having sensitive products that is vulnerable to damage while transportation	,048	,000

According to H1 results; businesses that do not make production within business, have been found to contain a higher ratio in a variable; having sensitive products that is vulnerable to damage while transportation. But also it was observed that the majority of interviewed enterprises (% 95) make production within business.

H2: The distribution of variables related to the basic logistics activities of businesses, vary according to export activities.

Table 5. H2 Test Result

Variables Related to the Basic Logistics Activities	Levene Test	P Value (sig 2 tailed)
Product damages during transportation process	,039	,006
Delays during transportation process and before	,031	,049
Cost increasing because of regulations about tonnage limits	,000	,002

According to H2 results; businesses that do not have export activities, have been found to contain a higher ratio in three variables; product damages during transportation process, delays during transportation process and before and cost increasing because of regulations about tonnage limits. According to group statistics results, businesses that do not have export activities were more affected from these five variables. But also it was observed that the majority of interviewed enterprises (% 84) have export activities constantly.

H3: There is a significant difference between the numbers of suppliers that businesses' work with and the average rating of the variable distribution of the basic logistics activities.

Table 6. H3 Test Result

Variables Related to the Basic Logistics Activities	Levene Test	P Value
Performing of storage activities as smoothly	,501	,012

According to H3 results; it was observed that there is a significant difference between the numbers of suppliers that businesses' work with and the average rating of the variable distribution of the basic logistics activities. When analyzed Sheffe test results, it is encountered that success of storage activities are completely different for the businesses which work with 6-10 suppliers and 16-20 suppliers. In same way it is also completely different for the businesses that work with 16-20 suppliers and more than 20 suppliers. Especially difference between working with 6-10, 16-20 and more than 20 suppliers is one of the remarkable results of this study.

H4: The distribution of variables related to the basic logistics activities of businesses, vary according to whether they have separate department for transport operations.

The main hypothesis is rejected.

H5: The distribution of variables related to the basic logistics activities of businesses, vary according to the storage structure.

Table 8. H5 Test Result

Variables Related to the Basic Logistics Activities	Levene Test	P Value (sig 2 tailed)
Performing of storage activities as smoothly	,001	,017
Loss of customers due to transportation problems	,003	,039
Delays in customs	,000	,006
The negative effect of urban transport entry-exit time applications	,000	,001

According to H5 results; businesses make storage activity have been found to contain a higher ratio in four variables; performing of storage activities as smoothly, loss of customers due to transportation problems, delays in customs and the negative effect of urban transport entry-exit time applications. It was observed that the majority of interviewed enterprises (%75) make storage activities within the business. Especially one finding of this test “loss of customers due to transportation problems” variable is higher in businesses that do not make storage than the businesses that make storage is one of the remarkable results of this study.

H6: There is a significant difference between the time period that businesses serve in the furniture sector and the average rating of the variable distribution of the basic logistics activities.

Table 9. H6 Test Result

Variables Related to the Basic Logistics Activities	**Levene Test**	**P Value**
Negative impacts of logistics company’s workers illiteracy on logistics process	,216	,032
Stowage faults while the vehicle loading process	,753	,045

According to H6 results; it was observed that there is a significant difference between the time period that businesses serve in the furniture sector and the average rating of the variable distribution of the basic logistics activities. Main hypothesis was supported for two variables; negative impacts of logistics company’s workers illiteracy on logistics process and stowage faults while the vehicle loading process.
H7: The distribution of variables related to the basic logistics activities of businesses; vary according to whether use the special packing material.

Table 10. H7 Test Result

Variables Related to the Basic Logistics Activities	**Levene Test**	**P Value (sig 2 tailed)**
Performing of purchasing activities as smoothly	,009	,000
Product damages during transportation process	,031	,000
Cost increasing because of regulations about tonnage limits	,023	,000
Disassembled vehicle loading	,049	,000
The negative effect of urban transport entry-exit time applications	,008	,000

According to H7 results; businesses that do not use special packing material have been found to contain a higher ratio in three variables; performing of purchasing activities as smoothly, cost increasing because of regulations about tonnage limits and disassembled vehicle loading. Also businesses that use special packing material have been found to contain a higher ratio in two variables; product damages during transportation process and the negative effect of urban transport entry-exit time applications. But as an important point, even if businesses do not use special packing material has not any problem with damages during transportation process, all interviewed businesses that not use special packing material are making disassembled vehicle loading like IKEA furniture model and they all are raw material suppliers. So that finding cannot represent importance of using special packing material for finished furniture product.

H8: There is a significant difference between the distribution channels of business and the average rating of the variable distribution of the basic logistics activities.

Table 11. H8 Test Result

Variables Related to the Basic Logistics Activities	**Levene Test**	**P Value**
Stowage faults while the vehicle loading process	,002	,031
The negative effect of urban transport entry-exit time applications	,000	,002

According to H8 results; it was observed that there is a significant difference between the distribution channels of business and the average rating of the variable distribution of the basic logistics activities. Main hypothesis was supported for two variables; stowage faults while the vehicle loading process and the negative effect of urban transport entry-exit time applications.

H9: There is a significant difference between the transport options used by the businesses and the average rating of the variable distribution of the basic logistics activities.

The main hypothesis is rejected.

CONCLUSION

In the 21st century while science and technology rapidly developing, import and export activities also increasing and developing around the world. When analyzed Turkey's furniture market that does not have foreign trade deficit at last 10 years it is encountered that institutional furniture businesses serving completely domestically and internationally has made significant progress. In this study, it is aimed to measure one of the Turkey's most well-known furniture production center Inegöl's logistics activities performances.

When analyzing the results of factor analysis, four variables with the highest load value are respectively; product damages during transportation process, performing of marketing activities as smoothly, stowage faults while the vehicle loading process and negative impacts of logistics company's workers illiteracy on logistics process.

Results of analysis show that; departmentalization system was not implemented correctly in İnegöl's furniture industry. They mainly dependent to road transport which costs a lot. The lack of professional transport companies and the excess of staff related problems, both transport companies and business' own staff, is another finding which is significant for the sake of logistics activities. High storage costs and unawareness of companies that do not make storage on their own can be used as an advantage with choosing the correct strategy like milk run systems. Additionally, pay string attention to export products, the lack of packaging problems except IKEA type disassembled furniture and loyalty of "production and sale" strategy as a distribution channel can be regarded as bright sides of findings.

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USAGE OF RADIO FREQUENCY IDENTIFICATION (RFID) TECHNOLOGY IN CONTAINER TERMİNALS AND TRANSPORTATION

Serdar ALNIPAK[1], Güler BİLEN ALKAN[2], Faruk ALKAN[3]

ABSTRACT

There is an ongoing change and development in information technologies. This change has impacts on container transportation and terminals as in every sector. The ports working hard to keep the competitive advantage and provide quality services for their customers; utilize these technologies in order to increase their operational efficiency and load and port safety. One of the most important technologies is Radio Frequency Identification (RFID) technology. RFID systems use the radio frequencies and define the lively beings or objects, stable or moving, as singular or plural. RFID is a technology that gathers accurate and automated information in terms of vehicle, equipment and people; therefore it is of great use in port activities. This technology provides many benefits in container terminals in terms of identification, monitoring and security; but it also has disadvantages in some other aspects. Although there are various academic works on retail sector where this technology is intensely used; the studies on its utilization in container transportation and terminals are limited. This study describes RFID technology with its general characteristics, explaining its utilization in container terminals with its advantages and disadvantages; thereby aiming to contribute the academic literature and to be a guide for the ports.

Keywords – RFID Technology, Container Terminals, Container Transportation

AUTOMATIC RECOGNITION SYSTEMS AND RADIO FREQUENCY IDENTIFICATION (RFID) TECHNOLOGY

Automatic Recognition Systems are the systems that collect the identity information of an object or a person in general. These technologies automatically recognize the information; thereby reduce the time and labor costs, minimize the mistakes and increase the information reliability. Recognition systems are generally gathered in 5 groups. These are: Optical Character Recognition Systems (OCR), Biometric identity recognition systems, Smart Card System, Barcode Systems and RFID [1]. Radio Frequency Identification (RFID) technologies use the radio frequencies and define the lively beings or objects, either stable or moving, as singular or plural [2]. A RFID based Auto-ID (Automatic recognition/ Data Collection- AR/DC) systems consists of: a unique recognition number

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allocated for a specific product, an identity tag added into the product by a chip which can store the unique recognition number, RFID readers with network which can gather high speed signals from various labels and preprocess such data, and one or more networked database that store the data processing systems and product information [3]. RFID systems consist of *tag*, *reader*, *computer* and *system software*s. The data transfer between the tag and reader which is realized via antenna is named as "coupling". The concept of Radio Frequency is used for the frequency of disseminated electro-magnetic waves. The frequency of RF signals may change between 125 KHz (125 thousand loops per second) and 5,8 GHz (5,8 billion loops per second). Almost all RFID systems operate in one of the four frequency bands below: Low Frequency, High Frequency, Ultra High Frequency and Microwave [6]. The frequencies of the tags widely used today are generally in HF (High Frequency) range and each country arranges the utilization of its own radio spectrum. [7]. One of the most important determinants of RFID system characteristics is the tag type. RFID tag is a portable module with a limited capacity of memory. RFID tags can be embedded or attached on all types of products. RFID tag consists of a silicon chip (microprocessor chip) that allows to receive and answer the queries made by radio frequency, an antenna and coating [8]. *Antenna* is the part that transmits and receives the radio waves for communication. There is a reading interval on the sides and front of a RFID antenna. The design and placement of antenna plays an important role for the determination of coverage area, coverage speed and accuracy of tag's communication. Because antenna receives energy from the signal of reader to provide energy for tag and sends the data received from the reader [9]. RFID tags can be classified differently according to their power sources and data writing-storage characteristics. RFID tags can be assessed in 2 different types according to their power sources: passive and active. A passive tag does not contain battery; it utilizes the energy generated by the electro-magnetic wave on the antenna in order to power up the chip and to transfer data back to reader. Passive tags reflect the energy from reader or they take the energy to generate the tag impact on reader and store that temporarily. Even though their communication distances are low, they do not require maintenance and they are simple and cheap, that is why they are preferred [10]. Active tag has its own source of power to activate the chip and to transfer the data to the reader. An active tag provides the receipt of very low level signals and it can generate high level signals to transmit back to reader. Active tags remain in sleeping mode until it receives a wakening signal from the receiver. As the tag receives the wakening signal it passes into data collector mode. After the data processing is done, tag reverts back to signal mode [11]. With the help of internal battery the active tag can transmit the data without the need for a reader to energize them. Therefore, the reading intervals are longer than those of passive tags. On the other hand, their utility periods are limited as they operate with battery [12]. There are active tags which can send signals to 1 km. distance. Active tags used in railways and maritime industry transportation operate in compliance with GPS and satellite communication systems; thereby allowing the product on which they are mounted to be monitored on earth. As they contain battery, they need maintenance and their costs are higher than other tag types [10]. RFID tags can also be categorized according to the information they store. These are; Read Only, Read Write and WORM tags. Read Only (RO) tag has a serial number which is written in its memory and programmed before. This serial number is placed during the production. User cannot change this serial number or cannot write new data on the tag. With a Read Write (RW) tag, new information can be written on a tag or you can write on the existing information. Writing information on tag is only possible when the tag is within the query area of a reader. Write Once Read Many (WORM) tag is between a RO tag and RW tag. As it can be understood from its name, you can write once on the tag and read it as many times as you want [12]. *RFID Readers;* sends the coded digital information to the tag as radio wave format via its antenna and receives the signal returned back from the activated tag. It can read the data inside the tag, write data on the tag and support one or more frequency intervals [6]. Depending on application, a reader can be designed in various forms. These are explained below: *External or internal antenna reader, Flexible Reader, Multiple-frequency reader, Mobile reader and Portable reader* [13]. Even though the manufacturers continue to study on the possibility of creating a universal reader able to read all types of tags; in the existing condition, each label type can be read with a special hardware. In order to read a HF tag, a HF reader is needed; and a different reader is needed to read a UHF tag [14]. *RFID Computer and System Software*; is evaluated as a function string that is located between pure RFID technology components and work applications that can use the value of technology by some software producers and EPC global. These functions can be summarized as follows*: Filtering, Route Determination, Data Management, Device Management, Device Adapters and Application Adapters*.

UTILIZATION OF RFID TECHNOLOGY IN CONTAINER TERMINALS

Ports constitute an important part of logistic chain today. Container transportation constitutes an important part of the ship transportation which is efficient in long distance transportations. Within this context, the items transported as open cargo were carried by container; then the container ports have developed and many ports have changed the formation and became container ports. Existing container ports have increased their capacities due to increase in demands and have been making investments on hardware, technology and system in order to utilize the maximum capacity more efficiently. The Information and Communication Technologies (ICT) becomes more important in container ports as in all sectors due to the current requirements [15]. In order to increase its reliability and competitive power in a competitive environment; a container terminal must focus on the productivity of terminal operations; and analyze the impacts of new technologies, automatic equipment and information technologies [16].According to [17], majority of operational and administrative works done in ports are either manual or paper-based; or they rely on systems which cannot establish efficient communication with other systems. This creates the intensity of unnecessary information and causes lack of connections that prevents productivity and generates problems. This is a reality that forces all countries in the world for investment; and there are severe problems experienced in our country on this matter. According to [18], there is an immediate need for investments on electronic information systems in Turkish ports. New technologies are being adapted to the ports for productivity, efficiency and security; and RFID technology is preferred more by terminal operators. At this point, RFID is considered as a mandatory technology in the ports of future [8].

Container Terminals and Container Transportation

A container terminal is the place where containers are loaded and unloaded via trucks and vessels. Generally, a container terminal consists of three different areas. These are: *Bulk (Piling) Area*; is the area where containers wait for the direction to go. This are consists of different bulk cell series positioned on different roads and there are gaps within it in order to ease the transportation within the terminal. *Loading/ Unloading Area*; is the temporary storage area used for the loading and unloading of vessels. *Terminal Entrance/ Exit Doors; t*hese are the doors where external vehicles enter and exit the terminal [19]. Also, we can add railways to these areas, although it is not a general characteristic of all the ports [20].

Utilization of Information Technologies (IT) in Container Terminals

Although the container traffic increases rapidly, the infrastructure that manages the containers (equipment, procedures etc.) cannot be modernized with the same progress. This causes the administrative problems stated below;

- Excessive waiting time while mooring the ship,
- Insufficient terminal productivity,
- Traffic congestion at terminal gates,
- Excessive loss of time at control procedures,
- Less information share among the stakeholders,
- Coordination problems [21].

According to the academic survey conducted by [22] on the actors of maritime sector; the electronic data interchange (EDI) developments, monitoring and tracking systems and supply chain integration systems are the global tendencies which are priorities for the maritime sector. According to [19], implementation of RFID tags in container transportation system can be divided into 4 phases as indicated in Figure 1, depending on the different utilization levels of RFID tags.

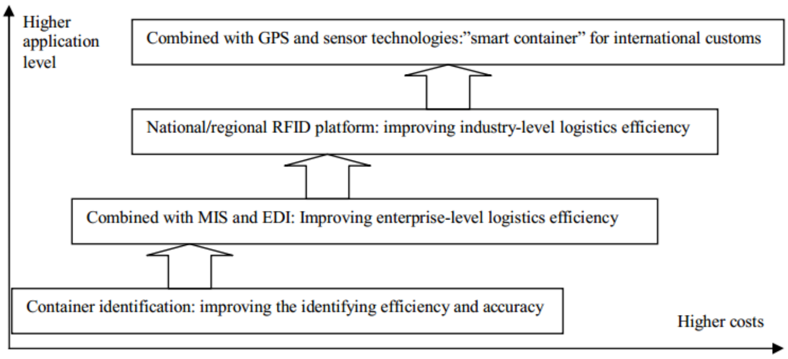

Figure 1: RFID Implementation Phases in Container Transportation

Many technologies can be used in container transportation as an addition to RFID or by its own. These are GPS (Global Positioning System), satellite messaging, mobile phones, Bluetooth, UWB (Ultra-Wide Band), Wi-Fi (Wireless Fidelity), OCR (Optical Character Recognition) and ZigBee (Short Distance Wireless Network Standard) [23].

ACADEMIC LITERATURE

The academic studies on the utilization of RFID Technology in container terminals have been very slow until the last decade; but they have been growing up since then. The studies conducted on this subject are summarized in the Table 1 below [1].

Table 1: Literature Summary of the Utilization of RFID Technology in Container Terminals

Authors	Subject
Balog et. al. (2005)	Container Monitoring and Safety
Tsilingiris et.al.(2006)	Container Safety
Kalaycı (2007)	Maritime Documentation Software with RFID
Mullen (2005)	General Evaluation and Benefits
Englert et. al. (2008)	Utilization of RFID in Long Beach and Los Angeles Ports
Tsilingiris et.al. (2007)	General Evaluation and Benefits
Park (2006)	RFID Based RTLS
Chen (2005)	Container Monitoring and Port Safety
Dempsey (2011)	Carrier Vehicle Tracking

Hu et.al. (2011)	RFID Based Gate Control
Bocca et.al. (2005)	Container Safety
Narsoo et.al. (2009)	SWOT Analysis for the Utilization of RFID in Port Louis
Chin and Wu (2004)	RFID Based E-Stamp
Chang (2008)	General Evaluation and Benefits
Kim et.al. (2006)	RFID Based Container storage management
Cho et.al. (2006)	RFID based system design to be implemented in the Port
Barro Torres et.al. (2010)	RFID Based terminal field management
Choi et.al.(2007)	RFID based gate passage system
Reiter et.al. (2008)	Utilization of RFID based E-Stamps at customs
Rizzo et.al. (2006)	Container Safety
Choi et.al. (2006)	Terminal gate entrance systems
Miragliotta et.al. (2007)	Benefits of RFID utilization at terminal gate entrances and field management
Wang et.al. (2006)	RFID utilization at Shanghai port
Yunming et.al. (2007)	RFID based container tracking
Kim et.al. (2004)	General Evaluation and Benefits
Kim et.al. (2008)	RFID based container tracking
Gehrke et.al. (2008)	RFID and GPS based smart container design
Park et.al. (2006)	RFID based terminal system
Ting et.al. (2012)	RFID based vehicle tracking
Dempsey (2011)	General Evaluation and Benefits
Shi et.al. (2011)	Actors in container transportation and RFID Technology
Louis (2007)	Container Monitoring and Safety
Anupama et.al. (2011)	Comparison of OCR, RFID and GPS technologies in terms of utilization in terminal

UTILIZATION AREAS OF RFID TECHNOLOGY IN CONTAINER TERMINALS

In today's world, as the importance of efficient supply chain management is understood, the performance of ports and container terminals is of great importance. This forces one of the most vital parts of the chain, container terminals to increase their efficiency by using information technologies. For this purpose, ports have been investing in RFID technology along with various technologies. RFID technology helps to recognize the objects and living creatures with the help of radio frequency and it is beneficial for the complete activities of the port as it is a technology that can gather automatic and accurate data. As it is clear, the control and monitoring of thousands of containers and equipment entering and leaving the port is very hard without the technological support and vulnerable to mistakes. RFID technology had been applied since the middle of 1980s in transportation and manufacturing sectors; and as its benefits will be seen more and costs decrease, it will be used more widespread. Leading ports such as Singapore, Rotterdam, Busan and Los Angeles generate projects where they use RFID technology and adapt the technology rapidly [24]. RFID technology gives an advantage to port operators as it does not necessitate any obligation of being in the sight with its long reading distance and ability to read multiple tags at once. Also; it is preferred because of its sufficient data capacity, dynamic data writability, ability to use with mobile objects, its enduring structure against harsh climate conditions and fast/correct reading rates [20]. The equipment listed below is needed for establishment of RFID system in terminals [25]; *RFID Tags* can be added as active and passive for each object and person within the terminal processes. Each tag has its unique code. All the information is related with this unique code. Active tags generally have 433 MHz frequency. Passive tags have 900 MHz frequency. Passive tags are generally used for transportation purposes; whereas active tags are preferred more frequently for containers. It has to be stated that different frequency intervals can be used in different countries. These intervals are set by laws in each country. For instance, the legal frequency used in Europe for these processes is 868 MHz, whereas it is 915 MHz in USA. The problems originating from this standardization difference are not yet solved [26]. If they will operate on containers as connected to E-seal, they can be installed on door handle; if it is to be used for vehicle then they can be installed on the right or left upper corner of front shield, and if it will be used without any connection with seal, then it can be installed on any part of container (internal and external included). The active tags placed on container are produced in accordance with ISO 17363 and they can make multiple writings. They can be added in the container by the shipper, agency or port, depending on the agreement. It needs to be replaced in time as it has batteries. It has a battery life for an average of 20 reading in 60 days period. It enters into sleep mode in certain intervals in order to keep the battery life longer. Passive tags used for container with low data capacity only carry the container identity information and maximum weight information and they are produced according to ISO 10374.2 standards. The data inside them cannot be changed. These tags are operated in 860-960 MHz frequencies. Depending on the data capacities and the specific objects they will be placed on; tags may contain information such as the container number, location information of container, weight of container, type of load, information on hazardous material, seal control information, damage assessment information, assessment results for empty container, carrier vehicle information, carrier vehicle driver information, carrier vehicle location information, container handling equipment (crane, internal truck, wagon, forklift etc.) [20]. *Portable PC with RFID Reader* is required for reading, locking and entering data to the tags in the field. *Desktop RFID Reader* is used for data entry and reading to tags in office. *Readers at Checkpoints* are placed at gates, terminal field and storages for reading the information on tagged objects. It is separated into two as active and passive. UHF (Ultra High Frequency) and MF (Microwave Frequency) readers are the most frequently used ones [27]. Utilization of RFID at container terminals is basically done through 3 objects. These are:

- Containers,
- Equipment and Vehicles (External and/or Internal) Used for Loading-Unloading and Transportation
- The people employed within this process.

By placing the passive and/or active tags on these objects; 2 interconnected goals are aimed. These are; *Identification* and *Monitoring and Safety*. According to [21] the 3 fundamental goals of container tracking are to implement; *Container ID determination*, *Seal control* and *Damage Control without any faults and in a fast way*. Container ID determination is the reading of figures on the container without any mistakes. In addition with this compulsory information, there are various identification marks on the container [28]. The number of each container to be identified will be controlled by hand terminals or prepared discharge lists depending on the system terminal used. If the container number does not match the number on the system, container agency will be notified about this and the container will not be discharged without the approval of agency. Container type is directly related with the port tariff, so it has to be identified accurately. Any extra invoicing due to different identification causes disatisfaction of customers [15]. In general, container identification control is made by employees visually. Sometimes employees implement video control. Human intervention is indispensable. Besides these applications, OCR systems with a tendency of fault are also used for container identification. Today, the identity information inside the active or passive tags added to the container with the help of readers established inside or outside the port can be read completely and accurately; and the information read, such as the container's identity or location can be automatically transferred into the system through a wireless LAN (Local Area Network). Depending on the type of tag to be placed into the container (active, GPS, sensor, satellite communication etc.); the information such as the location and content of container, sender, receiver, destination port etc. can be monitored and reported [1]. Tagging the cranes, tractors and other equipment with RFID is becoming widespread in fleet and terminal field management operations. With the help of readers placed in terminals, gates and other entrances; it is possible to determine the exact entry and leave times of specific trucks or containers. Recording the locations of vehicles and equipment by RFID readers enhances the quality of data and the efficiency of all operations increase. The ability to observe on screen in emergencies can decrease the reaction time. In addition to these, with the help of matching the tagged objects with one another; the right person-right vehicle matching and/or right container for right vehicle is provided, thereby the security of supply chain increases. Figure 2 indicates the screen interface showing the locations of tagged containers to the port operators. Figure 2.36 contains the screen interface showing the locations of carrier vehicles and equipment [29].

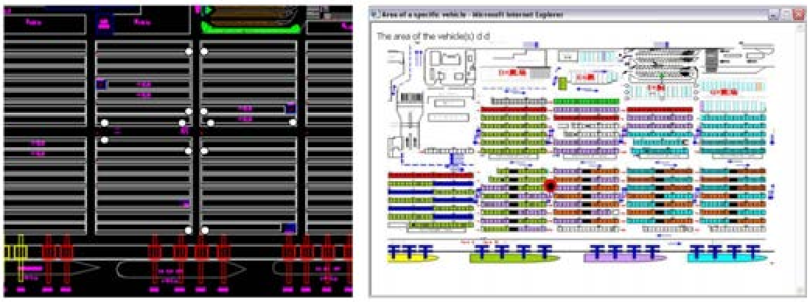

Figure 2: Screen Interface For Terminal Field

Also, it is very important to only keep the authorized personnel at specified areas in order to provide the security of terminals. The utilization of smart RFID identity cards for the personnel might be used as a tool to provide security. With contact-free smart cards; in addition with entry information (shift, definition of job, permitted vehicles etc.); biometric information such as photographs can also be retained. With the help of photograph information inside the card, any attempts of fraud are reduced at security points. In secluded entrance points, closed circuit televisions (CCTV) match the personnel and the existing employee on the card, thereby control is possible. The picture can be obtained from the data on the card and transferred to the security station; or the related picture can be reached from the database with the unique serial number [30].

Container Safety and Utilization of RFID Technology for Container Safety

Millions of containers are roaming in the world every year with approximately 250 million containers on move in 220 ports. Only 2 % of this is subjected to security controls, and this rate cannot be reached for empty containers. Any terrorist activities towards a commercial activity with this volume might interrupt all of the ports. In addition to threat of terror, theft and smuggling are also major threats towards commerce. In this sense, the importance of security needs for air and sea ports is a common concern for all the states of world [31]. Especially the containers via sea may be subject to illegal activities stated below;

- Nuclear weapons, radioactive substances and conventional weapon smuggling,
- Drug smuggling,
- Human smuggling,
- Contamination of containers with nuclear, radioactive, chemical and biological substances,
- Container theft (piracy),
- Theft towards the contents of container,
- Damaging the containers wit hazardous material (detonationr or leakage) etc. [32]

Significant attempts and arrangements are implemented in recent years in order to increase the container carrying security. The efforts to develop the utilization of seal is at the top. As it is known, seal is an equipment which is installed on a single or each door of container, preventing entry. The seal also has a structure indicating that it was not changed or replaced, and it has its own identity. The breaking or replacement of these seals are provided with eye controls. There are various seal types, but generally they are separated into 2. First of them is the mechanical seal. Mechanical seals are conventional apparatus with different thickness levels and they are used for various material such as plastic and steel. The identity of these seals are processed on them with a special identity number and it is visually detectable [33]. Even if the traditional seals show any type of tampering, manual inspection is still necessary and there will be a loss of time until such inspection is done (Mullen, 2005). The change in the physical structure of these seals (broken, ruptured etc.) and the existence of a different ID number than the one indicated on documents (even if the seal is solid) means that there was an unauthorized entry into container [34]. It is very hard to determine the time and place of illegal attempt and the person. The reason of frequent use of mechanical seals is because it is cheap and disposable [35]. Other one is the smart seals. This seal group is more comprehensive and they provide smart form characteristics to the user when compared with mechanical seals. These seals provide information about their statuses and ease the inspections. Seals fulfill this function with the different technologies contained (pressure sensor, thermal decomposition, electronic signature, hologram, RFID etc.). The basic application of RFID technology for providing the security of load is the "E-Seals" [36]. The most frequently used one among the technologies stated above are the ones with RFID tags. E-seals with RFID may be active or passive. The most frequently used one among the technologies stated above are the ones with RFID tags. E-seals with RFID may be active or passive tags have specific ID numbers and they cannot be imitated or changed. Passive tags can be read from a distance of 2-3 meters; whereas active tags can be read from 100 meters. The simplest type only has ID seal number. The mostly used tag type in these is passive. Those in a more complex structure consist of active tags which spread the call in an emergency case [33]. Smart seals give out signals when they are opened or when there is unauthorized access. When the container arrives at destination, the authorized personnel will scan the information on RFID tag via the reader and determines the load. These tags can transmit the status information via GPS to the port and customs authorities before arrival [37]. Classical e-seals have the structure to provide proof only in cases of unauthorized entrances. The type which effectively provides security are the ones with continuous recording and observation of locations at a specific geographical spot [36]. The companies using e-sealed smart containers have an advantage named as "Green Lane". This advantage allows the containers to pass through customs without any controls. With this application, the time at customs is reduced and all logistic processes are executed in high level security. By this, logistic costs are reduced, inventory storage costs decrease and customer service quality is increased. E-seals with RFID are not only used for security, but also for monitoring and positioning. Depending on the data capacity of used tag, it may contain information on container (container number, load type etc.) [33]. These seals can also be equipped with sensors to control the environmental conditions [36]. Sensors are suitable to be used by RFID technology and the parameters they measure can be classified as moisture, light, heat, air pressure, vibration, noise, chemicals, location, movement, acceleration etc. In addition to all these, placement of these sensors on each one of the containers might cause troubles in application due to costs. However, this technology can be applied on a specific number of containers depending on load types and significance (advanced technology or military products) [32]. Also, if the technologies stated above are integrated with gamma ray display, radiation scanning and optical character recognition technologies; performance increase will be indispensable. The data gathered via these technologies will also provide extra benefits for port management in terms of managing the port operations. The planning within the port will become easier with the information provided; and containers with specific characteristics can easily be determined as the elements within the field (tractor, forklift, train, personnel etc.) will be rapidly and efficiently coordinated. Also, the information on RFID tag (type of load, amount of load, destination port, date of loading etc.) will be compared with ship manifest; operational mistakes will be minimized, paper waste will be prevented, personnel will be utilized efficiently and port production will be increased [38].

Container Terminal Gate Entrances-Exits and Utilization of RFID Technology

Container terminal gate is the location where import containers arriving via ship or open loads without containers exit the port; or where export containers or open loads with ships are exported and enter the port. While conducting door management at container terminals; traffic congestion occurs due to container identification, truck identification and the lack in information technology, manpower is wasted and the productivity of terminal fields decrease. The gate and intra-port traffic due to export and import container carrying vehicles has a negative impact on the field and ship operation processes of the port. Various gate and intra-port traffic arrangements can be developed in accordance with the movement of external vehicles [15]. For this purpose, various studies were conducted on the usability of RFID technology at container terminal gates and projects were implemented. The RFID based gate systems have the competency to automatically recognize the vehicles, drivers and containers with the tags via the readers placed [16]. Gate operations in its traditional sense cover the physical controls, and the entering and approving of information into the system. The officials at terminal gates are obliged to efficiently implement the physical controls and checks on documents and information depending on the type of vehicles and containers. Besides, controls are being made for the driver of vehicle at the gate. Gate operations can be examined under two parts as entry and exit. All types of export items entering into port area, whether in container or not, should be controlled at the gate entrance and they must contain the information valid in the existing operating system of the port [15]. In traditional gate systems, the transactions such as identification by truck and container number, determination of container damage, determination of container's position on the container field and control of container seal are implemented by gate officials manually. Related transactions are expected to be implemented via RFID based system in a more productive, fast and perfect way. Accordingly, system will be created by the readers to be placed at gate entrances and tags to be installed at the vehicles arriving to the port and the containers they carry [39].

ADVANTAGES OF UTILIZING RFID TECHNOLOGY IN CONTAINER TRANSPORTATION

The utilization of RFID technology in container terminals is still at the beginning phase. It will definitely increase the performance of all supply chain once it is efficiently, commonly used with proper costs at a global level. Its operation at terminal level brings many benefits together. Although its benefits change depending on the utilization of tags and readers on specific objects and positions; the benefits listed in Table 2 will be provided with its local or global level of usage;

Table 2: Advantages of Utilizing RFID Technology in Container Transportation [1]

• Provision of efficient data flow between the departments depending on its integration with other systems used at terminal, • Decrease of paper waste depending on automatization, • Efficient management of all processes depending on obtaining the location information, monitoring the terminal activities and all the people, vehicles and loads inside the activity (instantly determining the activity planning, source allocation, field management, pier management, and instant problems and changes, giving accurate responses etc.) • Increase of port and load security depending on obtaining the location information, monitoring the terminal activities and all the people, vehicles and loads inside the activity, • Advantage of efficient planning for future with the quality and accurate data provided, • Decrease of waiting times due to efficient use at gate operations, minimizing the human faults and increase in port security,	• Decrease of the time external vehicles remain in port and decrease of vehicle traffic, • Optimum utilization of port areas, • Increase of port and load security depending on the decrease in illegal attempts such as loss, theft and forgery, • Securing the integrity of containers arriving at terminal, • Decrease in container control and customs durations, • Decrease in employee costs, • Decrease in fault handling, fault delivery and loss of containers, • Increase of container production depending on the decrease in transaction periods (gate, field, loading etc.) and faults, • Efficient container storage management, • Optimum utilization of terminal sources (workforce, equipment etc.), • Increase of optimum productivity, • Increase in competitiveness depending on faster and quality services

POSSIBLE PROBLEMS OF UTILIZING RFID TECHNOLOGY IN CONTAINER TRANSPORTATION

Most of the implementations mentioned in this study necessitate cooperation between ship owners, shippers, carriers, terminal operators etc. and therefore they are mostly future-oriented. However, the R&D investments made by USA on this issue and legal arrangements show us that the utilization of related technology will be worldwide in a near future. There are still severe problems about the utilization of RFID technology [30]. These are*; inhibition of actors in container transportation*, *lack of standardization*, *uncertainties on the investment return*, *missing points in legal arrangements*, *variability of actors in container industry*, *high costs* and *integration deficiencies in knowledge share* ([21], [38]). According to [23], the major barriers for RFID applications are; cost, concerns on data security, possible ineffectiveness, possibility of interference of radio waves, lack of clarified standards via protocols among manufacturers, lack of organizational support and uncertainty of return on investment. Also, according to [29], as this technology can easily be utilized indoor such as storage areas, some problems in terms of communication with radio waves are experienced during their outdoor utilization. The main reasons of these problems are; weather changes, intense metallic environment, installing the hardware at wrong locations due to inaccurate determination of vehicle routes and equipment installation problems depending on the geography of port. According to [19], the problems listed below are present for the application of possible technology. These are:

- The fitting and installation of container RFID tags (the appropriate tag type, undertaker of application, the standards where the reader will be used and unpredictability of costs),
- Selecting the most accurate application mode (container carriage system consists of a large and open cycle; therefore container flow includes incidental variables),
- Problems to determine the RFID software interface and the common standards to be implemented.

CONCLUSION

RFID technology can be implemented in various processes of container transportation and specifically in terminals. Terminals spend a significant amount of their budget for the purchase of this technology. In this context, terminal managers have to consider various criteria and alternatives while determining the area where the related technology will be applied at. Although there are several studies conducted about RFID technology in retail, logistics and health sectors; the studies conducted on the application of RFID in container terminals are not sufficient for Turkey and for the world. This study examined the utilization of RFID technology in container terminals, its advantages and disadvantages. Various leading port operators have started to utilize the RFID technology. In this context; the studies to be conducted on this technology are important for various port operators due to high market potential of RFID. RFID technology is also implemented in container terminals within Turkey and it is appropriate to use on container, the external vehicles entering or leaving the port and port equipment and personnel. The managers of ports have to find out the suitable combinations and solve some possible problems by working together with other actors within the sector, taking steps to integrate their ports in the supply chains. They should also utilize the RFID technology with other technologies proper for utilization, thereby increase the performances of port. Depending on the increase of RFID investments in the sector, in accordance with the new information to be provided for researchers, the future research subjects will be; *(i) Standardization, (ii) The analyses of costs and benefits for the actors outside the ports who will participate in the processes, (iii) Enhancement of technical processes (frequencies, decomposition of signals, reading problems etc.), (iv) RFID applications for container transportation chains, (v) Designing a unique RFID system architecture to prevent terrorism and to establish maritime security*.

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ANALYSIS OF CONTAINER TRAFFIC HANDLED IN TURKEY ACCORDING TO TYPES OF CONTAINER

Olgay OKSAS[1]

ABSTRACT

Turkey is a country that can feel the effects of both regional and international trade directly as its geographical location. Due to the increase of international trade each passing year, the amount of cargo handled in Turkey generally shows an upward trend. The majority of the cargo in the world is carried by maritime transportation and container transportation which has an increasing share in maritime transport is more preferred to carry this increased cargo traffic. In this study, the container traffic handled in Turkey between 2005 and 2015 is examined in annual basis and demand of container type with regard to total container traffic is analyzed.

Keywords − *Container transportation, container type, maritime transportation*

INTRODUCTION

Maritime transportation has a significant role in the world trade. Container transportation which has an increasing share since the 1950s, is an important part of maritime transportation and has been one of the most important transportation type today. Standardization in cargo transport with containers provides great convenience in world trade, significantly reduces the costs and offers fast and regular liner services.

There are various types of containers which are used in container transportation but the most common used ones are 20 foot and 40 foot dry containers. 40 foot containers have double length and same width of 20 foot containers. Containers are usually belong to the shipping lines or rented by them. An important part of container transportation is to store a certain number of empty containers according to that region's demand. In order to avoid idle capacity of empty containers, positioning of containers should be analyzed and planned attentively.

In this study, container traffic in Turkey between 2005 and 2015 is examined. Total TEUs (twenty foot equivalent units), tons, container numbers and the rate of 20 and 40 foot containers in total container numbers are listed and the demand of container types is analyzed.

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CONTAINERIZED TRADE

Containerized trade started with the first container transport in 1956 by Malcolm P. McLean between Newark and Houston ports. There are many advantages of containerization such as standardization, flexibility, costs, velocity, warehousing, security and safety [1].

Containerization has led to the emergence of some other components. Most important components of container transportation are container vessels, container ports and container itself [2]. Container vessels' capacities and ports' throughput are mostly measured by the number of TEUs. TEU means twenty equivalent unit and equals to 20 foot containers. Most common used container types are 20 foot and 40 foot containers and 40 foot containers are generally represents two TEUs. In special cases, such as 45 foot container equals 2,25 TEUs.

According to [3] , China is ranked first in the world list of container port throughput with the total of 181 million TEUs where the second Singapore has 34 million TEUs in 2014. Turkey is ranked at the 15th place in the same list with the total throughput of 7,6 million TEUs.

Turkey is geographically at a very strategic position where is in the Mediterranean area, on the East-West trade routes and close to Europe, Middle East, North Africa and Arabian peninsula. However, still not reached to the deserved place in the world container transportation [2].

Table 1 summarizes total TEUs, tons and the number of total containers handled from 2005 to 2015. Even there is an upward trend in general it is not enough when compared to the world's other developed economies.

Table 1. Total TEUs, tons and number of containers handled

Years	Number	TEU	Ton
2015	5.382.610	8.146.398	87.025.857
2014	5.508.785	8.351.122	88.138.346
2013	5.258.193	7.899.933	84.656.192
2012	4.794.927	7.192.396	79.311.373
2011	4.379.527	6.523.506	70.381.257
2010	3.891.404	5.743.455	61.175.130
2009	2.991.935	4.404.442	46.030.743
2008	3.429.929	5.091.621	52.530.084
2007	3.145.865	4.582.268	48.644.314
2006	2.660.181	3.858.052	45.938.206
2005	2.391.081	3.312.208	36.857.885

It's very important to respond to the demand in container transportation on time. Due to the trade imbalances, there is a problem of empty container repositioning in container transport. Shipping lines mostly calculate the costs to move a container on a return-trip basis, taking probability for empty positioning into account. When trade balance is negative, a country's imports exceed its exports and the greater the imbalance, the lower the freight rates will be for the country's exports because of the higher empty containers; but if exports exceed imports, then the larger the imbalance, the higher the expected freight rates for exports will be [3]. Table 2 shows that there is a balance between export and import container numbers and total TEUs as well. This situation approves that there is no imbalance between export and import trade of Turkey.

Table 2. Total number of containers and TEUs on the basis of export/import

Years	Export		Import	
	Number	TEU	Number	TEU
2015	2.685.761	4.067.265	2.696.849	4.079.134
2014	2.742.230	4.157.916	2.766.555	4.193.206
2013	2.619.694	3.935.281	2.638.499	3.964.653
2012	2.386.980	3.575.196	2.407.947	3.617.201
2011	2.174.835	3.236.025	2.204.692	3.287.481
2010	1.933.624	2.851.870	1.957.780	2.891.585
2009	1.500.615	2.205.464	1.491.320	2.198.978
2008	1.693.185	2.520.797	1.736.744	2.570.824
2007	1.548.398	2.258.228	1.597.468	2.324.039
2006	1.332.185	1.916.851	1.327.997	1.941.201
2005	1.231.277	1.683.716	1.159.805	1.628.493

Growth in the container trade is ultimately driven by economic growth. The economic relationship between GDP and trade volume is considered useful in forecasting the development of the container sector, although the relationship is not considered a sufficient explanation of the growth. There are a wide range of factors that impact on the volume of container imports and exports, including exchange rate fluctuations, changes in economic structure etc. [4].

GDP is one of the fundamental fact of a nation and a country's economy. GDP growth of Turkey significantly decreased starting from the second quarter of 2008 [5]. Figure 1 shows the graph of GDP growth (annual %) of Turkey. It’s also obviously seen in Table 1 that there is an increase in all sections till 2009 when the effects of global crisis is felt. These two data approves the relationship between GDP and container trade for Turkey as well.

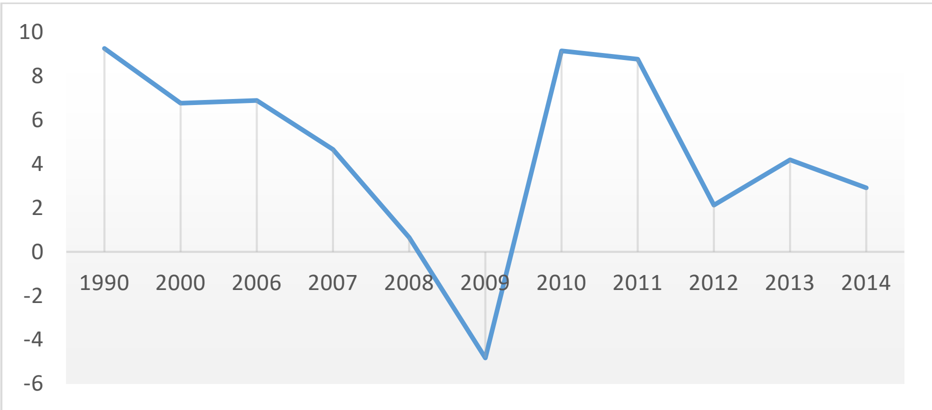

Figure 1. GDP growth (annual %) of Turkey [6]

ANALYSIS OF CONTAINER TYPES HANDLED IN TURKEY

Analyzed data are collected from the website of Ministry Directorate General of Merchant Marine which are available for the 11 years period from 2005-2015 [7]. Data were summarized as total handled container numbers either empty or full. Total container numbers and TEUs which were handled from

2005 to 2015 in Turkey is shown in Figure 2. While the graph shows an increasing trend in general, the effect of 2008 global crisis can be seen in both curves for 2009.

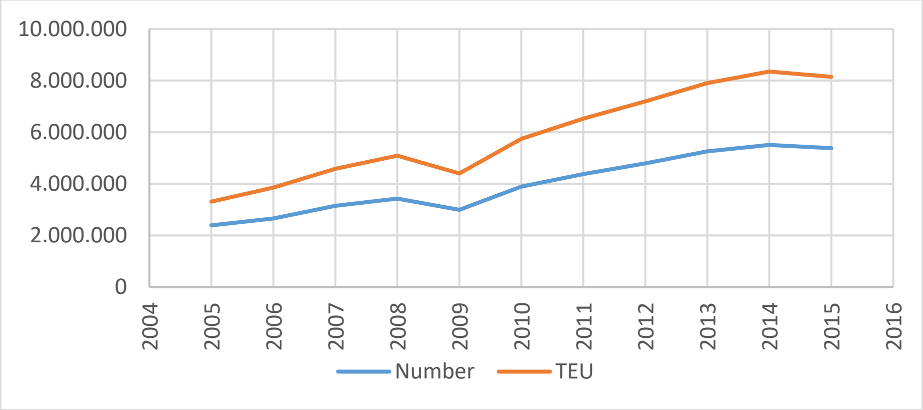

Figure 2. Graph of total container numbers and TEU between 2005 and 2015

Container types were mentioned under four categories in the annual statistics which are 20 foot, 40 foot, between 20 and 40 foot and over 40 foot. Container numbers which are between 20 and 40 foot are assumed as 20 containers and over 40 foot are assumed 40' containers. Except for 2005 data, the numbers of over 40 foot and between 20 and 40 foot containers have very low percentage in total data and does not affect grand total. But the data for 2005 was unreliable and ignored from the breakdown of containers. Table 3 shows the breakdown of container numbers for each year. Also, percentage of numbers to grand total is mentioned in Table 3.

Ports are the places where the container traffic of a country is handled. Most of the container ports are located at the Marmara region in Turkey. Although the throughput of ports are measured by TEUs, container types are very important for the container terminal operations. Besides, out of the terminals, there are container depots where empty containers are located. Container types becomes more of an issue to plan the storage are of these depots appropriately.

Table 3. Numbers and percentage of 20 and 40 foot containers

Years	20'	%	40'	%
2015	2.623.133	49%	2.759.477	51%
2014	2.671.001	48%	2.837.784	52%
2013	2.618.548	50%	2.639.645	50%
2012	2.397.757	50%	2.397.170	50%
2011	2.235.747	51%	2.143.780	49%
2010	2.039.417	52%	1.851.987	48%
2009	1.579.610	53%	1.412.325	47%
2008	1.768.301	52%	1.661.628	48%
2007	1.709.482	54%	1.436.383	46%
2006	1.463.036	55%	1.197.145	45%

It's seen in Figure 3 that 20 and 40 foot container numbers show similar trend between 2006 and 2015. 20 foot container usage was more than 40 foot in 2006, it was almost equalized in 2012 and 2013, and 40 foot container usage is more than 20 foot since 2014. Despite this change in the last 10 years, it's obviously shown in Table 3 and Figure 3 that 20 and 40 foot container usage is very close. In 2015, 49 % of total handled container numbers were 20 foot and the rest 51 % was 40 foot containers. In 2014 it was 48 % and 52 % respectively. Maximum percentage difference was in 2006 as 10 %.

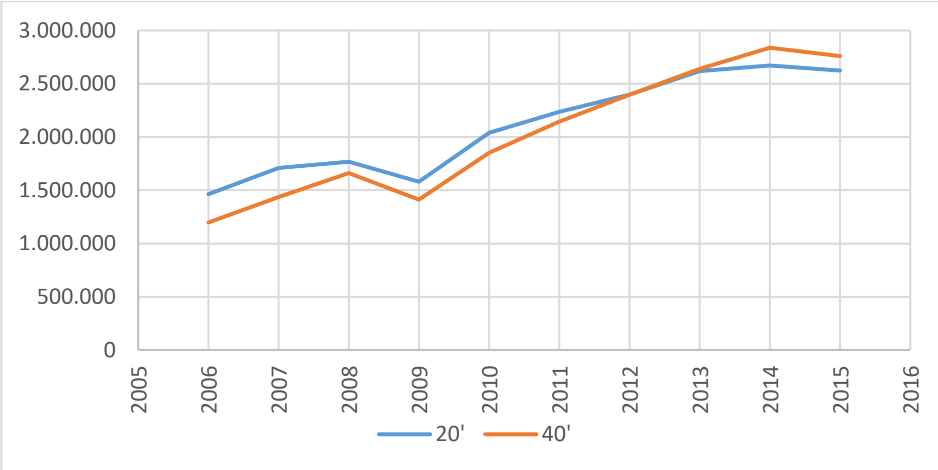

Figure 3. Graph of 20 and 40 foot container numbers between 2006 and 2015

CONCLUSIONS

The increase of containerization in maritime transport has led to the emergence of various problems related to the container. One of the most important problem is to position empty containers and their storage. In order to avoid idle capacity of empty containers, it is important to estimate demand of containers in which type would be needed. The numbers of most used container types, 20 and 40 foot containers, are examined with the total handled number of containers from 2005 to 2015. Except for the year of 2009, generally it was found to follow a rising trend till 2014. In 2015, a small decrease was observed in both numbers of 20 and 40 foot containers which can be connected with economic stagnation in 2015.

During the examined time span, it is seen that number of 20 and 40 foot containers are very close to each other. Number of 20 foot containers is higher than 40 foot containers till 2012. It's almost same in the years of 2012 and 2013. After 2013, the number of 40 foot containers becomes higher. There is also a similarity between the numbers of import/export containers. This means there is no imbalance in the foreign trade of containerized cargo of Turkey.

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INVESTIGATION ON SEAFARERS WORK STRESS AND JOB SATISFACTION IN TERMS OF SOME VARIABLES

İbrahim Düğenci[1], Gökhan Kara[2]

ABSTRACT

In recent years work stress and job satisfaction issues has become one of the most important issues of business performance management. Nowadays, securing sustainability of organizations and gain competitive advantage depends on the employment of the qualified human resources. The success of the organization is directly related to the motivation of the company employees. Stress is one of the factor which affect to employees via leading their attidutes. Work satisfaction concept is also need to be investigated and evaluated for maritime sector which is arise the point of matching between job attributes and employees expactations. In this research job stress and job satisfaction of seamans have been examined in terms of some variables. In line with this 392 seamans have been consisted of research sample. The collected data were analyzed using descriptive statistics and quantitative data analysis methods.

Keywords – *Seamen, Job Satisfaction, Job Stress.*

INTRODUCTION

Despite many descriptions made about organizational commitment, the most widely used definition and perhaps the simplest and effective definition is that: “Organizational commitment is to accept individual institutional aims and values, to make efforts towards reach these aims and desire to carry on corporate membershipç” [5,9].

In terms of organizational behavior another of the most important attitude that is developed against job by inviduals. This is generally referred to as job satisfaction. If this attitude is positive, the high satisfaction levels of employees, if negative it is seen that the low level of satisfaction [15].

Maritime is consisting of First as maritime transport, ship building industry, port management and integrated marine and coastal activities including services.

Working conditions of seamans and land workers show significant differences depend on operating conditions. For this reason, seamans factors of stress and job satisfaction are also quite different. The execution of the maritime tarnsport that the basic forms of maritime is possible thanks to ship staff which is called seamans. Seamans. conditions of professional are quite different from the conditions

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of the employees who work in other lines of business, as noted above. Marinesis employee; that task constantly away from family and friends. Sometimes for days or months stay on ship without landing, exposed adverse physical or psychological conditions such as bad weather and storms while sailing, in a different organizational structure work places are continiously changing and just working in the social environment in which they are created by the people on board.

Stress is one of the factor which affect to employees via leading their attidutes. Work satisfaction concept is also need to be investigated and evaluated for maritime sector which is arise the point of matching between job attributes and employees axpactations

JOB SATISFACTION

Job satisfaction and job satisfaction to be related to issues such as Organizational commitment, intention to leave, the frustration, job performance has been an important subject that interested in organizational behavior and human resource management applications. it consists of filtered and processed perception perception filtered through the invidual's system of norms values expactations and so fort [19].

In this sense Job satisfaction is emotional responce for perception related with employee's job and job's provides and responce against this perception [12].

Rusbelt, Farrell, Rogers, Maınous [18], Suggesting that some individuals develop different responses against job dissatisfaction Employees will be in behaviors against job dissatisfaction eihter negative like leave the organization or positive as voicing problems and finding solution Some reactions may be developed by the individual in the face of job dissatisfaction could have same behaviors such as loyalty andignore problem. Job satisfaction is one of the positive work attitude, an attitude that developed against the people's work and working conditions. Job satisfaction, work conditions (work itself, the attitude of the administration), or the results obtained from work (wages - such as job security) is a personal evaluation Work satisfaction is an emotional reaction against jop condition. The relationship between job satisfaction and job changes have been identified that differ according to individual variables [17]. As a result of the studies to determine the many factors affecting Job satisfaction emerged that; wages, safety, promotion, leadership, participation in decisions, management style, role clarity, the recognized, working conditions, friendship, recognition and such as work itself factors has significant impact. It is one of the important tasks of management in the enterprises to provide job satisfaction working to identify these factors and make the necessary arrangements Theoretical background of job satisfaction, was occurred from Maslow's 1954 "Hierarchy of Human Needs Theory" and Herzberg 1959 "Two Factor Theory" [1,2].

STRESS IN WORK

Stress is reaction to difference between inviduals expactations an real lifes [7].

In last 20 years Literature has significant increases about Job and occupational stress that negatively affect to employees mental a physical health [8].

Also used in different meanings by different researchers, stress and strain concepts, gradually it began to be used widely in occupational stress research [16]. Stress can generallybe defined as an aversive or unpleasant emotional and physiologicalstate resulting from adverse work experiences, particularly experiences that are uncertain or outside the employee’s control [10]. Stress expressed as modern society's disease [6].; contribute to increasing employee efficiency but excessive stress is adversely affect the health of the employee and the organization.

It is alleged that Working in a stressful environment,is cause depression, feeling of worthlessness, low commitment to work move away from the work group, which is a condition that increases the intention to leave, [8].

METHOD

Aim of this study is determine between, seaman’s job stress perception job satisfaction levels and the relationship with demographic characteristics.

Measuring Seaman’s that participant of the success in maritime industry in recent years’ job stress and job satisfaction was chosen as the subject of this study at. Job satisfaction and job satisfaction is related to job stress is one of the key issues of interest to organizational behavior and human resource management practices.

From time to time human resource company management measures to seamans job satisfaction and job stress by various methods and develop projects on behalf of staff satisfaction. Human resources comes first, in the resources used in the discovery of services produced in the enterprises

For the efficiency of seamans, as well as in other sectors; behaviors attitudes and expectations towards their work constitutes an important role.

RESEARCH PROBLEMS AND HYPOTHESES

Problems of the research; to determine whether the relationship between seaman’s job stress perception, job satisfaction and demographic variables

To achieve this goal, the research will look for an answer to the hypothesis located below.

This study tested the following hypotheses:

$H_{1:}$ seaman’s job stress perception varies according to demographic variables.
H_{1a}: seaman’s job stress perception indicate statistically significant differences acording to ages
H_{1b}: seaman’s job stress perception indicates statistically significant differences acording to educational status
H_{1c}: seaman’s job stress perception indicates statistically significant differences acording to the period of job experiences
H_{1d}: seaman’s job stress perception indicates statistically significant differences acording to ranks.
$H_{2:}$ seaman’s job satisfaction level varies according to demographic variables.
H_{2a}: seaman’s job satisfaction perception indicate statistically significant differences acording to ages
H_{2b}: seaman’s job satisfaction level indicates statistically significant differences acording to educational status

H_{2c}: seaman's job satisfaction level indicates statistically significant differences acording to the period of job experience
H_{2d}: seaman's job satisfaction level indicates statistically significant differences acording to ranks.

Universe and Sample of Research

Research universe, consists of 115 774 Tanker staff that is statistical data published by the Baltic and International Maritime Council.

Samples consist of 392 tanker crew that choose via simple random sampling method (randomly) due to impossible to reach the entire population. Number of samples should be 383 that work acording to surveys with 0,95 confidences and 0,05 tolerance level [4].

Data Analysis Method

One of the statistical software package is SPSS 16.00 (Statistical Package Social Science) was used for the analysis of survey data. Both statistical methods frequency distribution and one-way analysis of variance(anova) were used for the analysis of survey data and results are expressed in the tables.

Data Collection Tools

In the research job stress and job satisfaction measuring scales were used for data collecting. Survey prepared fort the research has 3 part.

In the first part containing demographic questions. In the Second part role conflict, role ambiguity [14] work-family conflict, the role of stress is the main factor were used. In the third part, Job Satisfaction Survey questionnaire was used, that developed by Spector [20].

RESULTS AND COMMENTS

This section includes result of the implementation of the survey findings and comments regarding the survey statistical analysis obtained. Firstly, the personal findings to the crew surveyed, then finding and comments relating with research hypothesis were presented.

Demographic Characteristics

The survey was applied in tanker ships crew and the demographics of seamans are given below

Seamans Ages Distribution

Seamans Ages Distribution informations who participated in the research are given in Table 1

Table 1: Seamans Ages Distribution

Ages	**N**	**%**
25-30	150	38,3
31-35	119	30,4
36-40	67	17,1
41 and upper	56	14,3
Total	392	100,0

Seamans who participated in the survey % 38,3 are between 25-30 ages, % 30,4 are between 31-45 ages, % 17,1 are between 36-40 ages, % 14,3 are 40 and upper ages,

Seamans Educational Distribution

Seamans Educational Distribution informations who participated in the research are given in Table 2.

Tablo 2: Seamans Educational Distribution

Educational Status	N	%
Elementary	93	23,7
High	78	19,9
Vocational High	47	12,0
College	139	35,5
Master's Degree	35	8,9
Toplam	392	100,0

Table 2 is examined; seamans education level who participated in the survey % 23,7 are elemantary level, % 19,9 are high level, %12,0 are Vocational High, %35,5 are College level, and %8,9 is master degree. According to the table nearly half of the Seamans that working tankers have Vocational High and College degree education.
So we can say seamans have high education level.

Seamans Rank Distributions

Seamans Rank Distribution informations who participated in the research are given in Table 3.

Table 3: Seamans Rank Distributions

Unvan	N	%
Officer	178	45,4
Assistant Officer	18	4,6
Cadet	33	8,4
Crew	147	37,5
Assistant Crew	16	4,1
Total	392	100,0

Officer: Master, Chief Eng., Chief officer…. Assistant Officer: Radio off. electricity, doctor. Crew: Bosun,A/B, Donkeyman, Oiler.. Assistant Crew: Cook, Steward.

Table 3 is examined; seamans who participated in the survey %45, 4 are officer, %4,6 are assistant officer, %8,4 cadet, %37,4 are crew, and %4,1 are assistant crew. According to the percentage distribution of the seamans surveyed about half consists officer.

Distribution of the seamen Job Experience

Distribution of the Seamans Job experience informations who participated in the research are given in Table 4

Tablo 4: Distribution of the seamen Job Experience

Deneyim Süresi	N	%
1-5 year	138	35,2
6-10 year	133	33,9
11-15 year	67	17,1
16-20 year	27	6,9
21 and upper	27	6,9
Total	392	100,0

Table 3 is examined; seamans who participated in the survey % 35,2' are 1-5 year, % 33,9 are 6-10 year, % 17,1 are 11-15 year, % 6,9 are 16-20 year and % 6,9 are 21 year and upper job experienced.

Analysis on the Research Hypothesis

Below, findings related to the research hypothesis are dealt and commented respectively. One-way ANOVA test was performed to test the hypothesis of the research.

Findings and Comments About 1st Hypothesis

The first hypothesis of the study has been arranged. "Seamans work stress perception varies according to demographic variables."

H_{1a}: seaman's job stress perception indicates statistically significant differences acording to ages

Table 5: Anova Results for Work Stress Perception According to Age

	AGE	$\overline{X}$	S.S.	F VALUE	P VALUE
Work Stress	25-30	2,4814	,64709	5,137	,000*
	31-35	2,6804	,85876		
	36-40	2,5533	,65008		
	41-45	2,1397	,58006		
	46 and upper	2,2629	,26468		
	TOTAL	2,5103	,71813		

$^*p<0,05$

Table 5 is examined seaman's job stress has significant differences according to age varies (F= 5,137, p=,000<0,05'e). As a result of the Tukey test this differences occur from seamans whose ages between 31-35 and between 41-45. So, "Seaman's job stress perception indicates statistically significant differences acording to ages''hypothesis is accepted.

H_{1b} : Seaman's job stress perception indicate statistically significant differences acording to educational status

Table 6: Anova Results for Work Stress Perception According to Educational Status

	EDUCATION	$\overline{X}$	S.S.	F VALUE	P VALUE
Work Stress	Elementary	2,6118	,88443	4,789	,001*
	high	2,2922	,76710		
	Vocational High	2,7080	,55485		
	College	2,4346	,64528		
	Master's Degree	2,7616	,30847		
	TOTAL	2,5103	,71813		

***p<0,05**

Table 6 is examined seaman's job stress has significant differences according to educational status varies (F = 4,789, p=,001<0,05'e). As a result of the Tukey test this differences occur from seamans that high school graduated.So, "Seaman's job stress perception indicate statistically significant differences acording to educational status'' hypothesis is accepted.

H_{1c} : Seaman's job stress perception indicate statistically significant differences according to the period of job experiences

Tablo 7: Anova Results for Work Stress Perception According to The Period of Job Experiences.

	JOB EXPERIENCES	$\overline{X}$	S.S.	F VALUE	P VALUE
Work Stress	1-5 year	2,5737	,78849	1,749	,139
	6-10 year	2,5745	,72726		
	11-15 year	2,3654	,67636		
	16-20 year	2,3627	,58099		
	21 and upper	2,3768	,39721		
	TOTAL	2,5103	,71813		

***p<0,05**

Table 6 is examined seaman's job stress perception has not significant differences according to the period of job experiences varies (F= 1,749, p=,137>0,05') and 1-5 year and 6-10 year job experienced seamans have the most work stress. So, **''**Seaman's job stress perception indicates statistically significant differences according to the period of job experiences'' hypothesis is not accepted.

H_{1d} : Seaman's job stress perception indicate statistically significant differences acording to ranks.

Table 8: Anova Results for Work Stress Perception According to Ranks.

	RANK	$\overline{X}$	S.S.	F VALUE	P VALUE
Work Stress	Officer	2,5076	,65349	6,189	,000*
	Assistant Officer	1,8908	,37463		
	Cadet	2,4796	,48294		
	Crew	2,6409	,83628		
	Assistant Crew	2,1013	,36285		
	TOTAL	2,5103	,71813		

***p<0,05**

Table 6 is examined seaman's job stress has significant differences according to rank varies ($F = 6{,}189$, $p=,000<0{,}05$'e) As a result of the Tukey test this differences occur from Assistant Officers. So ''Seaman's job stress perception indicates statistically significant differences acording to ranks'' hypothesis is accepted. According to this results; ''seaman's job stress perception varies according to demographic variables'' hypothesis is partly accepted.

Findings and Comments About 2nd Hypothesis

The Second Hypothesis of the study has been arranged "Seamans job satisfaction perception varies according to demographic variables."

H_{2a} : Seaman's job satisfaction perception indicate statistically significant differences acording to ages.

Tablo 9: Anova results for job satisfaction perception according to age

	AGE	$\overline{X}$	S.S.	F VALUE	P VALUE
Job Satisfaction	25-30	3,0543	,43746	7,976	,000*
	31-35	3,1623	,71059		
	36-40	3,0136	,52115		
	41-45	3,5507	,67708		
	46 and upper	3,4232	,16470		
	TOTAL	3,1458	,58663		

***p<0,05**

Table 9 is examined; seaman's job satisfaction has significant differences according to age varies ($F = 7{,}976$, $p=,000<0{,}05$'e) As a result of the Tukey test this differences occur from seamans whose ages between 41-45.So So, “ Seaman’s job satisfaction perception indicate statistically significant differences acording to ages’’hypothesis is accepted.

H_{2b} : : Seaman’s job satisfaction perception indicate statistically significant differences acording to educational status.

Table 10: Anova Results for Work Stress Perception According to Educational Status

	EDUCATION	$\overline{X}$	S.S.	F VALUE	P VALUE
Job Satisfaction	Elementary	3,3370	,78484	10,945	,000*
	High	3,2293	,57588		
	Vocational High	2,7289	,45907		
	College	3,1644	,44939		
	Master's Degree	2,9380	,18077		
	TOTAL	3,1458	,58663		

***p<0,05**

Table 6 is examined seaman’s job satisfaction has significant differences according to educational status varies (F =10,945, p=,000<0,05’e). As a result of the Tukey test this differences occur from seamans that Vocational High graduated. So, “Seaman’s job satisfaction perception indicate statistically significant differences acording to educational status’’ hypothesis is accepted.

H_{2c} : Seaman’s job satisfaction perception indicate statistically significant differences according to the period of job experiences

Table 11: Anova Results for Job Satisfaction Perception According to The Period Of Job Experiences.

	JOB EXPERIENCE	$\overline{X}$	S.S.	F VALUE	P VALUE
Job satisfaction	1-5 year	3,0863	,44625	12,953	,000*
	6-10 year	3,0773	,58938		
	11-15 year	3,0392	,66183		
	16-20 year	3,8317	,78644		
	21 and upper	3,3661	,14461		
	TOTAL	3,1458	,58663		

***p<0,05**

Table 6 is examined seaman’s job stress has significant differences according to the period of job experiences varies (F=12,953, p=,000<0,05’e) As a result of the Tukey test this differences occur from 16-20 years experienced seamans. So, ‘‘Seaman’s job satisfaction perception indicates statistically significant differences according to the period of job experiences’’ hypothesis is accepted.

H_{2d} : Seaman's job satisfaction perception indicate statistically significant differences acording to ranks..

Table 12: Anova Results for Work Stress Perception According to Ranks.

	RANK	$\overline{X}$	S.S.	F VALUE	P VALUE
Job Satisfaction	Officer	3,0437	,45414	9,375	,000*
	Assistant Officer	3,6794	,50804		
	Cadet	3,2563	,45409		
	Crew	3,1223	,70829		
	Assistant Crew	3,6714	,35914		
	TOTAL	3,1458	,58663		

$*p<0,05$

Table 6 is examined; seaman's job satisfaction has significant differences according to rank varies (F = 9,375, p=,000<0,05'e). As a result of the Tukey test this differences occur from Assistant Officers and Assistand Crew. So ''Seaman's job stress perception indicate statistically significant differences acording to ranks'' hypothesis is accepted. According to this results; ''seaman's job satisfaction perception varies according to demographic variables'' hypothesis is accepted.

CONCLUSIONS

Seamans who participated in the survey % 38,3 are between 25-30 ages, % 30,4 are between 31-45 ages, % 17,1 are between 36-40 ages, % 14,3 are 40 and upper ages. seamans education level who participated in the survey % 23,7 are elemantary level, % 19,9 are secondary level, %12,0 are associate's degree, %35,5 are Graduate level, and %8,9 is master degree. According to the table; nearly half of the seamans have college and master degree education then vocaional high scholl graduates comes. Hence said that seafarers have high level education. Seamans who participated in the survey %45 ,4 are officer, %4,6 are assistant officer, %8,4 cadet, %37,4 are crew, and %4,1 is assistant crew. According to the percentage distribution of the seamans surveyed about half consists officer. seamans who participated in the survey % 35,2' are 1-5 year, % 33,9 are 6-10 year, % 17,1 are 11-15 year, % 6,9 are 16-20 year and % 6,9 are 21 year and upper job experienced.

There is no analysis of the gender due to no women in research group. This is because the number of women who do active duty at sea is too low. Apart from that analysis is performed with using age, educational status, job experience and rank variables. Seaman's job stress perception indicates statistically significant differences according to ages. It is seen that 31-35 ages are the most stressed group,41-45 ages is the least stressed group. Seaman's job stress perception indicates statistically significant differences acording to educational status. It is seen that seamans in master degree is the most stressed group, seamans in high scholl is the least stressed group. Seaman's job stress perception has not significant differences according to the period of job experiences and 1-5 and 6-10 years' job experienced group is the most stressed. Seaman's job stress has significant differences according to rank varies. It is seen that crews is the most stressed group, assistant officers is the least stressed group.

Seaman's job satisfaction perception indicates statistically significant differences according to ages. It is seen that 41-45 ages are the most satisfied group,36-40 ages are the least satisfied group. Seaman's job satisfaction perception indicates statistically significant differences acording to educational status. It is seen that seamans in elementary degree is the most satisfied group, seamans in vocational high scholl is the least satisfied group. Seaman's job satisfaction perception has significant differences according to the period of job experiences. It is seen that 16-20 years experienced seamans is the most satisfied group, 11-15 years experienced seamans is the least satisfied group. Seaman's job satisfaction perception has significant differences according to rank varies. It is seen that assistant officers are the most satified group, officers are the least satisfied group.

All of these findings prove that seamanship is very difficult and stressfull job due to work and life conditions which can not find other jobs. Companies can measure their personal's job satisfaction level via surveys. Works can be done to increase improvement of working conditions and job satisfaction on the ship. Prize thanks etc applications should be developed for satisfaction of working in harsh conditions. For promotion and job belonging Performance monitoring should be done and seamans edcuations should be followed. Social activities should be carried out for reducing stress at work.

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EXPERIMENTAL INVESTIGATION OF FLOW STRUCTURES AROUND A TORPEDO-LIKE GEOMETRY PLACED IN A BOUNDARY LAYER FLOW

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ABSTRACT

Defense applications for both under oceans and seas, particularly underwater vehicles have been considered in this research. With this aim, flow characteristics around a torpedo-like geometry under the effect of the boundary layer flow over a smooth flat plate have been experimentally examined by using PIV technique. All of the experiments have been done for Re=20000 and Re=40000 based on the length (L) of the geometry as a characteristic length. As a result, time-averaged streamwise velocity components <u>, velocity vectors <v>, streamline topologies <ψ> and Reynolds stress correlations $<u'v'/U_\infty^2>$ in the wake region of the torpedo-like geometry have been acquired in the range of $0 \leq G/D \leq 1.5$. Here, G is the space between the bottom point of the geometry and flat plate surface; D stands for the diameter of the geometry. It is found that at the smallest value of G/D=0.25, jet-like flow occurs between the plate and the model which causes a powerful scouring. As the gap ratio is increased to G/D=0.5 and G/D=1.0, the jet-like flow diminishes slightly and then the flow structure in the wake region becomes similar to the uniform incoming flow condition for G/D=1.50. Due to the effect of the jet-like flow and boundary layer flow, time-averaged flow patterns present asymmetrical distributions which are clearly shown a bigger size focus close to the plate in streamline topology. Reynolds stress patterns form more powerful viscous forces in the boundary layer flow due to the occurrence of eddy vortices and viscosity effect. It is observed from the aforementioned flow patterns that interaction between the flow structure, the model and boundary layer flow yields very complex structure. In order to decrease the energetic flow in this condition, passive or active flow control method can be integrated on the torpedo-like geometry.*

Keywords − *Boundary layer flow, PIV, turbulent flow, torpedo-like geometry, vorticity.*

INTRODUCTION

Torpedoes, torpedo-like geometries and underwater unmanned vehicles have been investigated in this research. Even though seas and oceans cover two-thirds of the earth, interests in oceans and seas are not enough when compared to land and atmosphere. A number of researches have been deduced to study the flow around underwater vehicles. These bodies are representative of natural and engineered objects such as torpedoes that swim like tuna. It is known from the researches underwater

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vehicles exposed to more viscous and hydrostatic forces than air and land for same geometry. In the literature, a lot of studies can be encountered about the flow around underwater vehicles. Zhao et al. (2016) investigated the vortex dynamics characteristics and wake structure of a sphere close to the wall at the Reynolds number Re=4170. The results of sphere situated near to flat plate were straightly founded by numerical simulations. They found the increase in boundary layer of sphere, in addition the effect of g/d on the velocity distributions as the gap ratios increase the velocity interaction because of its weakness [1]. Ozgoren et al. (2013) investigated flow patterns around sphere placed over flat plate by using PIV and dye visualization. The closer position of the sphere to the wall result in distribution of Reynolds stress correlations ($u'v'/U^2_\infty$). They found the boundary layer thickness about 63 mm and observed flow characteristics around sphere at different gap ratios with flat plate for $0 \leq G/D \leq 1.5$ at $2500 \leq Re \leq 10000$ in terms of the turbulent boundary layer generated by using trip wire [2]. Cheng (2007) obtained analytically that the power law can be obtained as the first order approximation to the log law, it was found that power law index was calculated with the dependence on Reynolds number alongside relative roughness height and the highest power index are required for flow upon very rough boundaries[3]. Ozalp and Dincer (2010) studied extensively computational analysis on the hydrodynamics, thermal, and mass transfer attribution of a circular cylinder, depend on the flow structure at Re=40. The results were specified at the higher blockage and the highest blockage of β=0.8 was used to simulate the downstream velocity values and the boundary layer distributed by the fluid-solid contact [4]. Ozgoren et al. (2011) have compared the flow structures in the wake region of both a cylinder and a sphere. They have done experiments of immersed bodies which were in the free-stream flow for Re=5000 and Re=10000 and they have used PIV and dye techniques. They have obtained Strouhal number values for a cylinder as St = 0.21 and a sphere as St = 0.18 at Re=5000, respectively [5]. Lin et al. (2016) investigated experimentally the characteristics of horizontal velocity profiles in the bottom boundary-layer flow. Here, the results were obtained by using High-Speed Particle Image Velocimetry (HSPIV) method. The experiments were done at different the ratio of wave height to water depth varying from 0.096 to 0.386 for the boundary layer in terms of laminar flow. They investigated the time influence on the horizontal velocity profile distributions. They obtained that the velocity profiles were divided into two parts depending on solitary wave-crest at measuring; when favorable pressure exerted the pre-passing (or acceleration) phase occur while adverse pressure exerted the deceleration phase occur [6]. Hajimirzaie et al. (2014) examined the mean wake and turbulent flow field around sphere placed structures by using experimental methods which are Particle Image Velocimetry (PIV) and Thermal Anemometry methods, they investigated at Reynolds number of 17800. They examined the flow surrounding the spherical obstacle by PIV techniques, and anemometry measurements used to characterize the instability in the weak. They identified a spectral peak in the wake at St=0.203, simply close to base plane [7]. Dantas and de Barros (2013) obtained the hydrodynamic forces generated on an AUV considering the combined effects of the control surface deflection and the angle of attack using CFD software based on the Reynolds-averaged Navier–Stokes formulations. They attained better results by using k–ω SST model compared to another models. These numerical results showed that fully turbulent models could approximate hydrodynamic forces with a good level of accuracy with little errors in streamline because major part of flow was laminar [8]. Maruyama et al. (2012) investigated wind loads acting on buildings located in turbulent boundary layer by using LES method with ANSYS. On the other hand, in wind tunnel experiment, Particle Image Velocimetry (PIV) technology has been modified to catch high frequency turbulent fluctuations. The results have shown that the turbulent boundary layer acceptably produced in LES with high resolution in near wall region as well as DNS though the experimental results of PIV were coarser than numerical with LES and DNS [9]. Jimenez (2007) has investigated the flow characteristics around submarine and torpedo-like geometry by using PIV flow visualization technique at high

Reynolds number. He found that with the increasing of Reynolds number 1.1×106 to 2.5×107, the stagnation point in the wake region moved from 3D to 15D, respectively [10]. Beheshti et al. (2009) studied on the flow physics around an airship in a water tunnel. They measured the drag on a small scaled model of the airship to identify a laminar-to-turbulent boundary layer transition. It was observed that the body with appendages resulted in 30% higher drag compared to the bare hull [11]. Mansoorzadeh and Javanmard (2014) have investigated the free surface effect on drag and lift coefficient of an AUV that obtained numerically and experimentally. They concluded that the drag coefficient was the function of the Reynolds number and submergence ratio of AUV[12]. Fureby et al. (2016) have examined a generic conventional submarine at yaw angle of 10˚. PIV system integrated to a wind tunnel which has been used for the experimental part of the study while LES turbulence model has been utilized to obtain numerical results[13]. The aim of this study is to examine the flow structures around a torpedo-like geometry placed in a boundary layer flow, experimentally.

MATERIAL AND METHOD

Large scale open loop water channel with a rectangular cross section 6000 mm x 770 mm x 600 mm has been used in the facilities of Advanced Technology Research and Application Center of Selcuk University in Konya/Turkey. The walls of the test-section were made of 15 mm thick glass plates to facilitate laser transmission and flow visualization. The water height was kept constant as h_w = 470 mm in all cases and the space between the bottom point of the geometry and flat plate surface differs from 0 to 60 mm and normalized with the diameter as G/D. The orientation of the torpedo-like geometry in the experimental setup has been shown in Figure 1. To have fully developed turbulent boundary layer, the torpedo-like geometry has been mounted about 1400 mm from leading edge of flat plate. It has been found that the developed hydrodynamic boundary layer thickness was δ=60.91 mm at Re=20000 and δ=40.45 at Re=40000 for the water channel without the torpedo-like geometry. The boundary layer thickness has been calculated from u-velocity profile and using free stream velocity. Reynolds numbers are calculated by, $Re = U_\infty L/v$; based on the characteristic length of the geometry. Here, v is the kinematic viscosity and L is characteristic length of the geometry. U_∞ is the free-stream velocity in the range of 100–200 mm/s. The geometry has been made of acrylic glass with the 2.5 mm thickness so that the laser light easily passes through the geometry. The inner section of the geometry has been filled with water to minimize the laser light deflection. Nd:YAG laser has been utilized to generate a laser sheet which was perpendicular to the axis of the geometry and it has passed through the geometry with 15 pulse per second. A Complementary Metal Oxide Semiconductor (CMOS) camera with a resolution of 1632 x 1200 pixels was used to record the images. The densities of the particles and water are close enough and the suspended seeding particles with a diameter of 10 μm in the flow are silver coated hollow glass spheres. Dynamic Studio software employing the adaptive correlation algorithm including proper filters was used for computing the raw displacement vector field. An interrogation window of 32 x 32 pixels in the image was selected and converted to approximately 1,41 x 1,41 mm^2 grid size consisting of 7474 (101 x 74) velocity vectors. During the interrogation process, an overlap of % 50 has been employed in order to satisfy the Nyquist criterion. Patterns of instantaneous particle images with a 1024 images consisting of a continuous series were taken at the rate of 15 Hz to calculate the time-averaged patterns of the flow structure.

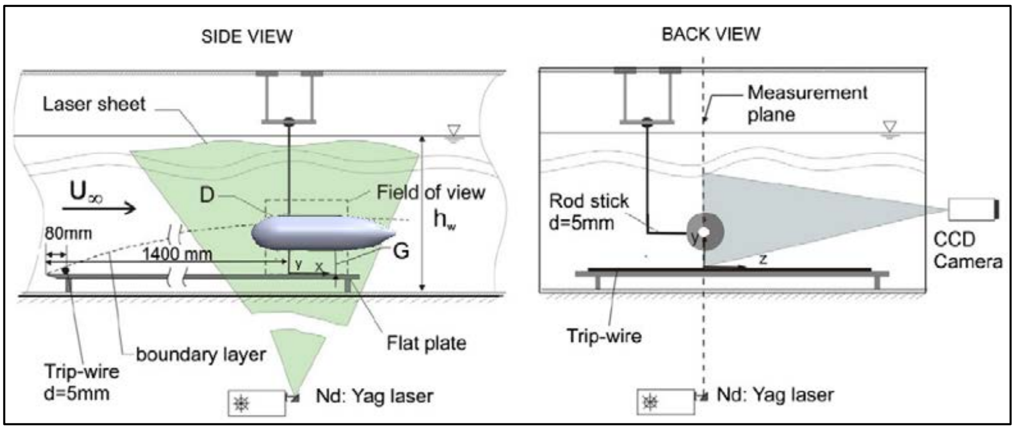

Figure 1. Schematic view of the experimental view of PIV system, laser illumination for a torpedo like geometry located in a boundary layer

Power law expression and experimental results have been compared and the power law index $u/U_\infty = (y/\delta)^{1/n}$ for n=5 for both Re=20000 and Re=40000 is in good agreement as indicated in Figure 2, respectively.

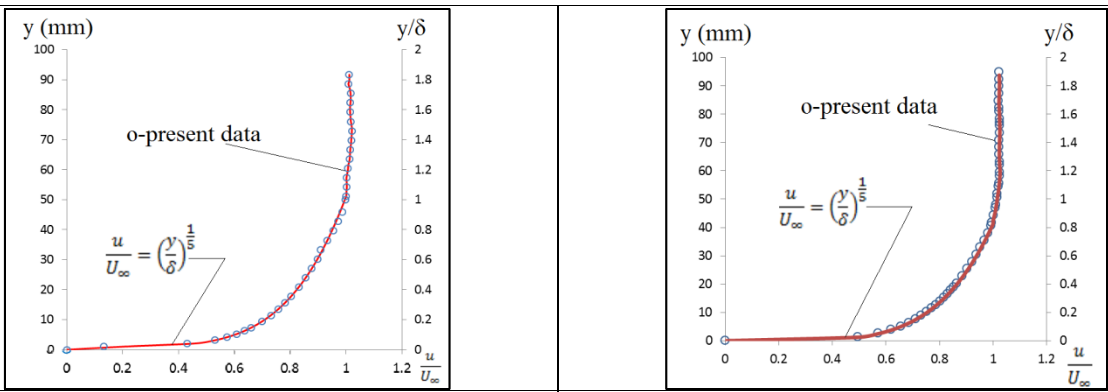

Figure 2. The development of turbulent boundary layer by the velocity distribution with the influence of tripwire and sharp-edged flat plate at Re=20000 (a) and at Re=40000 (b) when compared between experimental and power-law results $u/U_\infty = (y/\delta)^{1/n}$ and here the index n=5

RESULTS AND DISCUSSION

Flow characteristics around a torpedo-like geometry have been investigated using PIV technique and time averaged vector fields <V>, Reynolds stress correlations $\langle u'v'/U_\infty^2 \rangle$, time-averaged streamwise velocity components <u*> and streamline topologies <Ψ> for different gap ratios of $0 \leq G/D \leq 1.5$ at Re=20000 and 40000. Normalizing the dimensions by dividing the amounts by diameter of torpedo like x/D, y/D and G/D has been done and streamwise velocity components have been normalized by free-stream velocity as $\langle u^* = u/U_\infty \rangle$. The maximum and minimum values have been given with a legend bar for the contours in each figures and divided with 15 levels. The positive layers of flow patterns have been displayed with continuous line contours as red background color, while the negative layers have been indicated with dashed line contours as blue background color. With the assistance of PIV method, the recirculating and separated flows in the near wake region of torpedo-like geometry have been observed under the effect of boundary layer.

In Figure 3 and Figure 4, time averaged vector fields <V> have been presented at Re=20000 and Re=40000, respectively. Rotational flow has been seen in the bottom section of trailing edge for the torpedo-like geometry due to the interaction between the flat plate and torpedo-like geometry. Jet-like flow occurs by increasing the gap ratio to G/D=0.25 and the separation point was at x=4.5D. Furthermore, reverse velocity vectors has been obtained in the wake region and positive vector values occur in the bottom section of the trailing edge because of jet-like flow and boundary layer effect in the first column (I) of Figure 5 and 6. In case of G/D=1.5, flow structure around the torpedo-like geometry approached to the uniform flow conditions as observed.
The effects of G/D ratios on the wake region of the torpedo-like geometry and the boundary layer were discussed, in terms of Reynolds stress correlations $<u'v'/U_\infty^2>$ and shown in Figure 3 and 4. Unsymmetrical peak values of negative and positive Reynolds stress correlations are generated in the wake region at downstream of the torpedo-like geometry. The boundary layer affected on Reynolds stress correlations $<u'v'/U_\infty^2>$ with unsymmetrical distribution when the geometry mounted near the flat plate. For G/D=0, only negative Reynolds stress correlations can be demonstrated on the top shear layer and showed with dashed lines. At G/D=0, torpedo-like geometry contacted with flat plate therefore the clusters and minimum values of Reynolds stress correlations located at top section of the torpedo-like geometry. Furthermore, with increasing the gap ratio, the effect of jet like flow at bottom on the positive values was bigger than the upper negative values showed in Figure 3 and 4. Moreover, the cluster of positive Reynolds stress correlations values began to get larger in the downstream of the torpedo-like geometry as the gap ratio between plate and torpedo-like geometry increased to G/D=0.25 for Re=20000 and 40000. Jet-like flows through the gap resulted in this condition. Reynolds stress correlations $<u'v'/U_\infty^2>$ at G/D=0.25, the positive region begins to occur and consists of two negative values one of them is over the flat plate due to the effect boundary layer and the jet-like flow through this gap and the other at the top of torpedo-like geometry. In case of G/D=0.25, the peak value has been obtained because the downstream of jet-like flow deployed up through the trailing edge of the torpedo-like geometry. The separation of downstream flow at the trailing edge of the torpedo-like geometry resulted in large scale correlations of Reynolds stress correlations $<u'v'/U_\infty^2>$ in the wake region. Reynolds stress correlations represented the comparative of momentum transfer for the two Reynolds numbers analyses. As examined from Figure 3 and 4, the disappearance of small scaled values of Reynolds stress correlations at a small distance from trailing edge of the torpedo-like geometry was about x/D=7.3 (i.e. 0.7D from the base of the geometry) and it was earlier at Re=40000 than Re=20000.
Streamwise velocity components $<u^*>$ have been obtained for different gap ratios and shown in column (III) of Figure 3 and Figure 4 at Re=20000 and Re=40000, respectively. Negative values of streamwise velocity components have been attained around the lower region of the symmetry axis due to the interaction of the model and the flat plate at G/D=0. In this region, rotational flow has been obtained. In cases of G/D=0.25 and G/D=0.5, the boundary layer kept its effect on the model but the cluster with negative values went up and approached to the symmetry axis. However, the distributions of streamwise velocity components nearly approached to uniform flow conditions at G/D=1 and uniform flow conditions have been approximately attained at G/D=1.5 as free-stream velocity values observed in the vicinity of the lower part of the torpedo-like geometry. For the gap ratio of G/D=0.25, the effect of jet-like flow in wake region observed. The symmetrical flow structure of the torpedo-like geometry was seen after the disappearance of the jet-like flow in the Figure 3 and 4. Another deduction from the results is that flow separation has been observed about x/D=4.5 and its influence on wake region has been seen with negative values of streamwise velocity components. However, flow separation differed due to the boundary layer effect when compared the upper and lower regions of the torpedo-like geometry. For this reason, flow separation points were different for lower gap ratios because of boundary layer on the flat plate. When Reynolds number

increased to Re=40000, wake region became closer to the torpedo-like geometry. Moreover, the boundary layer affected the wake region less than Re=20000 as seen in Figure 2(b).

As some reflection on the torpedo-like geometry caused by manufacturing defect, the presence of symmetrical flow structure was not seen obviously for time-averaged streamline patterns $<\Psi>$ of the torpedo-like geometry in Figure 3 and 4. Over here, F_1 and F_2 show the foci of the rotational flow field in a limit cycle, S_1 and S_2 are saddle point and they represent free stagnation points in the flow field. At G/D=0, there were only two saddle points in the region for all cases while no available foci points due to the boundary layer. Streamline topology was raised from the bottom of the torpedo-like geometry toward the trailing edge and entangled by shear layer then separated from the bottom section of the torpedo-like geometry. While the gap ratio rose to G/D=0.25, a focus point has been obtained for each cases but one of them was over the symmetry axis for Re=20000 and the other was below at Re=40000. On the other hand, as jet-like flow began the shedding shear layer not to just happen over the trailing edge but it also occurred in the bottom section of the trailing edge. At Re=20000 in case of G/D=0.5, there were two foci points and only one saddle point obtained. However, streamline topologies of the torpedo-like geometry for G/D=1.0 and G/D=1.5 were well-ordered.

As seen from Figure 5, the Reynolds stress correlations $<u'v'/U_\infty^2>$ distributions was obtained in the vertical line from second column of Figure 3 and 4 and at the x/D=5.7 from the trailing edge of the torpedo-like geometry at Re=20000 and 40000. The gap ratio between the flat plate and the bottom

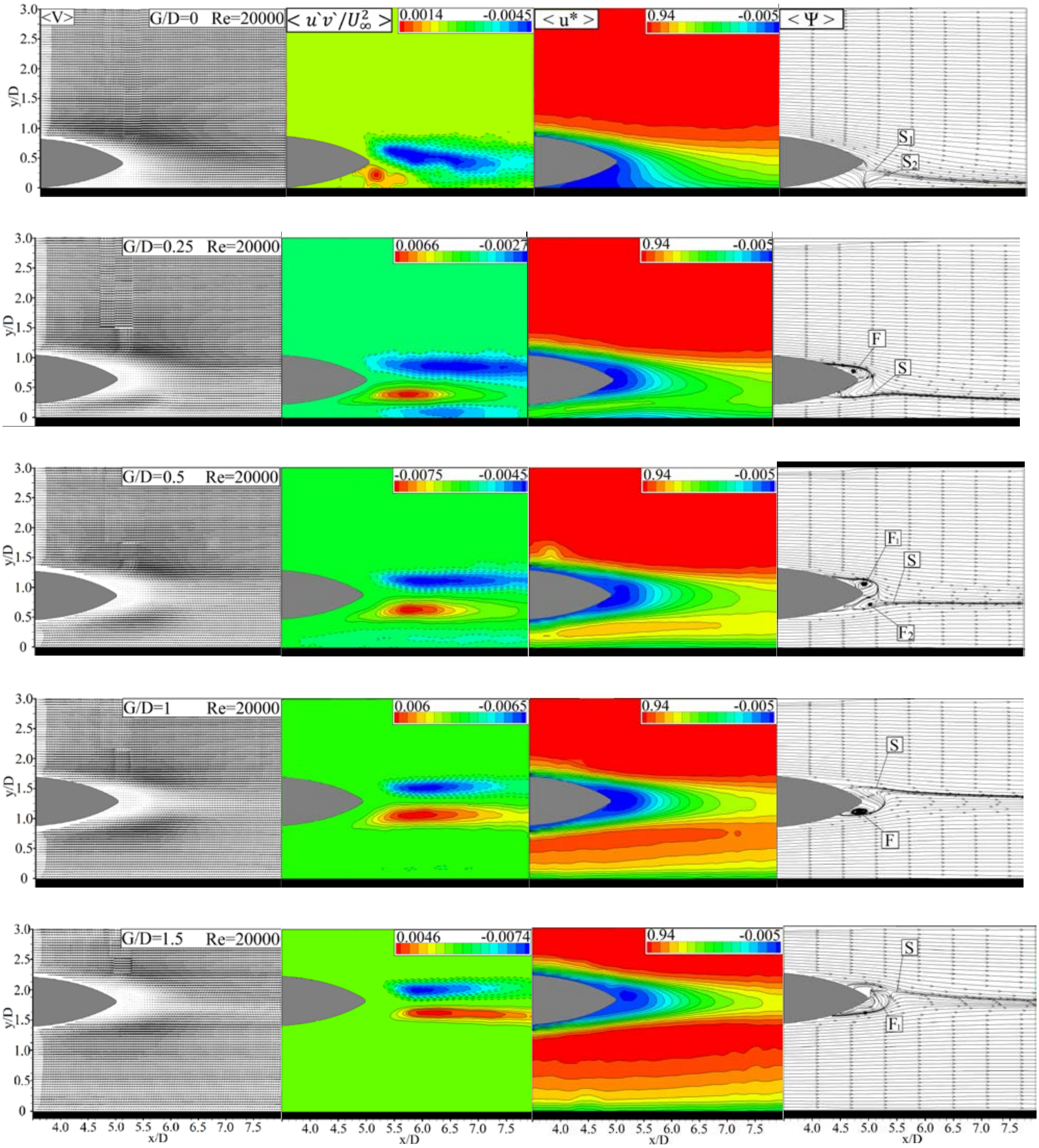

Figure 3. Comparison of velocity vector field <*V*> (column I), Reynolds stress correlations<u'v'/U_∞^2> (column II), normalized time-averaged velocity components in x direction <u*> (column III), variations of the time averaged streamline topology<ψ> (column IV) around the torpedo for 0 ≤G/D ≤ 1.5 at Re = 20000

point of the torpedo-like geometry is validated between 0 mm and 60 mm for both Reynolds numbers of Re=20000 and Re=40000. At G/D=0, only negative Reynolds stress correlations

$<u'v'/U_\infty^2>$ were demonstrated in the wake region of the torpedo-like geometry. As the gap ratio increased to G/D=0.25 and G/D=0.5, the negative values of the Reynolds distributions $<u'v'/U_\infty^2>$

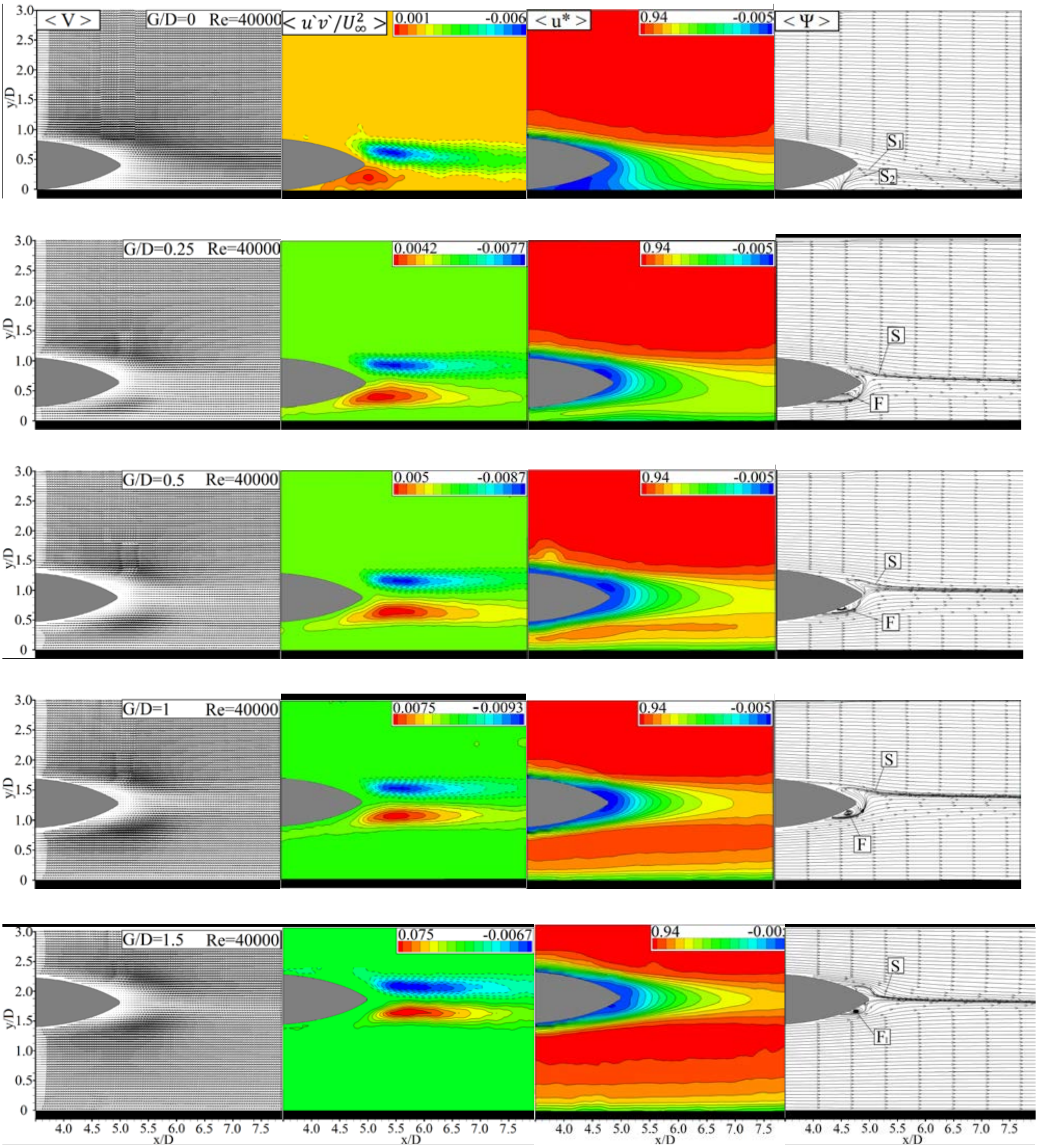

Figure 4. Comparison of velocity vector field <*V*> (column I), Reynolds stress correlations$<u'v'/U_\infty^2>$ (column II), normalized time-averaged velocity components in x direction <u*> (column III), variations of the time averaged streamline topology$<\psi>$ (column IV) around the torpedo for 0 ≤G/D ≤ 1.5 at Re = 40000

occurred at the upper of downstream, the positive value occurred in the bottom and became symmetric from the tails axis. The boundary effect is gradually disappear and symmetric shape of distribution occurs at G/D=1.0 and 1.5 for both Re=20000 and 40000.

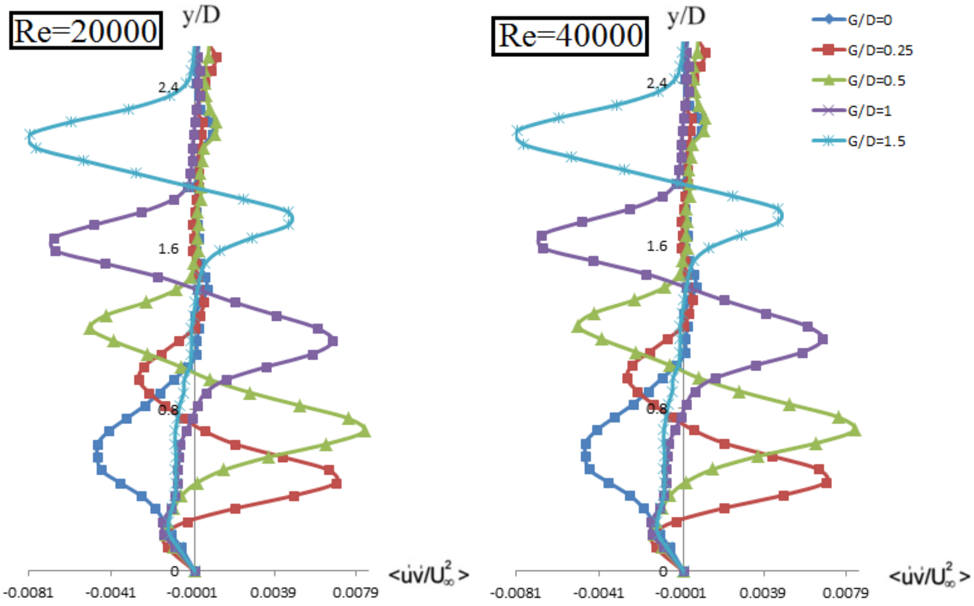

Figure 5. Variation of Reynolds stress correlations <u'v'/$U_\infty{}^2$> along the vertical line displayed in the second column of Figure 3 and 4 at x/D=5.7 away from the tail of the torpedo for 0 ≤ G/D ≤ 1.5 at Re = 20000 and 40000

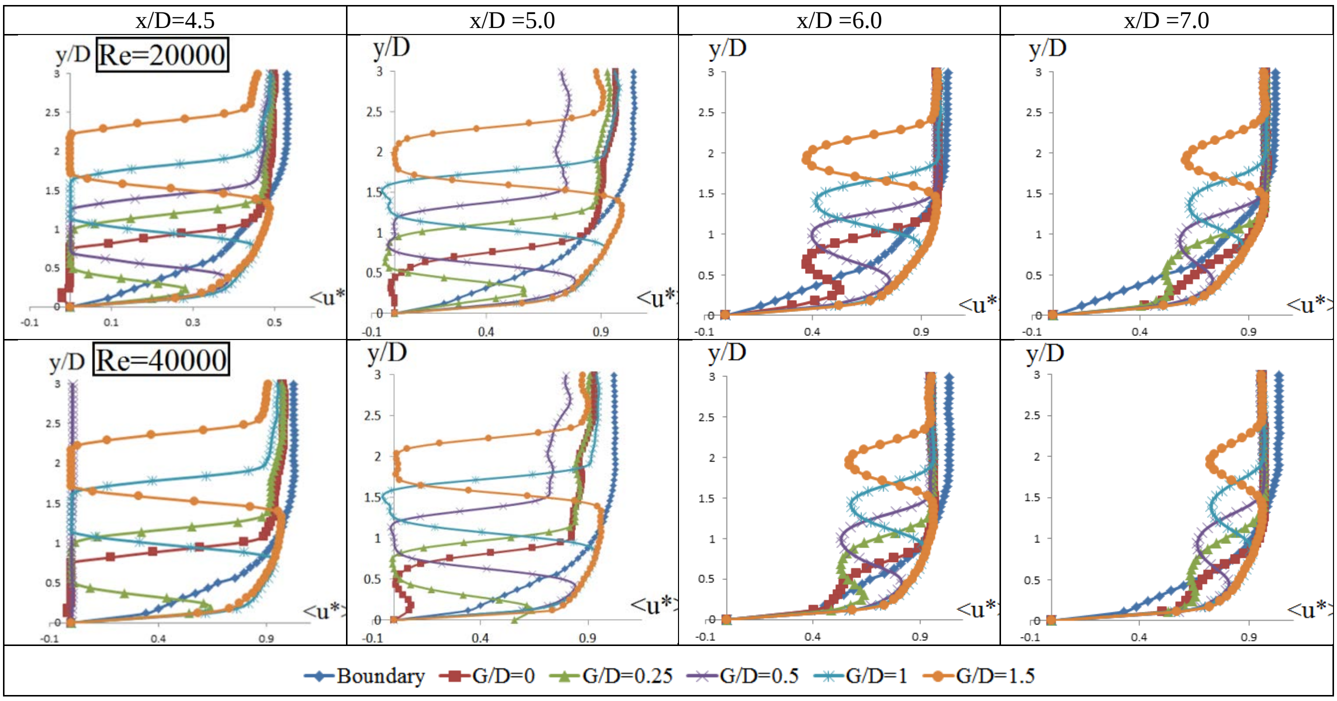

Figure 6. Distributions of time averaged streamwise velocity component <u*> along the vertical lines designated with x/D = 4.5, 5.5, 6.0 and 7.0 in the third column images of Figure 3 and 4 downstream of the torpedo at gap ratio values of 0 ≤ G/D ≤ 1.5, right column for Re = 20000 and left column for Re = 40000. Continuous line represents the boundary layer velocity profile over a flat plate in the wake region of torpedo

Figure 6 shows the time averaged streamwise velocity distributions <u*> along a vertical line. They were obtained at different values of torpedo wake region x/D= 4.5, 5.0,6.0 and 7.0 showed in the third column of Figure 4 and 5 at the gap ratios $0 \leq G/D \leq 1.5$ and for Re= 20000 and 40000. Here, the blue line that increased gradually refers to the boundary layer over a flat plate as discussed before in Figure. 3 and 4. The negative velocity components <u*> was demonstrated at gap ratio G/D=0 for both Reynolds number 20000 and 40000, in addition the negative <u*> value was occurred at G/D=0.25 and Re=20000 but it wasn't seen for Re=40000 at the same gap ratio G/D=0.25. At Re=20000 value for all gap ratios the uniform flow condition was occurred at height ratio y/D=2.5, and the same condition was occurred at y/D=2.3 for Re=40000. Different velocity distributions was demonstrated at length ratio x/D=4.5 for all gap ratios both Re=20000 and 40000 at height ratio y/D=2.5, however the velocity distributions <u*> for all gap ratios at x/D=5, 6 and 7, and height ratio y/D=2.5. The reason was the flow streamwise at different gap ratios for length ratio x/D=4.5 influenced from the boundary layer that generated at torpedo's surface.

CONCULUSION

In this paper, the effects of boundary layer on the flow characteristics of a torpedo-like geometry and the correlation investigation of these mechanisms all were done experimentally. All x-direction velocity <u*> results has been obtained under the same scale, the normalized minimum and maximum values (-0.005 and 0.94) for both Re= 20000 and 40000.
Some of the obtained points and investigation results are presented as follow:

- The effect of gap ratio, between the torpedo-like geometry and flat plate on wake region is started at G/D=0.25 and increased gradually until G/D=0.5, furthermore the effect of gap ratio decreased at G/D=1.0 which the symmetric structure has been occurred at G/D=1.5.
- For the velocity distributions <u*> obtained with influence of boundary layer on the torpedo-like geometry has been disappeared at height ratio y/D=2.5 at Re=20000, and at y/D=2.3 for Re=40000.
- The back flow at wake region of the torpedo-like geometry for the gap ratios G/D=0.25 and 0.5, the separated flow from the bottom of the torpedo-like geometry tail and the gap flow was affected on the flow structure .
- The non-uniform velocity profile of the boundary layer have been resulted in various shapes of separated shear layers from the tail of torpedo-like geometry and have resulted in changing the patterns of negative and positive values of x-directions velocity over the flat plate.

ACKNOWLEDGMENT

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INVESTIGATION OF FLOW CHARACTERISTICS AROUND A SEMI-ELLIPTICAL NOSE SHAPED CYLINDRICAL GEOMETRY AT LOWER REYNOLDS NUMBERS AND DIFFERENT ANGLES OF ATTACK

S. Yagmur[1], I. Goktepeli[2], M. Ozgoren[3], F. Kose[4], L. A. Kavurmacioglu[5], M. Kaynarcalioglu[6]

ABSTRACT

Aerospace industry has expanded with increasing defense and transport demands. In recent years, studies on new generation of high-tech aircrafts, defense systems and space vehicles have been increasing rapidly. In this study, flow characteristics around a semi-elliptical nose shaped cylindrical geometry at the attack angles of α = 0°, α = 10° and α = 20° have been analyzed numerically using with Computational Fluid Dynamics (CFD) ANSYS-Fluent program and experimentally with Particle Image Velocimetry (PIV) method in a water tunnel and also compared with each other. The purpose of this study is to minimize the drag force and increase the lift force of the model investigated. For this reason, the semi-elliptical nose shaped has been formed partially as conical. Flow characteristics around the semi-elliptical geometry such as time-averaged streamwise velocity <u>, time-averaged cross-stream velocity <v*>, time-averaged vorticity <ω*> and streamline topology have been determined in terms of using k-ω SST (Shear Stress Transport) turbulence model and PIV technique. All numerical analyses have been solved as time-averaged and unsteady in a three-dimensional control volume at Reynolds number values of Re = 32000 and Re = 64000. These results have shown that depending on the angle of attack, deformation in the wake region and instability increase the drag and lift coefficients so that more complex flow structures are observed. Flow separation occurs later in the leading edge side for the semi-elliptical model. Size of the wake region is larger for the semi-elliptical geometry case. Streamline patterns display two foci and bigger focus in the upper side of the wake region for angle of attacks values of 10°.*

Keywords – *Angle of attack, k-ω SST turbulence model, PIV, semi-elliptical, turbulent flow, wake region*

INTRODUCTION

Examination of aerodynamic flow characteristics around aerial vehicles is one of the most important areas in the defense industry and transportation sector. Even though there is water dominance in the world by 71%, it is known that especially atmosphere and land researches are widespread. For this reason, aviation applications are improving day by day. In the improvement process, it is critical to understand the flow characteristics of any aerial vehicles. For instance, varying drag and lift forces

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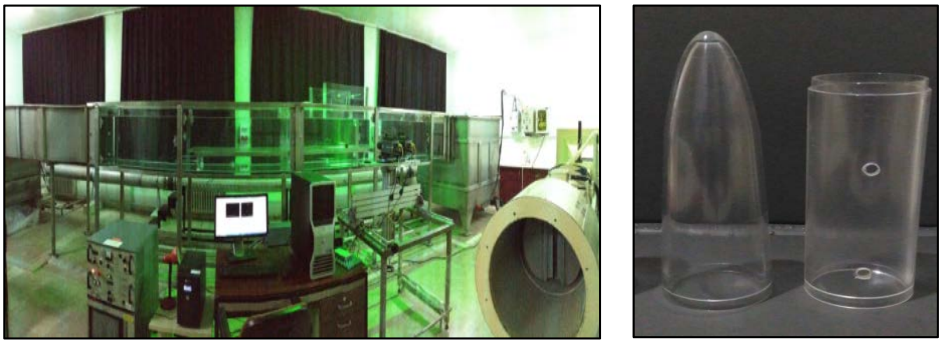
occur due to flow separation in case of pressure difference between attack and trailing edges of a body. Pressure difference and fluctuations cause excessive energy consumption and instability during the movement for a moving vehicle. Consequently, decrease of drag force acting on an aerial vehicle with its investigation in terms of scientific perspective provides both improvements for energy consumption and maneuver capability. Aerial vehicles are exposed to shock waves in case of cruising at supersonic speeds. This situation is another case encountered in aviation. Moreover, various studies about aforementioned cases are found in the literature. Ericsson (1990) has considered the effects of transition on wind tunnel simulation of vehicle dynamics. It has been explained that transition and vehicle motion were critical for the unsteady aerodynamics even in attached flow [1]. Siclari (1990) has prepared a study about asymmetric separated flows over slender bodies at supersonic speeds. Finite volume Navier-Stokes solver has been utilized to investigate asymmetric separated flows at high incidence and supersonic speeds. The presence of asymmetric flows was not unique for circular cones and also obtained for various cross-sectional shapes [2]. Koren et al. (1992) have presented a study about the aerodynamic characteristics of elongated forebodies with circular cross-section and various bluntness ratios. The experiments have been done for three cases which are at Ma = 0.1 with $\alpha = 80^\circ$; at transonic Mach numbers with $\alpha = 30^\circ$ and at Ma = 3.2 and $\alpha = 15^\circ$ [3]. Cummings et al. (1995) have investigated supersonic, turbulent flow computation and drag optimization for axisymmetric afterbodies. Numerical results of the bodies for six different diameter variations and with or without a boattail have been obtained and compared with experimental data attained from the wind tunnel [4]. Chae and Hodges (2003) have examined the dynamics and aeroelastic analysis of missiles. They have used structural formulation based on geometrically-exact mixed finite elements and also slender body theory for aerodynamics [5]. Zeiger et al. (2004) have reviewed the unsteady behavior of separated flows over slender bodies at incidence. They have expressed that the effect on the wake shapes and modes of vortex interaction was important for larger Reynolds numbers [6]. Grove and Wang (2005) have studied on a cylindrical body ogive using five different turbulence models. The geometry model consists of a three caliber nose with a cubic profile followed by a ten calibre cylindrical body. The numerical results have been compared to experimental results gathered from a test case at Ma = 2.4 and attack angles of $\alpha = 14^\circ$. They have stated that k-ω SST turbulence model gave the best results [7]. Khan et al. (2013) have evaluated the side force in oseen flow slender body theory and compared with the numerical results. They have used four different slender models with varying elliptical cross-section for the verification of the theory [8]. Kumar and Nair (2013) have utilized two corrections for Spalart-Allmaras turbulence model and examined their performance at higher angles of attack. The turbulence model has been tested for flow past an ogive cylinder at the attack angle of $\alpha = 14^\circ$. They have observed that the corrected turbulence model gave better result especially for higher Mach numbers and density gradients [9]. Ma et al. (2014) have investigated the low frequency unsteadiness of vortex wakes around an ogive-tangent cylinder at high angle of attack. The experiments have been performed at angles of attack varying from $\alpha = 60^\circ$ to $\alpha = 80^\circ$ for the range of Re = 0.6×10^5 and 1.8×10^5. In their study, the reduced frequencies of the unsteadiness were between 0.038 and 0.072 which were less than the frequency of Karman vortex shedding [10]. The aim of this study is to examine the flow structure around a semi-elliptical nose shaped cylindrical geometry both numerically and experimentally.

MATERIAL AND METHOD

Flow characteristics around a semi-elliptical nose-shaped cylindrical geometry at the attack angle of $\alpha = 0°$, 10° and 20° have been analyzed numerically using with Computational Fluid Dynamics ANSYS-Fluent program and experimentally with Particle Image Velocimetry (PIV) method in a water tunnel, and also compared with each other for Re = 32000 and Re = 64000.

Experimental Setup

Large scale open loop water channel with a rectangular cross section 6000 mm x 770 mm x 600 mm has been used in the facilities of Advanced Technology Research and Application Center of Selcuk University in Konya/Turkey as shown in Figure 1(a). The walls of the test-section were made of 15 mm thick glass plates to facilitate laser transmission and flow visualization. The water height was kept constant as h_w = 450 mm in all cases and the geometry has been located at uniform flow conditions. The water is pumped by a centrifugal pump, controlling with a frequency converter, and previously reaching the test section, passed through a honeycomb section and a two-to-one channel contraction.



(a) **(b)**

Figure 1 (a) Experimental setup and (b) the semi-elliptical nose shaped cylindrical geometry

Reynolds numbers are calculated by, $Re = U_\infty L/v$; based on the characteristic length of the geometry. Here, v is the kinematic viscosity and L is the length of the geometry that is L = 320 mm. U_∞ is the free-stream velocity in the range of 100–200 mm/s. Furthermore, the diameter of the model is D = 40 mm and length/diameter ratio is L/D = 8. The geometry has been made of acrylic glass with the 2.5 mm thickness so that the laser light easily passes through the geometry and indicated in Figure 1(b). The inner section of the geometry has been filled with water to minimize the laser light deflection. Nd:YAG laser has been utilized to generate a laser sheet which was perpendicular to the axis of the geometry and it has passed through the geometry with 15 pulse per second. The model is horizontally located at the middle section of the water channel between two walls to avoid surface and wall effects from channel bottom. Moreover, to provide the high-image- density criterion, it is enabled that the interrogation area contains nearly 20–30 particles per image. A Complementary Metal Oxide Semiconductor (CMOS) camera with a resolution of 1632 x 1200 pixels was used to record the images. The densities of the particles and water are close enough and the suspended seeding particles with a diameter of 10 μm in the flow are silver coated hollow glass spheres. Dynamic Studio software employed for the adaptive correlation algorithm including proper filters was used for computing the raw displacement vector field. An interrogation window of 32 x 32 pixels in the image was selected and converted to approximately 1.41 x 1.41 mm^2 grid size consisting of 7474 (101 x 74) velocity vectors. During the interrogation process, an overlap of % 50 has been employed in order to satisfy the Nyquist criterion. Patterns of instantaneous particle images with a 1024 images consisting of a continuous series were taken at the rate of 15 Hz to calculate the time-averaged patterns of the flow structure.

Numerical Simulation

For numerical studies, a lot of methods are used to simulate turbulent flow in the literature. In this study, flow characteristics around the cylindrical geometry of uniform flow conditions were investigated numerically by using the k-ω SST turbulence model because this model provides fast and effective approach for viscos layer of external flows. On the basis of turbulence model, the general equations of fluid mechanics Navier-Stokes and continuity equations is used. Continuity and Navier-Stokes equations for incompressible flow:

$$\nabla . \vec{V} = 0 \tag{1}$$

$$\rho \frac{\partial \vec{V}}{\partial t} = \rho \left[\frac{\partial \vec{V}}{\partial t} + (\vec{V} \cdot \nabla)\vec{V}\right] = -\nabla P + \rho \vec{g} + \mu \nabla^2 \vec{V} \tag{2}$$

where g is the gravity, P pressure, μ is the kinematic viscosity of the fluid, ρ indicates the density of the fluid. Wilcox (1988) has stated that although standard k-ω model provided high success in the boundary layer flow simulations as popular, it was computed more shear stress calculations [11]. Menter (1993), in his study, has led to improved results with small changes made in the calculation of turbulent viscosity [12]. In addition, he has ensured that these changes are in the boundary layer by adding an intelligent function of the turbulent viscosity formula.

RESULTS AND DISCUSSIONS

Flow characteristics around a semi-elliptical nose-shaped cylindrical geometry at $\alpha = 0°$, $\alpha = 10°$ and $\alpha = 20°$ angles of attack have been analyzed numerically using with k-ω SST turbulence model in terms of CFD and experimentally with Particle Image Velocimetry (PIV) method in a water tunnel, and also compared with each other for Re = 32000 and Re = 64000. Moreover, time-averaged streamwise velocity components <u*>, time-averaged cross-stream velocity components <v*> time-averaged vorticity <ω*> and streamline topology <Ψ> have been obtained and then shown in Figure 2, Figure 3 and Figure 4 for these different cases mentioned above. The maximum and minimum values have been given with a legend bar for the contours in each figures and divided with 15 levels. The positive layers of flow patterns have been displayed with continuous line contours as red background color, while the negative layers have been indicated with dashed line contours as blue background color.

In Figure 2, both CFD and PIV results show same minimum and maximum levels of the values of streamwise velocity contours <u*> at Re = 32000 and Re = 64000 for the attack angle of $\alpha = 0°$. Negative velocity values have been attained near to the symmetry axis of the model. When Reynolds number increased to Re = 64000, wake region became closer to the model. Another deduction is that the center point of the negative values shrank due to increase in Reynolds number. Contour ranges for both CFD and PIV results are $-0.02 \leq \langle u^* \rangle \leq 0.1$ and $-0.05 \leq \langle u^* \rangle \leq 0.2$ at Re = 32000 and Re = 64000, respectively. Here, time-averaged cross-stream velocity components <v*> have been indicated in Figure 2. The symmetrical flow distribution with $-0.013 \leq \langle v^* \rangle \leq 0.013$ for Re = 32000 and $-0.03 \leq \langle v^* \rangle \leq 0.03$ for Re = 64000 has been clearly observed. Time-averaged cross-stream velocity values are approximately zero through the symmetry axis of the model at y/D = 0. Over the symmetry axis of the model, negative values have been obtained whereas positive ones have been observed at the lower region of the geometry. However, smaller clusters belong to the cross-stream velocity contours have also been seen at the region adjacent to the model where $8 \leq x/D \leq 8.1$ as seen in the results of CFD. Time-averaged vorticity contours <ω*> have been presented in Figure 2. With respect to the given contours, nearly symmetrical distributions of vorticity values have been obviously seen as $-16 \leq \langle \omega^* \rangle \leq 16$ for Re = 32000 and $-30 \leq \langle \omega^* \rangle \leq 30$ for Re = 64000. Due to flow separation, two different regional clusters in terms of vorticity have been attained. Here, negative values have been obtained at the upper side of the model while vice versa for positive values. In the meantime, zero values of vorticity contours have been found in the vicinity of the symmetry axis or at y/D = 0. Smaller clusters have also been observed for vorticity contours in the downstream of the model in which $8 \leq x/D \leq 8.05$ for $\alpha = 0°$. Some reflection on the geometry because of manufacturing defect of the model occurred; the presence of symmetrical flow structure has not been detected smoothly for streamline patterns <ψ> of the geometry in Figure 2. Over here, F_1 and F_2 indicate the foci of the rotational flow field in a limit cycle, S is saddle point and it represents free stagnation point in the flow field.

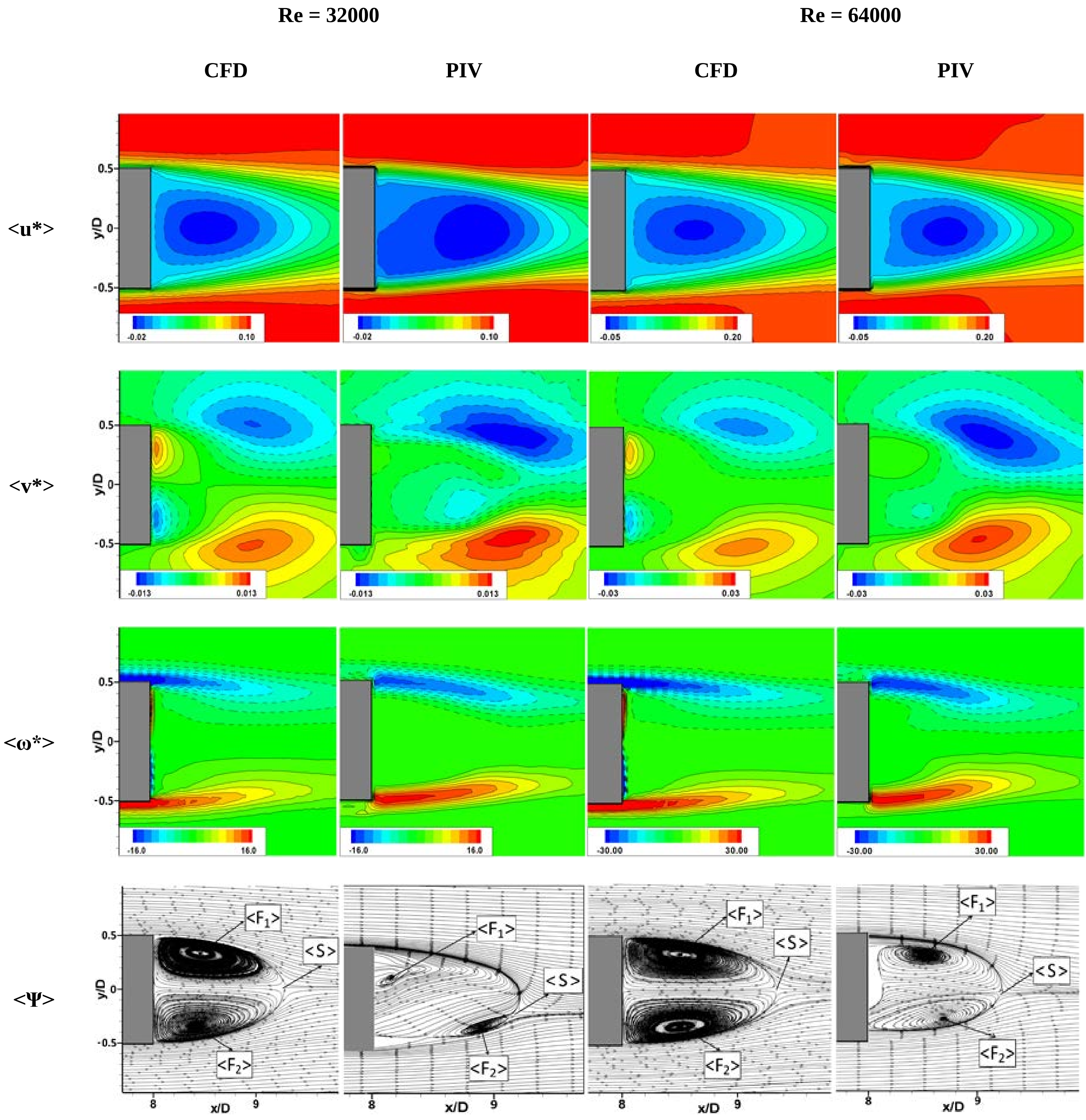


Figure 2 Comparison of time-averaged streamwise velocity components <u*>, time-averaged cross-stream velocity components <v*>, time-averaged vorticity <ω*> and streamline topology <Ψ> for the semi-elliptical nose shaped cylindrical geometry at Re = 32000 and Re = 64000 in case of attack angle of α = 0°

In addition, certain symmetrical flow structure has been provided and nearly two foci points are symmetrical with respect to each other in case of CFD results. However, PIV results were not sufficient enough for the representation of the symmetrical distribution as there were asymmetrical foci points obtained in the wake region. Saddle points in terms of three cases except for PIV result at Re = 32000, have been acquired around the symmetry plane of the model.

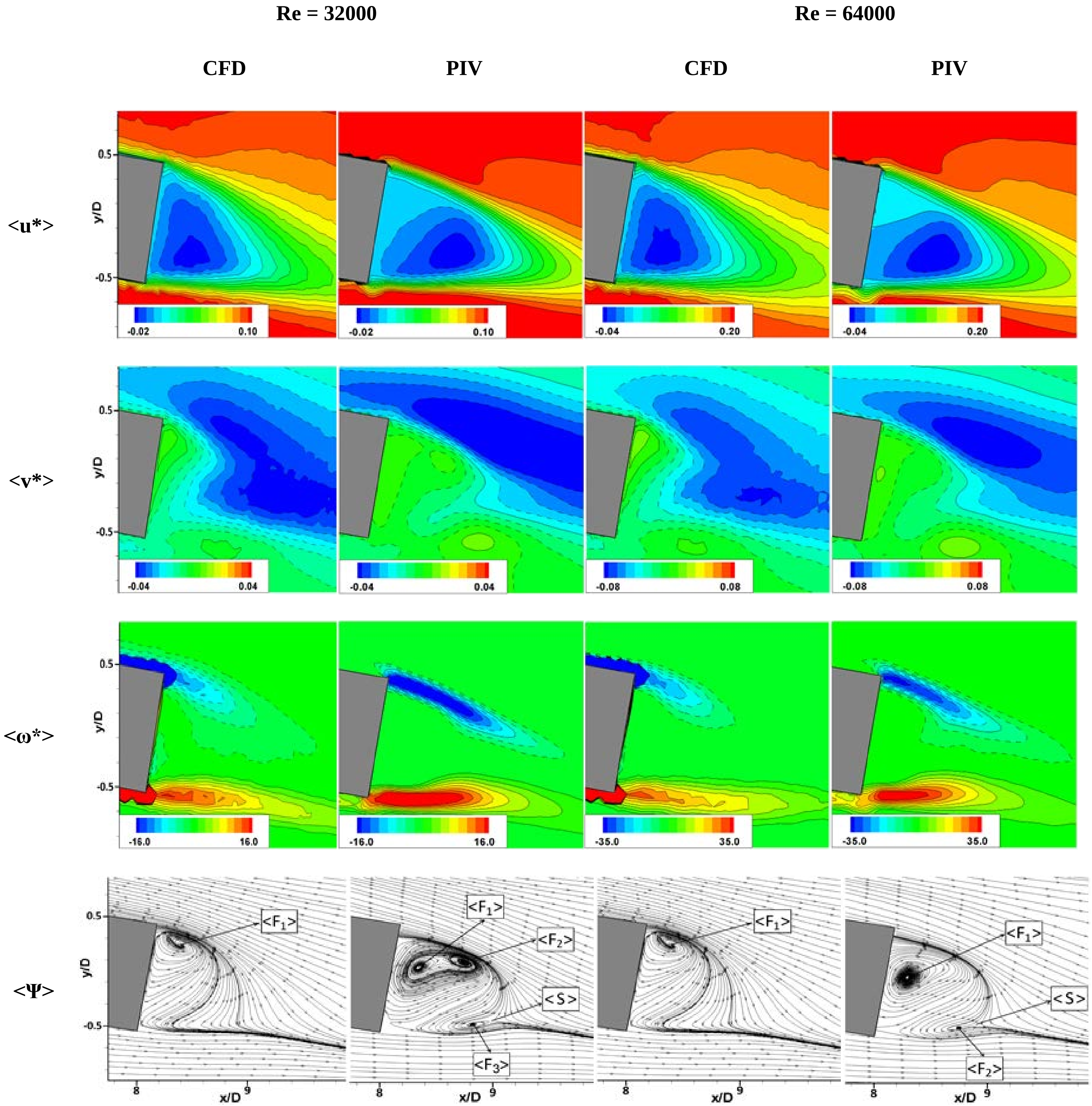


Figure 3 Comparison of time-averaged streamwise velocity components <u*>, time-averaged cross-stream velocity components <v*>, time-averaged vorticity <ω*> and streamline topology <Ψ> for the semi-elliptical nose shaped cylindrical geometry at Re = 32000 and Re = 64000 in case of attack angle of α = 10°

In Figure 3, streamwise velocity contours <u*> have been presented at Re = 32000 and Re = 64000 for the attack angle of α = 10°. Dissymmetrical distribution of streamwise velocity contours have been observed for all cases due to angle of attack. Negative velocity values have been obtained but the center point of the cluster was at the lower region of the model where the intersection point of x/D = 8.4 and y/D = -0.4, approximately.

Re = 32000 **Re = 64000**

CFD **PIV** **CFD** **PIV**

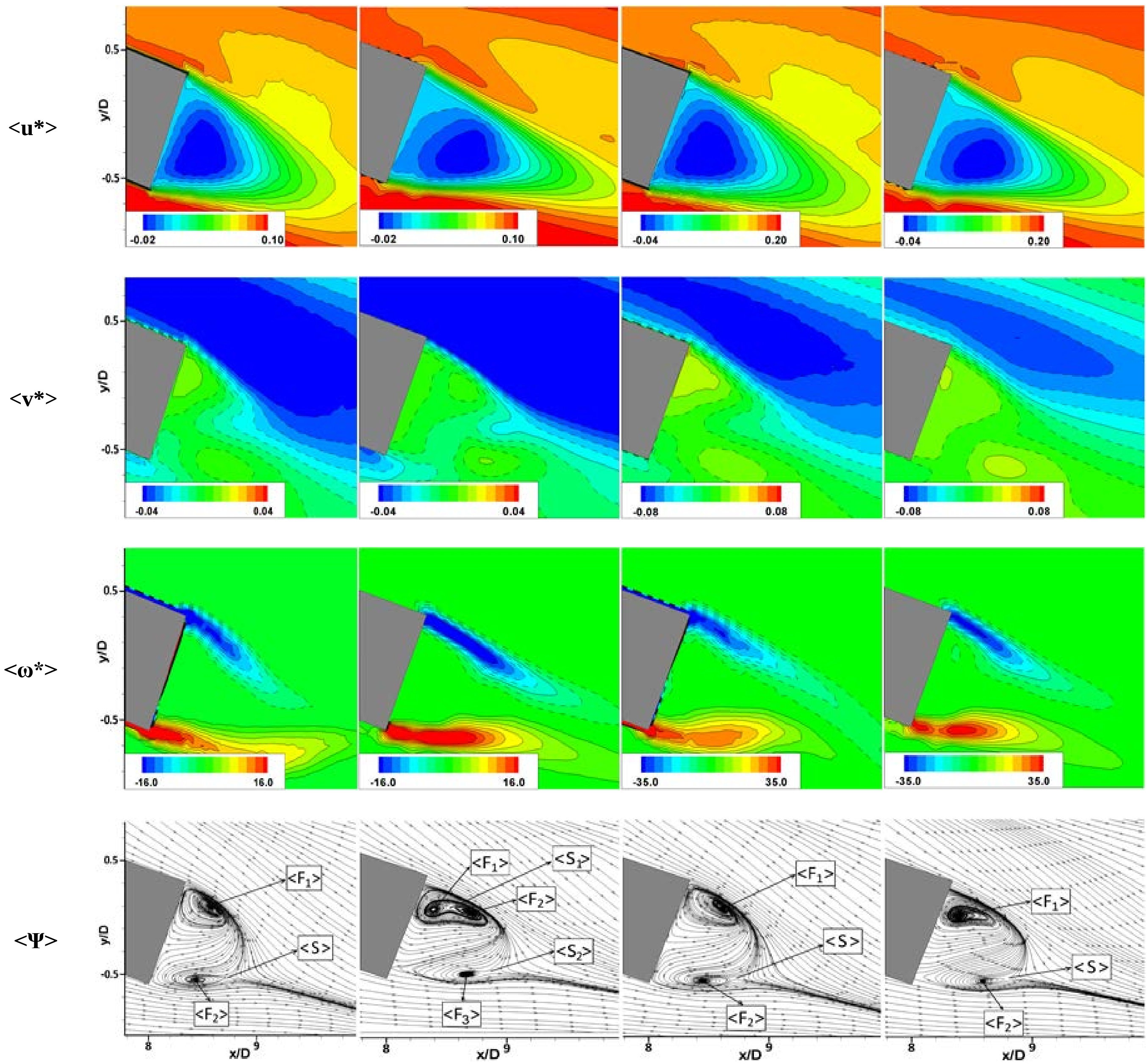


Figure 4 Comparison of time-averaged streamwise velocity components <u*>, time-averaged cross-stream velocity components <v*>, time-averaged vorticity <ω*> and streamline topology <Ψ> for the semi-elliptical nose shaped cylindrical geometry at Re = 32000 and Re = 64000 in case of attack angle of α = 20°

These clusters tended to enlarge because of rise in Reynolds number. However, the distinct difference between CFD and PIV results has been found especially in the wake region. In the given legends, contour ranges have been attained for both CFD and PIV results are $-0.02 \leq \langle u^* \rangle \leq 0.1$ and $-0.04 \leq \langle u^* \rangle \leq 0.2$ at Re = 32000 and Re = 64000, respectively. Moreover, time-averaged cross-stream velocity components $\langle v^* \rangle$ have been given in Figure 3. The symmetrical flow distribution has been lost when compared the reference case of $\alpha = 0°$. This situation has formed asymmetrical flow structure causing the pressure difference between the upper and lower regions of the model. Here, these values range with $-0.04 \leq \langle v^* \rangle \leq 0.04$ for Re = 32000 and $-0.08 \leq \langle v^* \rangle \leq 0.08$ for Re = 64000. Negative values of cross-stream velocity components have been found at the upper zone of the symmetry axis passing through y/D = 0. The cluster with the minimum value of cross-stream velocity component has shrunk and lost its dominancy in the wake region due to increase in Reynolds number. Asymmetrical distributions of vorticity values have been clearly observed. The values are in the intervals of $-16 \leq \langle \omega^* \rangle \leq 16$ for Re = 32000 and $-35 \leq \langle \omega^* \rangle \leq 35$ for Re = 64000. Due to attack angle, there is dominancy for positive values around the model especially at the lower part of the model. In addition, with the increasing Reynolds number, the clusters have got smaller by size. Moreover, vorticity values are zero along the symmetry axis of the model in which y/D = 0. Although, smaller clusters have been obtained for vorticity contours in the downstream of the geometry in case of $\alpha = 0°$, there are any obtained eddies for $\alpha = 10°$ due to fluctuations in the wake region. Manufacturing defect of the model triggered the reflection in the vicinity of the geometry, streamline patterns $\langle \psi \rangle$ differed in the wake region in terms of foci and saddle points. F_1, F_2 and F_3 define the foci of the rotational flow field in a limit cycle, S is saddle point and it represents free stagnation point in the flow field. However, saddles points have been observed for only PIV results whereas no available for CFD results. Additionally, three foci points have been seen for PIV results at Re = 32000 while there were only two ones for again PIV results at Re = 64000. Finally, CFD results have presented only one focus point in the wake region for each case.

Streamwise velocity contours $\langle u^* \rangle$ have been given at Re = 32000 and Re = 64000 for the attack angle of $\alpha = 20°$ in Figure 4. In the presence of attack angle, asymmetrical distribution for streamwise velocity contours has been obtained for all cases. Negative velocity values have been attained and the center point of the cluster was at the lower region of the model. Clusters having minimum values have got bigger a little after the rise in Reynolds number for only CFD results. On the other hand, clusters having minimum values have shrunk by size due to increasing Reynolds number. Here, contour ranges for both CFD and PIV results are $-0.02 \leq \langle u^* \rangle \leq 0.1$ and $-0.04 \leq \langle u^* \rangle \leq 0.2$ at Re = 32000 and Re = 64000, respectively. Furthermore, time-averaged cross-stream velocity components $\langle v^* \rangle$ have been presented in Figure 4. It is not possible to mention about symmetry in flow structure for the attack angle of $\alpha = 20°$. For instance, negative velocity values were highly dominant at the upper region of the model. However, negative values have lost its superiority over positive values as a result of increase in Reynolds number. The pressure difference between the upper and lower regions of the symmetry axis have been found as a consequence of dissymmetrical flow structure related with the increasing angle of attack. Over here, the intervals for cross-stream velocity components are $-0.04 \leq \langle v^* \rangle \leq 0.04$ for Re = 32000 and $-0.08 \leq \langle v^* \rangle \leq 0.08$ for Re = 64000. When time-averaged vorticity contours are investigated, the existence of attack angle has caused asymmetrical flow structure around the trailing edge of the model. Positive time-averaged vorticity values have been attained at the lower region of the symmetry axis while negative values were at the upper zone. Due to the difference between the upper and lower region of the model, pressure difference has been observed. Lastly, streamline patterns around the model have been presented in Figure 4 and approximately same results have been seen in terms of foci and saddle points. F_1, F_2 and F_3 define the foci of the rotational flow field in a limit cycle, S is saddle point and it represents free stagnation point in the flow field. However, the streamline topology obtained from experimental PIV results at Re = 32000 was different when compared with other cases in terms of foci points. On the other hand, the positions of foci and saddle points have matched.

CONCLUSIONS

In present study, flow structures around a semi-elliptical nose-shaped cylindrical geometry have been examined under the effect of attack angles following $\alpha = 0°$, $\alpha = 10°$ and $\alpha = 20°$. Numerical analyses have been completed by using k-ω SST turbulence model in terms of CFD while the experiments have been done with PIV method in a water tunnel. As a consequence, the obtained results have been compared at Re = 32000 and Re = 64000. Time-averaged flow fields have indicated symmetrical flow patterns at attack angle of $\alpha = 0°$ occurring along the symmetry axis of the semi-elliptical nose shaped cylindrical geometry. However, the symmetrical flow structure has been broken down by the increasing attack angle. For vorticity patterns, attack angle plays an important role because the positive values of vorticity are more dominant than the negative values of vorticity due to the increase of attack angle. Angle of attack has also affected the wake region of the geometry. With the increase in angle of attack, wake region has moved away from downstream to the lower region of the trailing part of model. It is an obtained result that the flow structure due to the changing angle of attack has caused to increase pressure coefficient of the model and hence drag and lift coefficients as well.

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INVESTIGATION ON HYDRODYNAMIC CHARACTERISTICS OF A TORPEDO-LIKE GEOMETRY VIA DIFFERENT TURBULENCE MODELS AND PIV

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ABSTRACT

Traditionally autonomous underwater vehicles have been built with a torpedo-like shape. When the torpedo like geometry moves underwater; the tail experiences a cross flow velocity component forming swirling vortex stream in the wake region. The purpose of this study is to improve the understanding of the hydrodynamic characteristics of a torpedo like geometry through quantitative and qualitative approaches. In this manner, the flow characteristics in the wake region of a torpedo-like geometry positioned in a uniform flow condition have been investigated in detail by using Particle Image Velocimetry (PIV) and computational fluid dynamics (CFD) methods. The investigation is carried out experimentally in an open water channel by using PIV for free stream velocities of 0.1 and 0.2 m/s and corresponding Reynolds numbers of Re = 20000 and 40000 based on the model length, respectively. Moreover, instantaneous and time-averaged velocity vector fields and vortices, streamwise and cross-stream velocity components, standard deviation of streamwise and cross-stream wise velocity, turbulence kinetic energy and streamline topology have been utilized to explain the flow structures. The experimental results were compared and discussed with obtained from Large Eddy Simulation (LES), k-ε RNG and k-ω SST turbulence models in terms of hydrodynamic flow characteristics. It is shown that LES method can be preferred to estimate the hydrodynamic features of a torpedo like geometry due to occurring difference in the range of approximately ± 5.1 % between PIV and CFD. The k-ε RNG turbulence model was failed to capture flow fluctuations in the wake region. The small and large eddies were partially occurred when the turbulence model k-ω SST was used, but the time averaged flow characteristics were not matched well with the PIV results. The behaviors of drag and lift forces around the model were also examined, numerically. Drag coefficients found from CFD calculation by LES have a good harmony with literature.

Keywords − *CFD, hydrodynamic, PIV, torpedo, turbulence model*

INTRODUCTION

It is known fact that oceans and seas cover 71 % of the Earth surface. For this reason, it is important to have knowledge about underwater world. With this perspective, the deeps of seas and oceans have been investigated by scientists and engineers to contribute for the improvement of underwater

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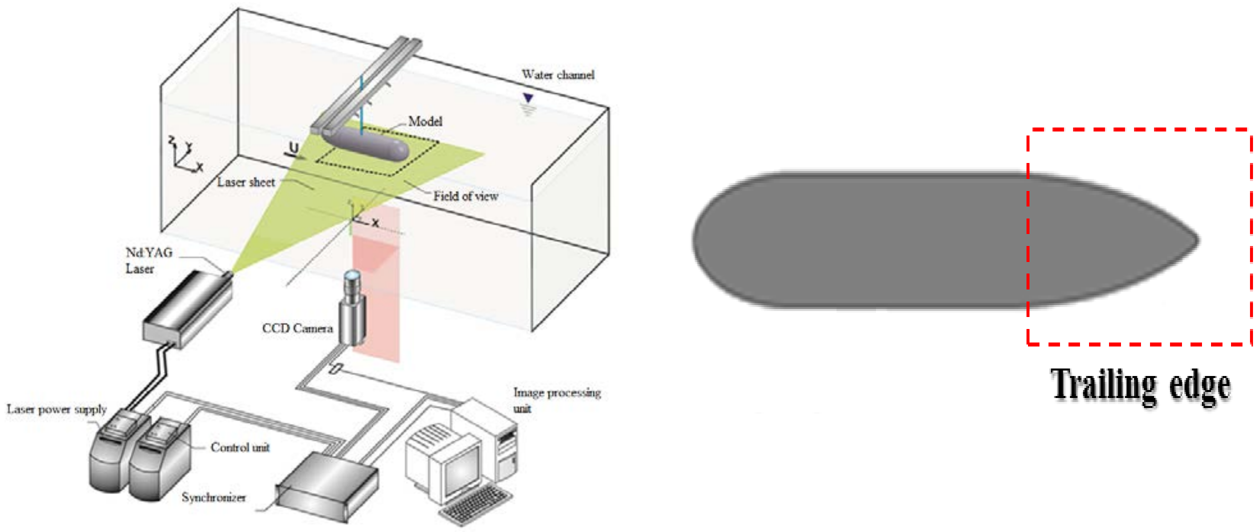
vehicles. In the development process, hydrodynamic characteristics of an underwater vehicle play important role. Hydrodynamic characteristics of an underwater vehicle are not only determined with experimental study but also numerically by using CFD. In the numerical part of a study, turbulence models of CFD are benefitted to present the closest results to the experimental study. However, it is uncertain that which turbulence model is appropriate for the numerical analyses and the choice of a turbulence model shows an alternation case by case. In the literature, different turbulence models are tested with respect to the experimental results as a preliminary study. With this approach, Large Eddy Simulation (LES), k-ε Re-Normalisation Group (RNG) and k-ω Shear Stress Transport (SST) turbulence methods have been applied as these turbulence models are the most preferred ones in the literature. The obtained results of these turbulence models have been compared with PIV results. In the literature, various studies related with the hydrodynamic characteristics of these underwater vehicles are encountered. Givler et al. (1991) have examined the vorticities in the wake region of underwater models at Re = 1.2×10^7 by using k-ε turbulence model [1]. Rodi (1997) has compared LES and RANS calculations of the vortex shedding flow past a square cylinder at Re = 22000 and the 3-D flow past a surface-mounted cube at Re = 40000. His comparative study has showed that LES was more suitable for the numerical analyses of these complex flows [2]. Sarkar et al. (1997) have simulated the flow over axisymmetric bodies with four different turbulence models which were standard k-ε turbulence model, Chen and Kim-modified k-ε turbulence model, RNG-derived k-ε turbulence model and Lam-Bramhorst turbulence model. They have stated that the standard k-ε turbulence model for high Reynolds numbers was enough to present flow characteristics when it was compared with other k-ε turbulence models. For low Reynolds numbers, Lam-Bramhorst turbulence model has been found as successful for wall-related quantities [3]. Schmidt and Thiele (2002) have analogized the numerical methods applied to the flow over wall-mounted cubes. They have considered Detached Eddy Simulation (DES), LES and RANS for the comparison at Re = 1.3×10^4. The results have clearly demonstrated that DES and LES were very successful to capture the most dominant flow patterns [4]. Fasel et al. (2010) have examined the laminar separation bubbles in external flows. They have employed highly-resolved direct numerical simulations to attain in-depth comprehension of the several physical mechanisms that govern separation, transition and reattachment. Hybrid RANS/LES simulations have also been performed for a turbulent square-duct [5]. Karim et al. (2011) have done a study on bare submarine hull and six axisymmetric bodies by using SST k-ω model. In their paper, a number of length-diameter (L/D) ratios ranging from 4 to 10 have been used as geometrical parameters. The obtained results have been compared with previous studies [6]. Dantas and de Barros (2013) have investigated the hydrodynamic effects for an autonomous underwater vehicle at different attack angles both experimentally and numerically and then they have stated that the most appropriate model for this case was k-ω SST turbulence model [7]. Elkhoury (2016) has assessed the turbulent models for the simulation of turbulent flows past bluff bodies with respect to the experimental data. He has investigated both the unsteady 3-D flow past a square cylinder at Re = 2.2×10^4 and the 3-D flow over a wall-mounted cube at Re = 4×10^4. In the study, LES has been indicated as a capable one for the 3-D simulation of building aerodynamics when compared with other turbulence models in compliance with experimental results [8]. Fureby et al. (2016) have examined a generic conventional submarine at yaw angle of 10˚. PIV system integrated to a wind tunnel with has been used for the experimental part of the study while LES turbulence model has been utilized to obtain numerical results [9]. Skarolek and Karabelas (2016) have numerically studied on the flow past an aircraft wing by using LES turbulence model at Re = 2.5×10^6 while the attach angles varying from 4˚ to 12˚. At lower attack angles, drag acting on this aircraft wing was decreased by approximately 40% as a maximum percentage [10].

In this study, the experimental results were compared and discussed with obtained from Large Eddy Simulation (LES), k-ε RNG and k-ω SST turbulence models in terms of hydrodynamic flow characteristics for the flow structures of a torpedo-like geometry.

MATERIAL AND METHOD

Experimental Setup

Large scale open loop water channel with a rectangular cross section 6000L x 770W x 600H mm has been used. The walls of the test-section were made of 15 mm thick transparent and glass plates to facilitate laser transmission and flow visualization. An overview of the experimental setup is indicated in Figure 1(a). Before reaching the test chamber, the water was pumped into a settling chamber and passed through a honey-comb section. The water height was kept constant as hw = 470 mm in all cases and the geometry has been located in uniform flow condition. The Reynolds numbers are calculated by, Re= $U_\infty L/v$; based on the characteristic length of the geometry. Here, ν is the kinematic viscosity of water and L is characteristic length of the torpedo-like geometry, U_∞ is the free-stream velocity and it is U_∞=200 mm/s in present study. The geometry has diameter of 40 mm and length of 200 mm. The geometry has been made of acrylic glass with the 2.5 mm thickness so that the laser light easily passes through the geometry. The geometry surface has been highly polished to avoid the effects of surface roughness. The inner section of the geometry has been filled with water to minimize the laser light deflection. Nd:YAG laser has been utilized to generate a laser sheet which was perpendicular to the axis of the geometry and laser sheet inside the flow field was approximately 1 mm. A CCD camera with a resolution of 1632 x 1200 pixels was used to capture 2048 image at the rate of 15 HZ to calculate 1024 vector fields. The densities of the particles and water are close enough and the suspended seeding particles with a diameter of 10 μm in the flow are silver coated hollow glass spheres. Furthermore, the high-image-density criterion was contented by ensuring that a minimum of approximately 20–30 particles was contained within the interrogation area. Dynamic Studio software employing the adaptive correlation algorithm including proper filters was used for computing the raw displacement vector field from the particle image data. An interrogation window of 32 x 32 pixels in the image was selected and converted to approximately 1.41 x 1.41 mm^2 grid size consisting of 7474 (101 x 74) velocity vectors. During the interrogation process, an overlap of % 50 has been employed in order to satisfy the Nyquist criterion. Due to the stable flow characteristics on the mid-section of torpedo like geometry, the experiments were only completed at the region of trailing edge of torpedo like geometry shown in Figure 1(b).



(a) (b)

Figure1. (a) Schematic figure of experimental setup, (b) Interested flow field of trailing edge of torpedo like geometry

Numerical Study

The governing equations for an incompressible flow form of the continuity equation and the Reynolds Averaged Navier-Stokes are specified below in the following equation:

$$\frac{\partial \bar{u}_i}{\partial x_i} = 0 \tag{1}$$

$$\frac{\partial \bar{u}_i}{\partial t} + \frac{\partial \bar{u}_i \bar{u}_j}{\partial x_j} = \frac{1}{p}\frac{\partial \bar{p}}{\partial x_i} - \frac{\partial \tau_{ij}}{\partial x_j} + v\frac{\partial^2 \bar{u}_i}{\partial x_i \partial x_j} \tag{2}$$

where u_i are the filtered velocity components along the Cartesian coordinates x_i, p is the pressure, q is the fluid density and v is the kinematic viscosity of the fluid.

k-ε Turbulence Model: The model transport equation for k is derived from the exact equation, while the model transport equation for ε was obtained using physical reasoning and bears little resemblance to its mathematically exact counterpart. The turbulence kinetic energy, k, and its rate of dissipation, ε, are obtained from the following transport equations:

$$\frac{\partial}{\partial t}(\rho k) + \frac{\partial}{\partial x_j}(\rho k u_i) = \frac{\partial}{\partial x_j}\left[\left(\mu + \frac{\mu_t}{\sigma_k}\right)\frac{\partial k}{\partial x_j}\right] + G_k + G_b - \rho\varepsilon - Y_M + S_k \tag{3}$$

$$\frac{\partial}{\partial t}(\rho \varepsilon) + \frac{\partial}{\partial x_j}(\rho \varepsilon u_i) = \frac{\partial}{\partial x_j}\left[\left(\mu + \frac{\mu_t}{\sigma_\varepsilon}\right)\frac{\partial \varepsilon}{\partial x_j}\right] + G_{1\varepsilon}\frac{\varepsilon}{k}(G_k + G_{3\varepsilon}G_b) - G_{2\varepsilon}\rho\frac{\varepsilon^2}{k} + S_\varepsilon \tag{4}$$

In these equations, G_k represents the generation of turbulence kinetic energy due to the mean velocity gradients, G_b is the generation of turbulence kinetic energy due to buoyancy, Y_M represents the contribution of the fluctuating dilatation in compressible turbulence to the overall dissipation rate, C_1, C_2, and C_3 are constants. σ_k and σ_ε are the turbulent Prandtl numbers for k and ε, respectively. S_k and S_ε are user-defined source terms.

k-ω Turbulence Model: The standard k-ω model is an empirical model based on model transport equations for the turbulence kinetic energy (k) and the specific dissipation rate (ω), which can also be thought as the ratio of k. As the k-ω model has been modified over the years, production terms have been added to both the k and ω equations, which have improved the accuracy of the model for predicting free shear flows.

$$\frac{\partial}{\partial t}(\rho k) + \frac{\partial}{\partial x_j}(\rho k u_i) = \frac{\partial}{\partial x_j}\left[\left(\mu + \frac{\mu_t}{\sigma_k}\right)\frac{\partial k}{\partial x_j}\right] + G_k - Y_k + S_k \tag{5}$$

$$\frac{\partial}{\partial t}(\rho \omega) + \frac{\partial}{\partial x_j}(\rho \omega u_i) = \frac{\partial}{\partial x_j}\left[\left(\mu + \frac{\mu_t}{\sigma_k}\right)\frac{\partial \omega}{\partial x_j}\right] + G_\omega - Y_\omega + S_\omega \tag{6}$$

In these equations, G_k represents the generation of turbulence kinetic energy due to the mean velocity gradients. G_ω represents the generation of ω. Γ_k and Γ_ω represent the effective diffusivity of k and ω, respectively. Y_k and Y_ω represent the dissipation of k and ω due to turbulence. All of the above terms are calculated as described below. S_k and S_ω are user-defined source terms.

Large Eddy Simulation Turbulence Model: The fundamental principle of Large Eddy Simulation (LES) turbulence model is based on low transitional filtration method. LES turbulence model enables the separation of large scaled and small scaled eddies from each other through filtration technique [11]. In the spatially filtered Navier-Stokes equation, the sub-grid scale (SGS) stress is given. In this equation, the effect of small scaled eddies on larger ones for small scaled stress tensors is evaluated as:

$$\tau_{ij} = \overline{u_i u_j} - \bar{u}_i \bar{u}_j \tag{7}$$

The eddy-viscosity type SGS models are based on Boussineq's assumption and these models are employed as:

$$\tau_{ij} - \frac{1}{3}\tau_{kk}\delta_{ij} = -2\mu_t \bar{S}_{ij} \tag{8}$$

where τ_{kk} is the strain residuals in a subgrid scale. In a subgrid scale, fluid viscosity is symbolized with μ_t and $\bar{S}_{ij}$ is the rate of strain tensor computed from the resolved scales.

Flow Domain and Boundary Condition: The model has been positioned at the center of the 3-D flow volume and its diameter is 40 mm and its length is 200 mm. The orientation of the model in the 3-D flow volume has been indicated in Figure 2 by referencing the length in terms of diameter (D).

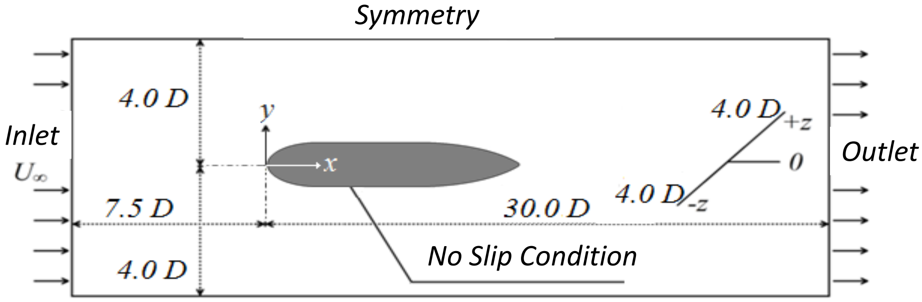


Figure 2. The flow volume and boundary conditions for the torpedo-like geometry

As shown in Figure 2, boundary conditions defined as a velocity inlet for inlet, pressure outlet for outlet, no slip boundary condition for body face interaction and finally symmetry boundary condition for out of the flow domain wall. Because of detail investigation at the closer region of wall and wake region of torpedo, and solution time and computer capacity the flow domain was divided into three parts. With describing different cell length for mesh generation, cell sizes were obtained in the created flow volume 1 million, 2.5 million, 11million and 55 million, respectively. Mesh independence study was done with these coarsen and fined grid size considering the variation of the drag coefficient (C_D) of torpedo like geometry with respect to the grid size for LES turbulence models in Table 1 at Re=40000. As seen in Table 1, the C_D changes with the grid size and the difference is about 2% when the values of grid size increase from 11 million to 55 million. For low grid size of flow domain percentage of difference between the C_D values and stream-wise velocity profile at the section x/D=5.0 are high and for transient analyses and it is hard to capture vortex shedding. Therefore, 11 million grid size of flow domain was used to analyses flow field, grid size effect on the C_D was small enough and it requires less computer capacity than 55 million mesh grid size. The nearest distance to the wall is defined as y^+ in the literature, has been found as 1.037 as a result of this study.

Table 1. Font Sizes and Type Styles

Grid size	Drag Coefficient
1 Million	0.183
2.5 Million	0.1796
11 Million	0.1665
55 Million	0.167

All CFD analyses completed with time resolved analyses. For transient analyses each steps, it has been taken as $\Delta t = 0.068$ seconds and throughout 68 seconds, 1024 images of the analyses have been captured. Convergence criteria defined as 10^{-8}.

RESULTS AND DISCUSSION

The flow characteristics around a torpedo-like geometry have been investigated by PIV. Following figures (Figure. 3, 4 and 5) indicate the comparison of PIV and different turbulence models k-ε, k-ω and LES at Re = 20000 and Re = 40000, respectively. As shown in Figure 1(b), interrogation area of the torpedo-like geometry has been considered. Time-averaged normalized vorticity $<\omega^*=\omega L/U_\infty>$, time-averaged normalized streamwise velocity components $<u^*=u/U_\infty>$, time-averaged normalized cross-stream velocity components $<v^* = v/U_\infty>$, time-averaged normalized turbulence kinetic energy values $<T.K.E.^* = T.K.E./U_\infty^2>$ and streamline topologies $<\psi>$ around the geometry have been obtained. The dimensions of all images have been normalized with the diameter of the torpedo-like geometry as x/D and y/D. The maximum and minimum values are given with a legend bar for the contours in each figure and divided with 15 levels for all minimum and maximum limits. The positive layers of flow patterns are displayed with continuous line contours as red background colour, while the negative layers are indicated with dashed line contours as blue background colour. In Figure 3, instantaneous vector and vorticity contours obtained from PIV, LES, k-ε RNG and k-ω SST results for a reference torpedo-like geometry have been presented at Re = 20000 and Re = 40000. In vorticity contours, various vorticity components with various sizes occurred in the wake region of the model. This situation shows that there is a chaotic flow structure in the wake region, negative and positive values of vorticity contours form due to these fluctuations. These vorticities are proofs of the presence of turbulence and fluctuations in the flow structure. For the uniform conditions, flows structure in the wake region of a reference torpedo-like geometry have been given for Re = 20000 in Figure 4. When the time-averaged velocity vectors $\langle V \rangle$ are examined, dense distribution of velocity vectors form because of intense mesh structure nearby the torpedo-like geometry. After the comparison of turbulence models, the closest result to the PIV results has been attained by LES turbulence model. While the time-averaged vorticity contours $\langle \omega^* \rangle$ were investigated, LES and k-ω SST turbulence models presented good agreement with experimental PIV results. Clockwise and counter clockwise vorticity contours have been observed in the wake region of the model. However, little difference between LES and k-ω SST turbulence models is the distribution in the wake region. Vorticities elongated to the wake region from the flow separation point in terms of LES and PIV results. While streamwise velocity components $\langle u^* \rangle$ are taken into account, there are not any negative values of time-averaged streamwise velocity components for k-ε RNG turbulence model and the range of the values is $0.01 \le \langle u^* \rangle \le 1.01$ for this case. On the other hand, negative values of time-averaged streamwise velocity components have been obtained by k-ω SST turbulence model in the range of $-0.05 \le \langle u^* \rangle \le 1.01$. In terms of obtained values and the form of the wake region, there is an agreement between the results of PIV and LES methods, substantially.Velocity values are $-0.02 \le \langle u^* \rangle \le 1.1$ for PIV results and also $-0.03 \le \langle u^* \rangle \le 1.05$ for LES turbulence model. In addition to this, the flow seperation point at *4.3D* is nearly same for PIV and LES results. Flow seperation could not be obtained for k-ε RNG turbulence model. Moreover, the flow seperation point is *4.5D* far from the nose tip for k-ω SST turbulence model. The stagnation point of the flow in the wake region is *1.0D* far from the trailing region of the geometry for PIV and also *1.2D* far from the trailing region of the geometry for LES. In terms of k-ω SST turbulence model, it is *0.4D* far from the trailing edge, but there is not any stagnation point obtained for k-ε RNG turbulence model. When cross-stream velocity components $\langle v^* \rangle$ are considered in Figure 4, negative and positive values of cross-stream velocity components have been obtained. Maximum positive and negative values in the wake region occurred at the point of *1.2D* far from the trailing edge, the range of PIV results is $-0.085 \le \langle v^* \rangle \le 0.085$ and also $-0.07 \le \langle v^* \rangle \le 0.07$ for LES turbulence model. Besides, maximum positive and negative velocity fields have been observed near to the surface of the trailing edge for k-ω SST and k-ε RNG turbulence models and the ranges are $-0.09 \le \langle v^* \rangle \le 0.09$ and $-0.08 \le \langle v^* \rangle \le 0.08$ for k-ω SST and k-ε RNG turbulence models, respectively. In Fig. 6, root mean square of streamwise velocity components $\langle u^*_{rms} \rangle$ and root mean square of cross-stream velocity components $\langle v^*_{rms} \rangle$ have also been presented and a good agreement between PIV and LES results has been attained. Root mean square of streamwise velocity components reached to the maximum values at two different locations in the wake region in the wake region. Maximum values have been observed at the points of *1.6D* and *1.5D* far from the trailing regions for PIV and LES results, respectively. In both PIV and LES methods, the ranges of the values are same and equal to $0 \le \langle u^*_{rms} \rangle \le 0.125$.

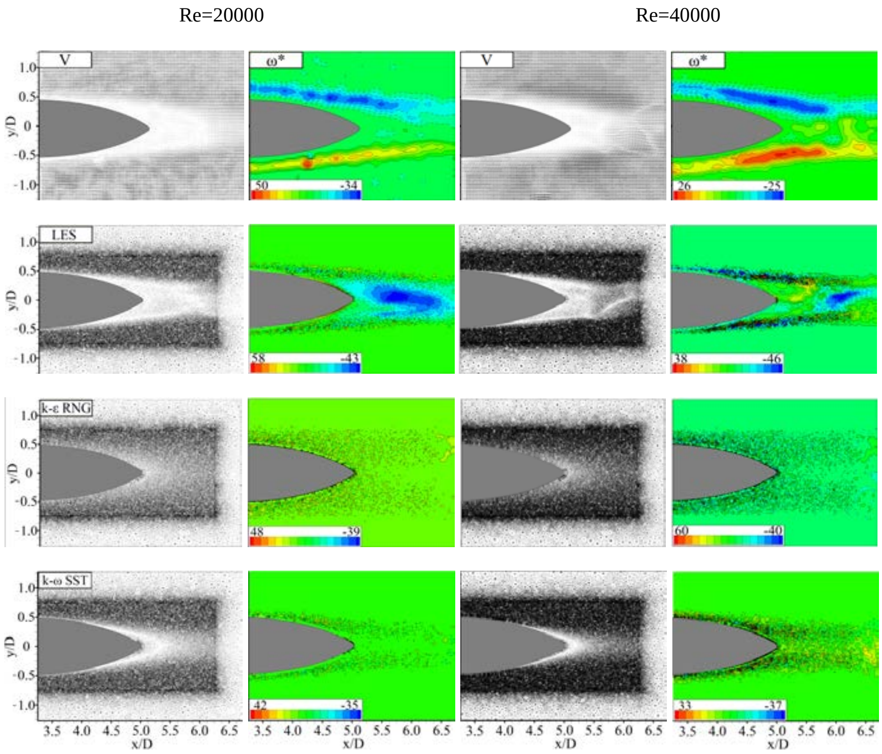


Figure 3. Flow patterns of the normalized time-averaged vector field (<V>), vorticity structures (<ω*>) components of experimental and numerical analysis (LES, k-ε and k-ω) results at Re = 20000 and Re=40000 for a torpedo like geometry.

However, root mean squares of velocity components could not be obtained successfully due to the high level fluctuations in the wake region for k-ω SST and k-ε RNG turbulence models. Maximum values for root mean square of cross-stream velocity components have been attained at the point of *1.5D* far from the trailing regions for both PIV and LES results. Additionally, the interval for PIV is $0 \leq \langle v^*_{rms} \rangle \leq 0.112$ and it is $0 \leq \langle v^*_{rms} \rangle \leq 0.1$ for LES turbulence model. In terms of turbulence kinetic energy contours at Re = 20000, the closest result to the PIV results have been observed in case of LES turbulence model. In the wake region near to the trailing edge, turbulence kinetic energy is getting its maximum values. Turbulence kinetic energy values change in the range of $0 \leq TKE \leq 0.0135$ for experimental PIV method and in the range of $0 \leq TKE \leq 0.014$ for LES turbulence model. Since some reflection on the geometry caused by manufacturing defect of the model occurred, the existence of symmetrical flow structure was not seen clearly for time-averaged streamline patterns of the torpedo-like geometry. F1 and F2 show the foci of the rotational flow field in a limit cycle, S is saddle point and it represents free stagnation point in the flow field. In terms of the comparison of PIV and LES methods, an agreement has been presented. Saddle point (S) occurred at the point of 1.0D far from the trailing edge for PIV and 1.2D far from the trailing edge for LES turbulence model. On the other hand, k-ω SST turbulence model presented two foci points and a so-called saddle point, but the locations of these points are different from the experimental results. Saddle point has been attained at the point of 0.4D far from the trailing region of the model for k-ω SST turbulence model. However, only one saddle point has been observed for k-ε RNG turbulence model. In terms of the uniform flow conditions, flows structure in the wake region of a reference torpedo-like geometry have been given for Re = 40000 in Figure 5. While the time-averaged velocity vectors are investigated, intense distribution of velocity vectors from because of fine mesh structure near to the torpedo-like geometry. With respect to the comparison of turbulence models, PIV and LES results have indicated a good agreement. When the time-averaged vorticity contours are taken into account, symmetrical and similar distribution has been seen for PIV and LES methods. Clockwise and counter clockwise vorticity contours have been attained in the wake region of the torpedo-like model. When streamwise velocity components are considered, there are not any negative values of time-averaged streamwise velocity components for k-ε RNG turbulence model just like Re = 20000. The interval of the values is $0.05 \leq u^* \leq 1.005$ for this case. Maximum and minimum values are in close agreement to the PIV and LES results. On the other hand, k-ε RNG turbulence model differed in the distribution of the values for the wake region. Another deduction is that PIV and LES results were similar to each other in terms of maximum and minimum values and also for the distribution of contours. Velocity values are $-0.025 \leq u^* \leq 1.03$ for PIV results and also $-0.025 \leq u^* \leq 1.02$ for LES turbulence model. In addition to this, the flow seperation point at 4.0D is nearly same for PIV and LES results. Flow separation could not be obtained for k-ε RNG turbulence model as for Re = 20000. Moreover, the flow separation point is 4.5D far from the nose tip for k-ω SST turbulence model. In terms of k-ω SST turbulence model, it is 4.4D far from the nose tip, but there is not any stagnation point attained for k-ε RNG turbulence model. When cross-stream velocity components are considered in Figure 5, negative and positive values of crossstream velocity components have been obtained just like at Re = 20000. Maximum positive and negative values in the wake region occurred at the point of 0.8D far from the trailing edge, the range of PIV results is $-0.12 \leq v^* \leq 0.11$ and also $-0.1 \leq v^* \leq 0.1$ for LES turbulence model. Besides, maximum positive and negative velocity fields have been observed near to the surface of the trailing edge for k-ω SST and k-ε RNG turbulence models and the ranges are $-0.115 \leq v^* \leq 0.115$ and $-0.09 \leq v^* \leq 0.09$ for k-ω SST and k-ε RNG turbulence models, respectively. In Fig. 7, root mean square of streamwise velocity components and root mean square of cross-stream velocity components have also been given and a good agreement between PIV and LES results has been obtained. As at Re = 20000, root mean square of streamwise velocity components reached to the maximum values at two points in the wake region for Re = 40000. Maximum values have been obtained at the points of 1.4D and 1.3D far from the trailing regions for PIV and LES results, respectively. In both PIV method, the range of the values is $0.01 \leq u^*_{rms} \leq 0.16$. Moreover, the interval is $0.03 \leq u^*_{rms} \leq 0.17$ for LES turbulence model. However, root mean squares of velocity components could not be obtained successfully due to the high level fluctuations in the wake region for k-ω SST and k-ε RNG turbulence models. Although maximum values for root mean square of cross-stream velocity components have been attained at the two points of nearly 1.4D far from the trailing regions for both PIV and LES results at Re = 20000, there is only one point with maximum value at Re = 40000. The clusters of the maximum values came closer to the torpedo-like geometry due to the increase in Reynolds number. Additionally, the interval for PIV is $0.01 \leq v^*_{rms} \leq 0.15$ and it is $0.01 \leq v^*_{rms} \leq 0.18$ for LES turbulence model. In terms of turbulence kinetic energy contours at Re = 40000, the closest result to the PIV results has been observed in case of LES turbulence model. In the wake region near to the trailing edge, turbulence kinetic energy riches maximum values. Turbulence kinetic energy values change in the range of $0 \leq$ T.K.E≤ 0.015 for experimental PIV method and in the range of $0 \leq$T.K.E ≤ 0.0175 for LES turbulence model. With the increasing Reynolds number, the T.K.E. intensity was increasing. Due to the some reflection on the geometry caused by manufacturing defect of the model occurred, the existence of symmetrical flow structure was not seen clearly for time-averaged streamline patterns of the torpedo-like geometry. F_1 and F_2 show the foci of the rotational flow field in a limit cycle, S is saddle point and it represents free stagnation point in the flow field. In terms of the comparison of PIV and LES methods, an agreement has been presented. Saddle point (S) occurred at the point of 0.6D far from the trailing edge for PIV and 0.9D far from the trailing edge for LES turbulence model.

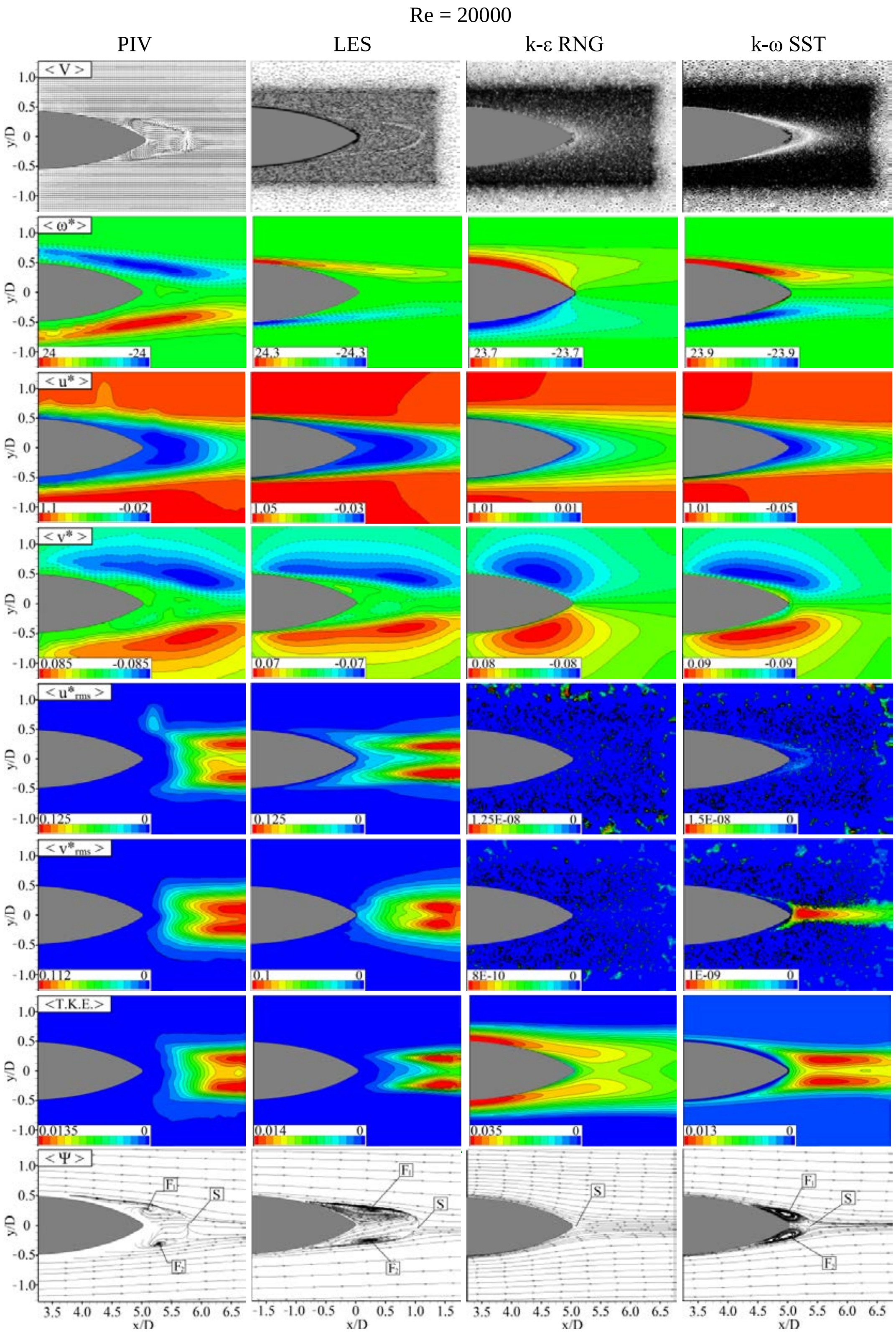


Figure 4. Flow patterns of the normalized time-averaged vector field (<V>), vorticity patterns (<ω*>), stream-wise velocity contour (<u*>), cross stream velocity (<v*>), standard deviation distribution of streamwise velocity component (<u*rms>), standard deviation distribution of cross stream velocity (<v*rms>), Turbulence Kinetic Energy <T.K.E> and streamline topology (< Ψ >) components of experimental and numerical analysis (LES, k-ε and k-ω) results at Re = 20000 for a torpedo like geometry.

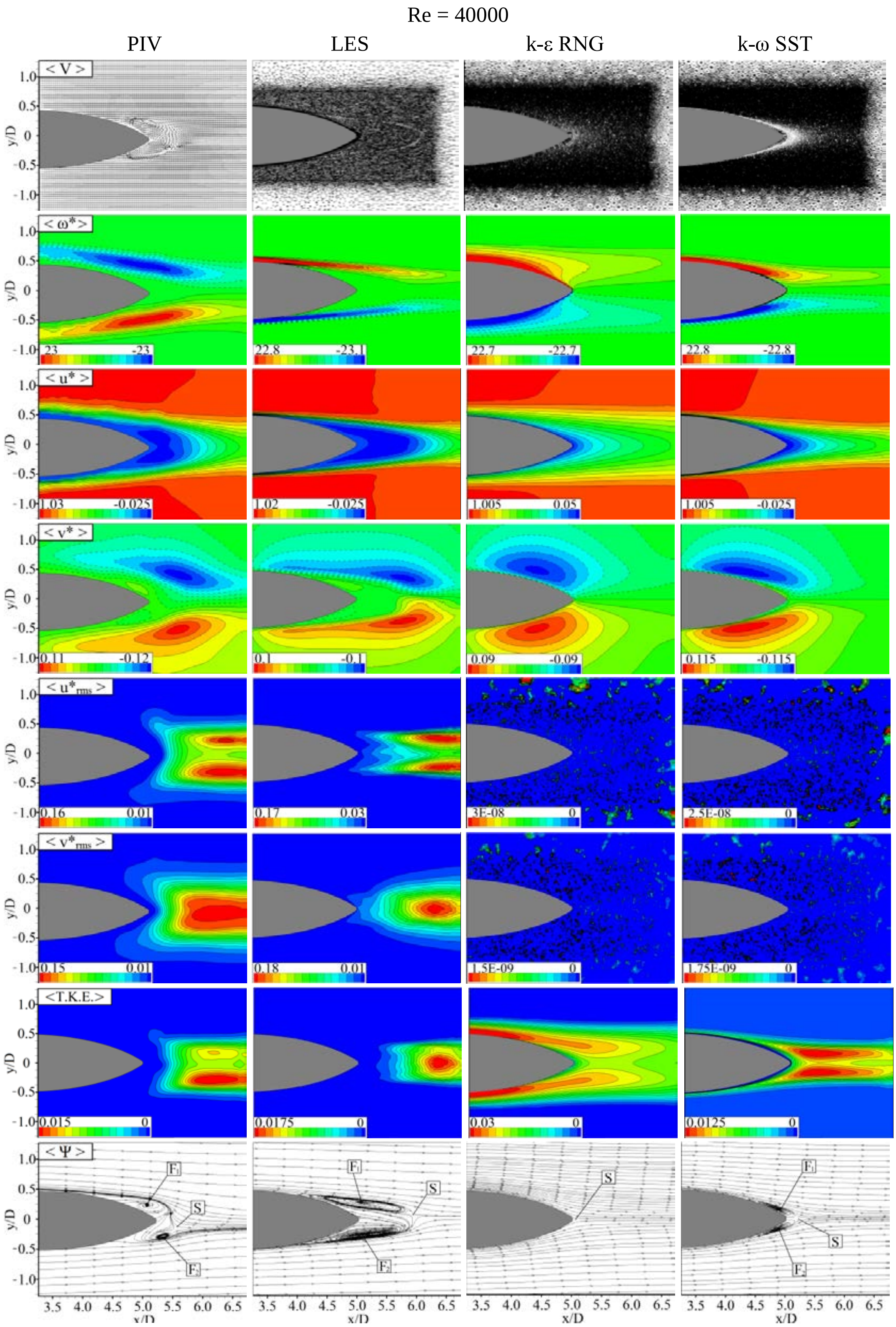


Figure 5. Flow patterns of the normalized time-averaged vector field (<V>), vorticity patterns (<ω*>), stream-wise velocity contour (<u*>), cross stream velocity (<v*>), standard deviation distribution of streamwise velocity component (<u*rms>), standard deviation distribution of cross stream velocity (<v*rms>), Turbulence Kinetic Energy <T.K.E> and streamline topology (< Ψ >) components of experimental and numerical analysis (LES, k-ε and k-ω) results at Re = 40000 for a torpedo like geometry.

On the other hand, k-ω SST turbulence model presented two foci points and a saddle point, but the locations of these points are different from the experimental results. After the increment of Reynolds number, saddle points approached to the trailing edge. Saddle point has been attained at the point of 0.3D far from the trailing region of the model for k-ω SST turbulence model. However, saddle point has not been observed for k-ε RNG turbulence model.

In addition, drag coefficients (C_D) were investigated numerically, and obtained from the following equations:

$$C_D = \frac{2F_d}{\rho {U_\infty}^2 A} \tag{9}$$

where: F_D is the drag force in the free stream flow direction of the velocity and A is the projection area of the front view. In Table 2, the mean drag coefficients by using LES, k-ε and k-ω method for torpedo like geometry at Re=20000 and Re=40000 are given.

Table 2. Comparison of drag coefficient for a Torpedo Like Geometry

Turbulence Model	Reynolds Number (Re)	Drag Coefficient (C_D)
LES	20000 / 40000	0.2278 / 0.1665
k-ε	20000 / 40000	0.7332 / 0.6392
k-ω	20000 / 40000	0.2552 / 0.2006
Behesti et al. (2009) [12]	99000 / 474000	0.48 / 0.35
Husaini et al. (2009) [13]	3×10^6	0.1603
Jun et al. (2009) [14]	1.6×10^6	0.2
Isa et al. (2014) [15]	750000	0.225
Mansoorzadeh and Javanmard (2014) [16]	1.9×10^6 / 3.17×10^6	0.195 / 0.18

The closest result to the experimental was obtained with using LES turbulence model in terms of flow characteristics and when the results were also compared with literature. The each value of time-averaged drag coefficient were closer for k-ω turbulence model, but the drag coefficient results of k-ε significantly different from others like counter plot of flow characteristics. When Reynolds number increased from Re=20000 to Re=40000, the drag coefficient values is also reduced. The results of LES turbulence model were different from other turbulence models. Moreover, the drag coefficient was obtained as C_D=0.7332 and 0.6392 for k-ε turbulence model at Re=20000 and 40000, respectively. Drag coefficient results of k-ω turbulence model are partially close to LES turbulence model and C_D=0.2552 and 0.2006 at Re=20000 and 40000, respectively. The results of LES turbulence model were different from other turbulence models and its 0.2278 at Re=20000 and 1665 at Re=40000, which is a close agreement with literature. For this reason, LES turbulence model is more convenient for detailed engineering applications around bluff body in absence of experimental data. On the other hand, LES turbulence models require more computer capacities and much solution time. Hence, for the basic applications k-ω turbulence models can be used. k-ε turbulence model was failed for that type of flow characteristics in terms of flow characteristics and hydrodynamic forces which is acting on body face.

CONCULUSION

In this study, flow characteristics variation depending on the Reynolds numbers at Re=20000 and Re=40000 were investigated by means of time-resolved PIV and CFD with three different Turbulence Models. The experimental results are compared to the numerical results obtained by means of transient simulations with k-ε, k-ω methods and LES turbulence models of ANSYS-Fluent Software. It is seen that the k-ε and k-ω methods does not give comparable results with the PIV when compared to LES method for the flow structure and force coefficients. Finally, it can be interpreted that the closest results to the experimental results were obtained by using LES turbulence model in terms of flow field and when results were compared with literature. LES turbulence model is more convenient for detailed engineering applications around bluff body in absence of experimental data. On the other hand, LES turbulence models require more computer capacities and much solution time. In future, force and pressure measurement around the body might be performed and compared with the CFD results.

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A STUDY ON THE IMPACT OF RENEWABLE ENERGY USE IN THE PORT OF PARIS CLIMATE SUMMIT

Birsen KOLDEMIR[1], Murat YAPICI[2]

ABSTRACT

At the end of the 19th century, air pollution and its effects on human health has increased by the industrial revolution. In the last 50 years, world temperature with the increase of fossil fuel consumption was increased 0.6 C^0. The need for renewable energy sources have increased limited available fossil fuels and source of energy demand. At last 10 years, the development of maritime transport and port technology had aimed environmental protection by rules, so that the need renewable energy has increased. In 2015, the participation of 200 countries in the Climate Summit held in Paris, it was found on limiting the global avarege temperature increase to 2 C^0. In addition, the average temperature increase to reduce climate change impacts from the heat and aims to limit the risk of 1.5 C^0. The agreement thus aims to reduce carbon emissions by all countries. Partly binding agreement, which is based partly on a voluntary basis. In this study, rules and practices on the future after the Climate Change Summit in Paris are described possible effects on ports and the use of renewable energy source.

Keywords − *Climate Changes, Air Pollution, Green Port*

INTRODUCTION

The climatic concept is described as " climatic " the Latin term, "climate" the Greek term in the report The Intergovernmental Panel on Climate Change (IPCC, 2007). According to this explanation the climate is expressed as "The statistics are proved to be tests with proven changes in the climate, or variability observed over a long period" [1]. According to the definition of Turkish Language Institution, the climate is expressed as " the situation which is based on the average of long-term effects of weather phenomena elsewhere on the earth " [2].

The first climate change studies started in the 17th century. Increased air pollution and intense environmental pollution were observed by The Industrial Revolution. Studies of countries' climate change started with the Stockholm Conference in 1972 and the First World Climate Conference in 1979 [3]. Important decisions have been taken at the Paris Climate Conference, which was last held 12th-15th December 2015.

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REVIEW OF THE LITERATURE

Climate Change and Impacts

Global warming emerges as a consequence of climate change. Global warming is the result of the change of water movements in the atmosphere and seas. According to the IPCC reports, 95% of climate changes are anthropogenic and 5% are due to natural pathways. +5 C^0 increase in global temperature will cause the glaciers to rise, +6 C^0 increase will lead to the disappearance of agricultural areas, and + 2 C^0 increase will cause the depletion of water resources. 40% of the anthropogenic air pollution released to the atmosphere after the industrial revolution occurred in the last 40 years [4]. 78% of the increase in emissions between 1970 and 2010 is the result of fossil fuel use and industrial activity.

The effects of climate change are beginning to be intense today. If protective measures are not taken, the severity of the effects will increase. The impacts of global climate change today and in the future;

• Damage to the life of the island countries due to rising precipitation and sea level rise,

• The spread of epidemic diseases in settlements,

• As a result of extreme rainfall, infrastructure, electricity, water, health services are in disrepair.

• Increased respiratory diseases, resulting in deaths,

• Loss of fertile agricultural land due to drought, problems of food sanitation problems,

• Reduced sources of clean drinking water,

• Decrease in biological diversity [5].

Climate Change Maritime Transport Relations

The most harmful gases that result from anthropogenic effects are CO_2, NO_x, CO, SO_x and PM. These harmful gases are also found in sea transport [6].

The greatest pollutant greenhouse gas in mass is CO_2. 2.7% of global CO_2 emissions are produced by sea transport. Each year an average of 850-900 million tons of CO_2 and 35-40 million tons of other harmful gases such as SO_X, NO_X, CO, PM are exhausted into the atmosphere [7].

In order to reduce air pollution caused by marine transport, MARPOL Annex 6 rules are applied for the design parameters, the sulfur content of the fuels and propulsion systems [8]. It is aimed to reduce the harmful gases that the ships have stored in the atmosphere during both the sailing and at berth.

INTERNATIONAL CLIMATE CHANGE PREVENTION ACTIVITIES

Climate Change Prevention Activities (Pre-1995)

In 1972, the Conference on the Human Environment was held in Stockholm to discuss climate change and its consequences. Following this first step, the IPCC (Intergovernmental Panel on Climate Change), as a mechanism linked to the United Nations was established.

Table 1. Between 1972-1994 Climate Change Theme of International Studies [3].

Date	Subject	Results
1972	Stockholm-UN 'Human Environment' Conference	Stockholm Declaration of 26 Principles, 109 Proposals.
1979	First World Climate Conference	Fossil fuels and CO2-induced climate change is discussed.
1988	IPCC'nin kurulması (Intergovernmental Climate Change Panel)	The basis of international agreements attached to the UN was created.
1990	First IPCC Assessment Report	The second call was made to the international agreements described in the WCC.
1992	Rio 'Environment and Development' of the UN conference	Biodiversity Agreement was signed.
1994	UN Framework Convention of Climate Change to enter into force	The UN Convention to Combat Desertification and the UN Biodiversity Convention was adopted.

At the United Nations Conference on Environment and Development; It is predicted that the ozone layer's weakness, water, air and sea pollution will come to fruition. It has been advocated for the participation of all countries for the joint action plan. Table 1 shows conferences on climate change carried out in various names from 1972 to 1994.

United Nations Framework Convention on Climate Change

The United Nations Framework Convention on Climate Change is the first serious environmental treaty signed by the United Nations countries against global warming. The principle adopted by the contract of 191 countries and European Union countries is the danger of pollution from anthropogenic sources and the damage of the atmosphere in the result of this pollution.

The United Nations Framework Convention on Climate Change, the principles of the United Nations member states signed the first serious environment against global warming sözleşmesidir.191 countries and the European Union held with the participation of the country's acceptance of the contract; dangers of anthropogenic pollution and damage to the atmosphere is the result of this pollution.

Table 2. COP conferences held between the years of 1995-2015 [9].

Date	Conference Name	Conference Venue
1995	COP 1	Berlin, Germany
1996	COP 2	Cenevre, Swiss
1997	COP 3	Kyoto, Japan
1998	COP 4	Buenos Aires
1999	COP 5	Bonn, Germany
2000	COP 6	The Hague (Lahey), Netherlands
2001	COP 7	Marakeş, France
2002	COP 8	Yeni Delhi, India
2003	COP 9	Milano, İtaly
2004	COP 10	Buenes Aires, Argentina
2005	COP 11/MOP 1	Montreal, Canada
2006	COP 12/MOP 2	Nairobi, Kenya
2007	COP 13/MOP 3	Bali, Indonesia
2008	COP 14/MOP 4	Poznan, Poland
2009	COP 15/MOP 5	Kopenhag, Denmark
2010	COP 16/MOP 6	Cancun Mexican
2011	COP 17	DurbanSouth Africa Republic
2012	COP 18	Doha, Train
2013	COP 19	Varşova, Poland
2014	COP 20	Lima, Peru
2015	COP 21	Paris, France

The Convention aims to keep the content of greenhouse gases at a certain level. The initial state of the contract has been determined to be acted with good intentions from the sanction. More concrete targets were set than the first protocol by the Kyoto Protocol in 1997. Table 2 shows the 21 most recent conferences organized by the Paris climate summit.

World states have decided on a new climate agreement at the conference held in the first days of December 2015. The agreement was found unsatisfactory by some authorities.

CLIMATE SCENARIOS

According to the European Union Peseta report; up to 2030, 1-4% increase will reach 30,000 people, which can affect 50-110,000 people by 2080. For this reason, it was aimed at the conferences to prevent the increase in water resources depletion based on an increase of +2 C^0 [10]. The global temperature difference between the ice age and today was around +5 C^0. For this reason, a difference of +2 C^0 will result in irreversible results. Figure 1 shows the estimates of the Global Carbon Project 2013 based on four different scenarios.

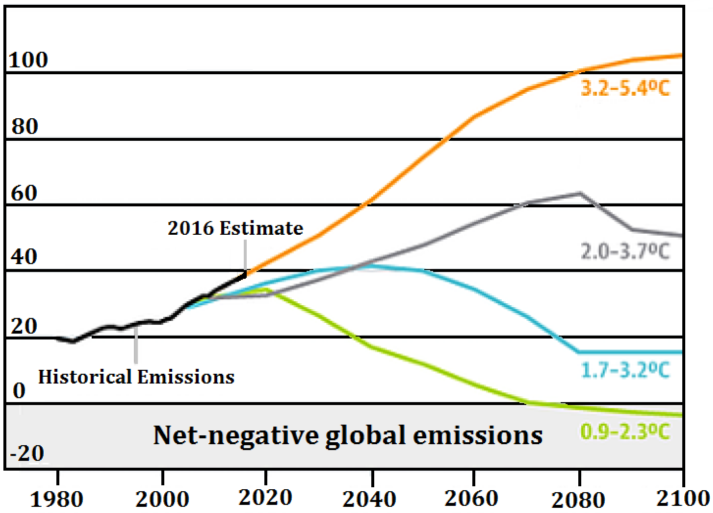

Figure 1. Future scenarious for CO_2 emissions, gigatonnes/ year
Source: GLOBAL CARBON PROJECT 2013

REFLECTIONS OF PARIS CLIMATE SUMMIT

The Paris Climate Summit's biggest difference than the Kyoto Protocol is to set a numerical target in terms of global warming. This target is a decision to keep under an increase of +2 C^0 until 2100. States parties were invited to submit the INDCs (Intended Nationally Determined Contribution) at the Warsaw Conference (COP 19) in 2013,). This step has laid the groundwork for the Paris Climate Summit [11], [12].

The Paris Climate Summit is responsible for all countries unlike the Kyoto Protocol. It has been tried to determine certain periods with the concept of the carbon budget, which is a result of the Paris Climate Summit. 2/3 of the calculated budget has been used, only 1/3 of the budget has to be used or reduced.

CONCLUSIONS

In order to raise awareness of the struggle between developed and developing countries, funds will be created under the name of "Green Climate Fund" for countries that are affected by climate negativity but have insufficient funds.

Equipping existing ports with renewable energy requires financial funds to be transformed into policies that encourage the renewal of ports.

All parties' efforts will be reassessed in 2023. An overall assessment will be made every 5 years. Concepts such as carbon tax or carbon pricing after the Paris climate summit have begun to be discussed. This indicates that the trend towards renewable energy sources will increase. In addition, R&D activities for the development of renewable energy resources will increase.

Shown as missing the point of the Paris climate summit problem is the lack of sanctions. However, both countries by the banner of the companies involved in both the private sector will be clearly spelled out to keep the promises made in good faith. This is of importance as this will cause a loss of prestige companies. Maritime companies should continue their activities in a way that does not cause loss of prestige. Renewable energies need to be made more widespread in port facilities by utilizing support funds.

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THE ROLE OF MARINE OBSERVATION SYSTEMS IN WEATHER FORECAST: AN APPLICATION OF IZMIR BAY

Ali Cemal Töz[1], Burak Koseoglu[2]

ABSTRACT

Port of Izmir is one of the leading Turkish ports making the highest contribution to either Turkish or Aegean region foreign trade. The number of ships visited port of İzmir is increased substantially in parallel with significant increases in regional trade. Increase in the number of ship passages affected marine traffic negatively in Bay of İzmir where shallowing process accelerated day by day due to coastal accumulation. The ships are suffered by grounding accidents so often in Bay of İzmir. The current statistical data indicate no reduction in the number of the grounding accidents encountered. The main reasons of the accidents can be mentioned as restricted depth conditions and moderate meteorological conditions in the region. Meteorological factors such as wind and sea current cause unstable environment for safety passage of ships in Bay of İzmir. Instant, valid and reliable regional meteorological data have crucial role in marine transportation safety. In this study initially the data provided by fixed surface meteorological station located at the entrance of İzmir bay is analyzed. The reliability level of two different meteorological stations which provide meteorological data for the same region was analyzed through comparative analysis with the real environmental data. It is expected that the results of the study provides certain outcomes and guidelines for related organizations dealing with yachting operations as well as suggestions for effective and efficient coordination among the relevant institutions.

Keyword- Bay of Izmir, Safety, Ship, Weather Forecast.

INTRODUCTION

Marine sciences and meteorology are sciences that impossible to separate from each other by the reason of their both deep-rooted past and common grounds. Weather condition in next periods are extreme important for seafarers. Early on, seafarers realized air conditions based on their experiences which they faced in past weather events. The weather events that are continuous on global scale and occurred in atmosphere were discovered by seafarer by chance.

WEATHER FORECASTING AND METEOROLOGICAL OBSERVATION

Oceans and seas have big importance in nation’s economic and social development. It is caused to a thought to save, improve and evaluate more rationalist for ocean and sea sources. Because of this reason, both providing maintainability of sea sources and existence of meteorological services become more important day by day.

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Weather Forecast and Meteorological Observations

It caused a collaboration necessity at an international level in terms of analysis, weather forecast and created different air conditions by shifting sands of atmosphere. In this regard, it is founded a global settlement as International Meteorological Organization (IMO) was established in 1878 that was changed the name as World Meteorological Organization (WMO) in 1947. Today, global weather observations could be presented in a standard format with 145 member nations [9]. It is seen on Figure1 about Global Meteorological Observation System.

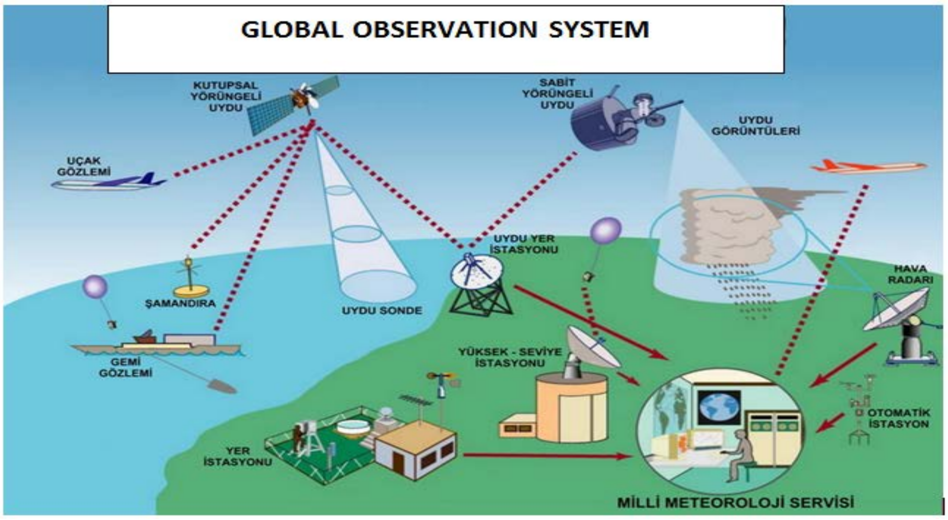

Figure 1. Global Meteorological Observation System
Source: [7]

Atmosphere's general situation and current circumstances are followed by 4000 land stations, 7000 mobile stations and 10000 high altitude observation stations every day; and data are mapped by central ground stations [1]. Data sent to central ground stations (Washington, Melbourne, and Moscow) as transferred into electronically format about 4 times a day every 6 hours. Then, these data are converted to a standard form and transferred to National Meteorological Centre (NMC) for analyzing, estimation and mapping activities. These prepared documents are sent to worldwide special and public meteorological institutions [9]. There are 3 phased foreseen study using subjective or objective methods based on observations and analysis of meteorological events in a specific period, in a specific country, region or a center. These are: Observation, Analysis and Estimation [7]

Meteorological Observation Methods

The observations used for weather estimation are developed by different method and technics. These observations are the most important stages of necessity comment for estimation providing measure and record the meteorological elements both with tools and without tools. To occur the weather estimation by observation stations in different points of atmosphere depends on these station data's currency and reliability. Observation methods and related products that are used in weather estimation like below [5].

- Ground Observations
- Vessel Observations
- High Atmosphere Observations
- Radar Products
- Satellite Pictures
- Automatic Meteorological Stations Data

Ground (Surface) Observations

There are being made 2 types of ground observations in for synoptic observation and climatological observation. Synoptic observations are used in weather estimation. Synoptic observation is being made in meteorological stations in whole world at the same time based upon GMT (Greenwich Mean Time). Today, meteorological services are conducted with completely scientific methods and international cooperation. At present, there are about 10.000 ground stations work 24 hours, observation vessels work in ocean more than 6.000 and meteorological stations make high weather drilling more than 1.000 in the world. Surface Observations are made in every 3 hours with 11.000 stations. Some of these stations make hourly observations and measure surface pressure, wind direction, wind speed, temperature and humidity. About 4.000 stations share the data and information based on regional synoptic network; 300 stations share the data and information based on climatological network. It is seen on Figure 2, by February 2016, stations that make surface observations worldwide [5].

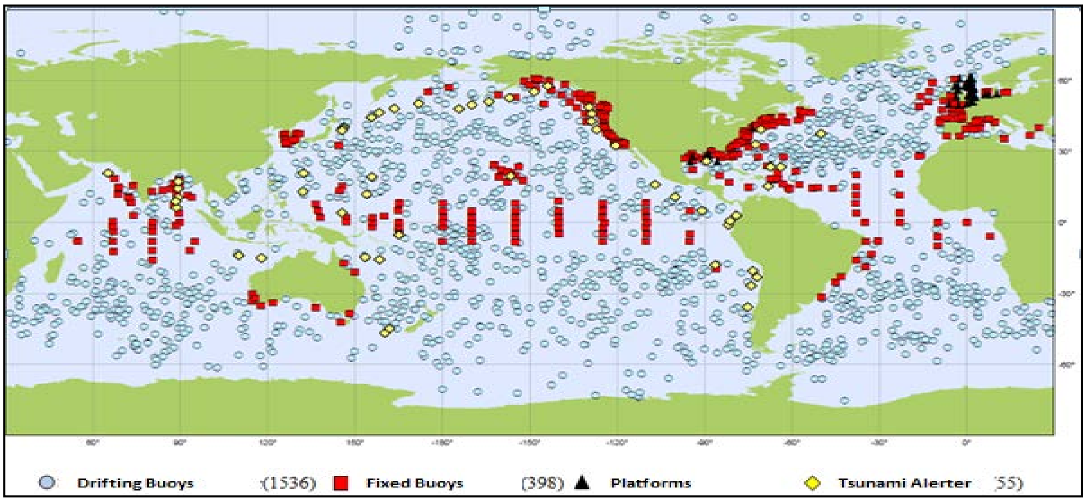

Figure 2. Surface Observation Stations
Source: [5].

High weather observations make pressure, wind direction, wind speed, temperature and humidity measurement with 1300 stations, 30 km height. These stations more than two thirds make observation at 00.00 GMT and 12.00 GMT. The rest stations make observation once in a day. Radiosonde measurements in oceans are made with 15 vessels. It is seen on Figure 3, stations that make high air observations worldwide [5].

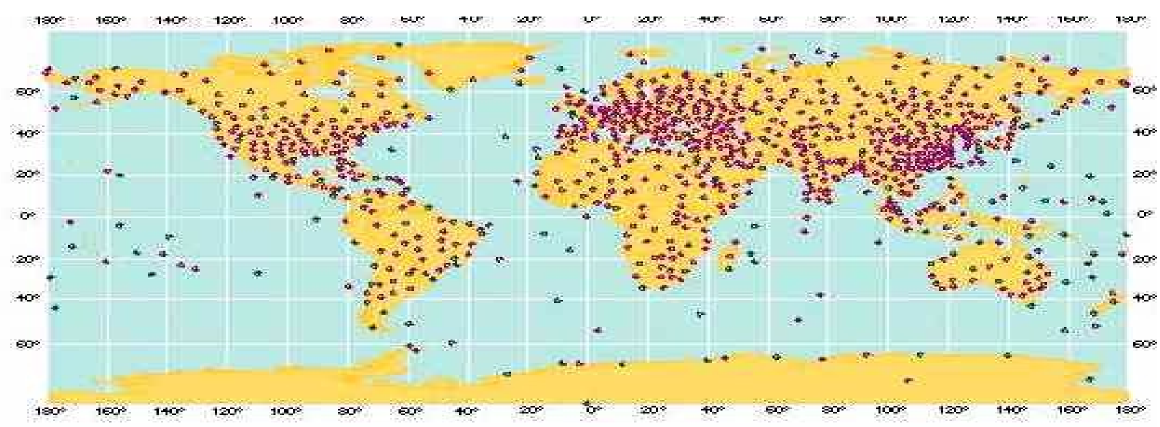

Figure 3. Upper Air Observation Stations
Source: [5].

Sea observations are made by satellites, mobile observation vessels, fixed and drifting buoys and fixed platforms. With this observations, sea surface temperature measurement, wave height and period measurement, wind direction, wind speed measurements are being done. There are about 4.000 vessels that make observation around the world and 1.000 of them report and observe once in a day. Buoy number is about 1.200 that is used for observation. Sea surface temperature measurement is made 27.000 times in a day. Half of these buoys measure the sea surface pressure 14.000 times in a day. It is seen on Figure 4, sea observation stations [5].

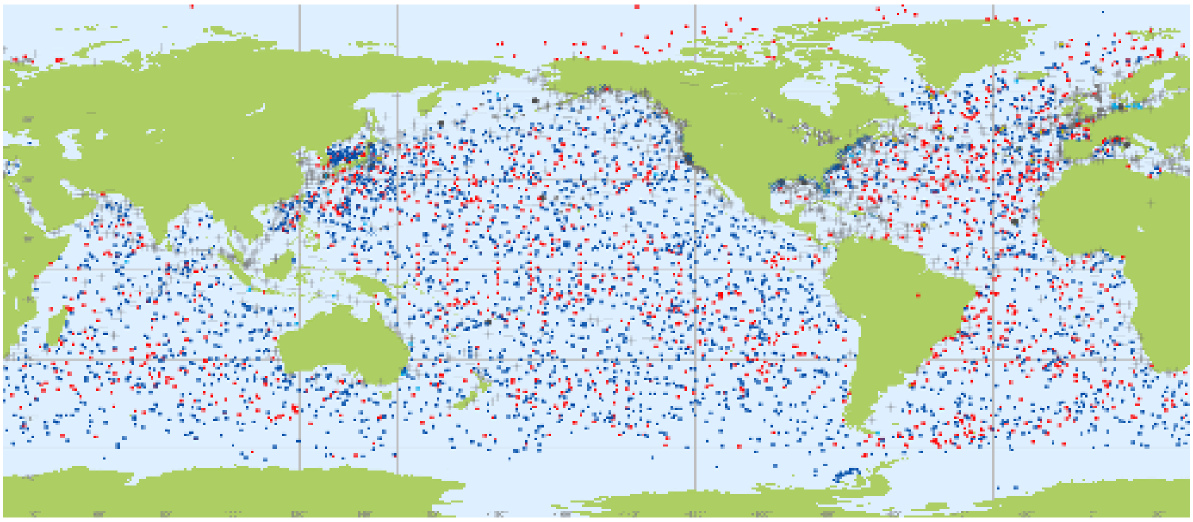

Figure 4. Marine Observation Stations
Source: [5].

Vessel Observations

Measured meteorological elements in ground observation stations could be measured with vessel observations as well. The only difference is being the vessels are mobile. Measured values are informed with the place's longitude and altitude that the vessel in [5]. World Meteorological Organization created "Volunteer Observation Vessels (Voluntary Observation Ships-VOS) approach with the purpose of utilizing from the observations made by vessels that cruising in different waters and in ocean. As is evident from its name, this system is an information sharing platform based upon voluntariness. The big part of fleet makes observations in north hemisphere while the rest are consisted of trade vessels in south hemisphere. Within related program, there is no financial income for missioned vessels and their managers. But equipment which will be used for observation is given without charge to vessels. Related equipment are positioned into vessels by meteorological responsible who is authorized by National Meteorological Service (MMS). At the same time, informing is realized about which transfer way to use and under which code the data will be done that collected vessel's WMO code [10]. On Table 1, there are types of data and their contents provided by this kind of vessels.

Table 1. VOS Observation Records

	Ship Type		
Factor	**Selected**	**Supplementary**	**Additional**
Wind Direction and Speed	X	X	X
Pressure	X, I	X, I	X
Barometer	X, I	O	O
Air Temperature	X, I	X, I	X
Dew Point	X, I	O	O
Water Temperature	X, I	O	O

Wave: Wind and Swell	X	R	R
Visibility	X	X	X
Current and Past Weather Cond.	X	X	X
Cloud: Type, Height, Distribution	X,X,X	X,X,X	X,O,O
Course and Speed of Ship	X	X	X
Ice	X^n	X^n	X^n

X: Observed X^n: Estimated Obs. O: Not Observed I: Equipment on Board R: Requiring Observation

Source: [4].

Upper Air Observations

High weather observations are realized with by equipment called rawinsode. Radio transmitter observation tool is left to atmosphere bindingly a balloon which is filled with hydrogen or a gas as similar lightness. Measurement device that could goes to 30-40 km height, measures and sends the specific pressure levels, temperature and wet in these levels, wind direction and wind speed intenseness to ground station with radio signals [9]. This procedure is repeated 2 times in a day at 00:00 and 12:00 GMT. Meteorological rocket probe can make observation till 100 km. But the data received from this height are used for research. High weather observations could be made with planes, satellites and radar devices also. Low level is especially used for determining air pollution in regions where urbanization density is existed [2]. It is seen on Figure 5, weather observation stations worldwide.

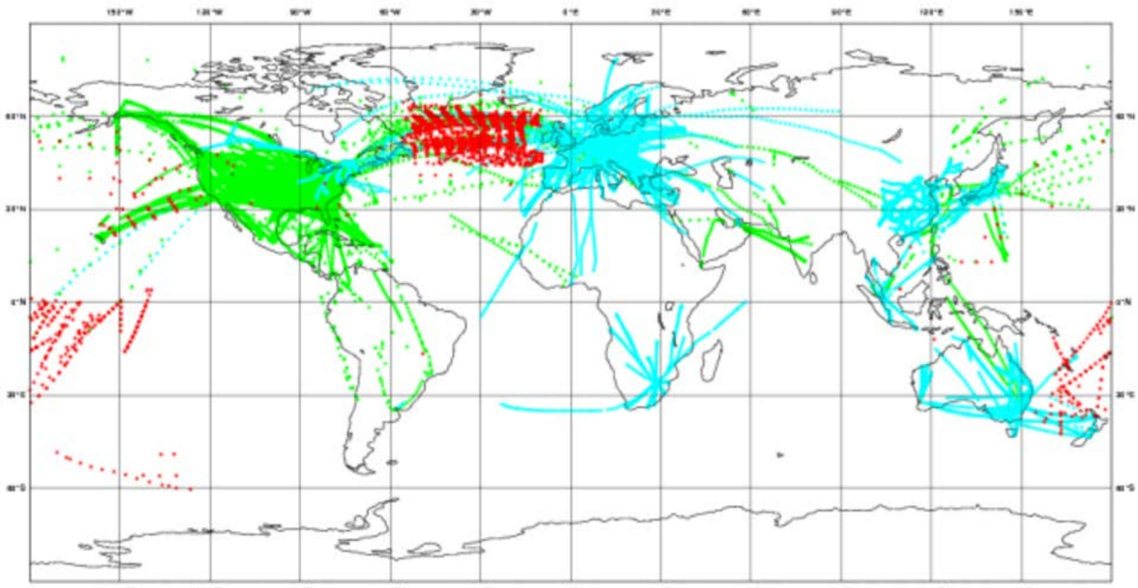

Figure 5. Weather Observation Stations

Source: [5].

Meteorological Radars

Radar devices are used for meteorological observations. There are 10 Meteorological Radars in our country that are used by 3 types.

1. Attention: Determine the severity and places of heavy rainfall, microburst-macroburst that caused full and whole gale, change of wind, turbulence, and tornado.
2. Short-run estimate: Estimation of vectorial components of wind places, precipitation forecast, front position, gust and storm.

3. For some sectors like insurance, agriculture and justice: Radar information is used in places where the meteorological measurement is not made, on the purpose of providing data retroactive.

Meteorology Satellites

Satellites make easy to investigate the weather events globally by periodically sending the data to ground stations which they record via sensors. Fist meteorology satellite is thrown to trajectory in 1960. Satellites have important position due to data that they provide from regions where the ground stations and proper atmospheric conditions are nonexistence. The clearance (blank) -will be able to occurred by the reason of being water bound of earth's big part and poorness of vessel observation stations-is compensated with satellite data system [3]. Satellite pictures weather estimators are very valuable information sources. Satellite pictures;

1. Provides to research the weather events globally
2. Provides to get information in the topics which have fewer observations.
3. Have a role in to short run estimation of nature events like rainfall, thunderbolt, flood and freshet. (Especially 6-12 hourly).
4. Provides input data to numerical weather forecasting.
5. Be useful in terms of getting information about atmosphere's dynamic and physical structure.

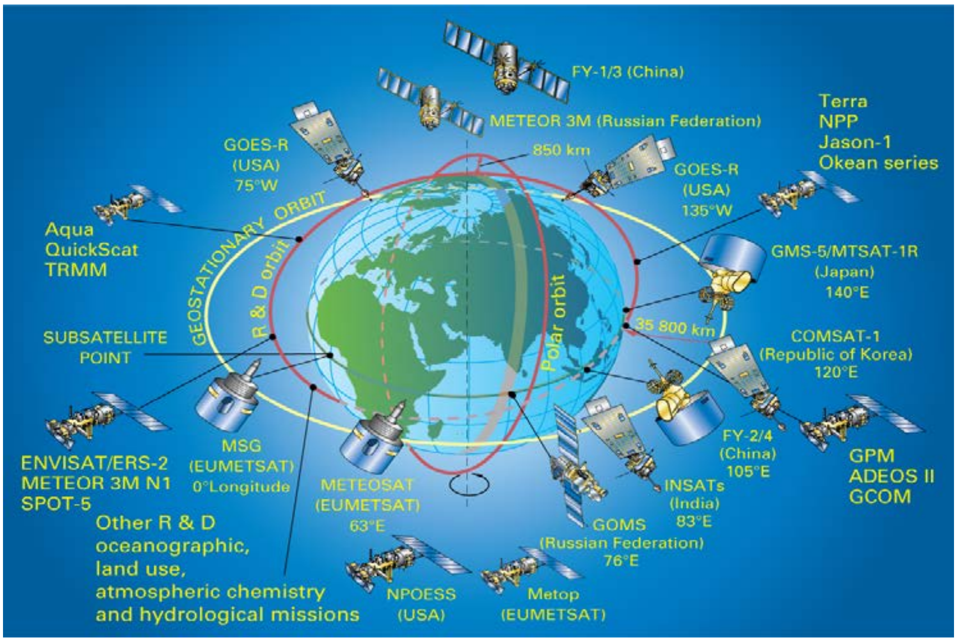

Figure 6. Satellites Service for Meteorological Purposes
Source: [7]

Second type satellites that are used for weather estimation system are pole trajectory satellites. These satellite trajectories are parallel with longitudes. It is possible to complete one tour on trajectory passing through pole points. They are in a fixed position to sun and pass over equator at the same time with local hour. Pole trajectory satellites pass through any point on the world every 12 hours. The image of any point on world could take with fixed and trajectory satellites at intervals of 6 hours, 4 times in a day [7].

Automatically Controlled Observation Stations

All measures that are made in normal meteorology stations are transmitted to related places as minimum fault range as automatically measured and coded. The spreaded observation network to whole country has 861 below points;.755 OMGİ (Automatic Meteorology Observation Station), .8 High Atmosphere Observation Stations (İstanbul, Ankara, İzmir, Adana, Isparta, Samsun, Erzurum and Diyarbakır),.56 Airports OMGİ (Automatically Meteorology Observation Station),.42 Sea Observation Stations.

Analysis

Isobars are occurred after processing the collected observation data onto ground map. Determine the low and high pressure areas. Analyze the fronts that present the line that separates the 2 different air masses from each other. The places of air masses which on maps analyzed with fronts are compared with the information of radar, prognostic maps and satellite pictures. All analyses are compared as well with numerical weather forecasting which is estimating process for future condition by doing equation's (movement, thermodynamic, continuity, hydrostatics equality) mathematical solving that states the variable's (shows atmosphere condition) (temperature, wind, wet and pressure) changing based on time and place.

Weather Estimation

All data which come from observation stations are analyzed and processed onto ground/upper level maps in National meteorology center. Estimation studies start at the end of this project. But, estimation process is so complicated and detailed process. Data's content and amount is so important in estimation. Because of this reason, nowadays, numerical modeling software are developed that called decision support element. Estimation systems are like below (Moran and Morgan, 1991: 422, Lutgens and Tarback, 2013: 332, Ahrens, 2013: 346); Global Models; IFS (ECMWF), UM (England), GM (Germany), ARPEGE (France), AVN, MRF (ABD), GEM (Canada), JMA (Japan).
Limited Area Models: ALADIN (France ve ALADIN Consortium), Eta, MM5, WRF (ABD), LM (Germany and Cosmo Consortium), HIRLAM (HIRLAM Consortium).

- Continuity Estimation.
- Trend Estimation.
- Analog Estimation.
- Statistical Estimation Methods.
- Climate Estimation.

Estimation methods are classified and fictionalized on estimated weather event's time taking. For example, a few hours estimation is commented as very short-date estimate. These estimations are usually realized due to surface observations, satellite pictures and radar images. Generally these estimations are occurred within trend methods and model identification. Estimation that is between 12 and 60 hours are classified as short dated estimate. These estimations are extended till 72 hours. Estimator unit uses a lot of sources and technics. Medium-dated estimations involve the estimates between 3 days and 8.5 days. The estimation that over than 200 hours is classified as long termed estimation. Especially mathematical software could estimate till 16 days. Just these methods are low trueness range about temperature and rainfall [10].

MARINE METEOROLOGICAL OBSERVATION SERVICES IN TURKEY

Meteorology General Management established totally 79 sea automatic meteorology observation station that 6 of it are fixed buoys. Meteorology General Management started to create high technology product systems within the project of Meteorological Observation Network Extended in 2011. These systems contribute high to the sectors from water transportation to fishing and produce knowledge for seaway transportation. Via system, the information could be getting that necessity in activities of wind speed and direction in sea, temperature, wet, sea water temperature, pressure, wave height and period, current velocity. This information contributes high as well to prepare estimations and early alerts for strong meteorological events. Figure 7, it is seen sea observation stations in Turkey-wide [7].

Figure 7. Sea Observation Stations in Turkey
Source: MGM, 2015

RESEARCH

City of Izmir has strategic importance because of being a door of Aegean Region that is opened to world. İzmir port is an important transshipment center where the related loads with South and East Aegean loading to vessels. Depends on region's increased trading volume, Izmir gulf became one of the main route of vessels. Increasing in vessel numbers that enters in Izmir gulf raises risks in the region that limits the ship passage also. Waterways are like narrow line which is used in gulf passing and port closing because of region conditions. It presents the cardinal system's importance as a result of being shallow endangering some point's vessel passages. Buoys are so important in terms of getting instant meteorological data and especially marking the shallowness. In this research, degree of reliability of meteorological data provides which service in region and service the remote estimation also.

Purpose of Research

Main purpose of research is to measure the reliabilities of data providers comparing the real instant data from fixed meteorological observation station in entry of İzmir gulf with the data from 2 different data providers who services remote estimation in same region. In this context, it is tried to measure the reliabilities of method and estimation system that data providers used.

Method of Research

Comparative analyses technic is used for measuring reliabilities of data that are presented by subjected meteorological stations. In this technic, error margins are calculated proving the deviation ratios between real data and estimated data. Size of error rates are evaluated as reliability values. Reliability values of high error rated stations are calculated as low.

Data Collection Method and Sampling

Instant data are obtained between the dates of 05.03.2015 -05.06.2015. It is identified as work area where the shallowness buoy is existence in entry of gulf. Instant and real data that received from this region are obtained entering into T.C Ministry of Forestry and Water Affairs official web site (http://www.mgm.gov.tr/deniz/deniz-omgi.aspx). Real data are obtained from İzmir Gulf A Point Lightened Buoy station which is one of the Sea Automatic Meteorological Observation Station in İzmir Gulf. Meteorological data provider's data which will be compared are obtained from this station's web sites. These data providers are called "Meteoblue" and "Viewweather", in same region. It is entered into the subjected stations web sites at local hour 12.00 by every day, recorded the wind, temperature, wet and pressure values in region. It is seen on Figure 8, definer information belong to buoy that provides real data.

Figure 8. Lightened Buoy "A" Located Enterance of Izmir Bay
Source: [8]

As it is understood from the figure, there is observation equipment that provides meteorological data on buoy. Buoy's daily energy need supplied by solar power and obtained data is sent to meteorological station via GPRS. At the same time, obtained instant data could be seen as well by entering the official site of Meteorology Central Management, www.mgm.gov.tr. It is shown on Figure 9, position of source station that provides the data in İzmir Gulf and presentation format of data.

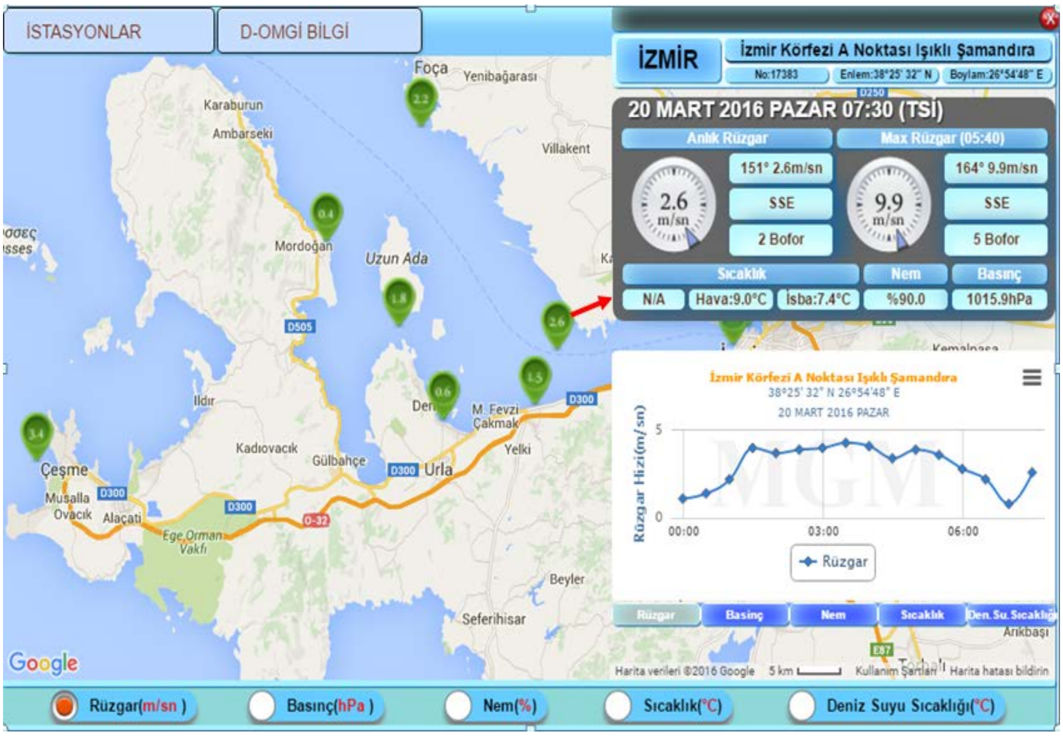

Figure 9. Data Presentation Format
Source: [8].

As it is understood from the figure, there are many observation stations in İzmir. And it has a different importance for seafarer about preferred buoy's position on main route of vessels which are doing entrance and exit to gulf. Because, seafarer need instant information on sea. This condition has especially irreplaceable importance in terms of navigation safety. At the same time, it could be reached to historical data due to graphical display besides instant data and also could be observed changing in the sense of weather events.

Figure 10. Data Presenting Format of Two Stations that Compared

As it is understood from the figure, data are presented in different formats in both data providers. But detailed data belong to region are shown in both systems too. These data especially include meteorological important parameters like measured wet, pressure, temperature and wind. Getting method ways differ from each other. So, these methods reliability degrees will be seemed when they are compared with real data in this region.

Analysis and Findings

The data of subjected meteorological data stations are viewed for 3 day period. Then, these data are listed by recording in Microsoft excel format. Subjected data are grouped under 4 titles. They are pressure, wet, air-sea water temperature and wind. It is shown comparison tables of these data on the basis of station. On Figure 11, comparison graphic of pressure measurement values between stations are shown.

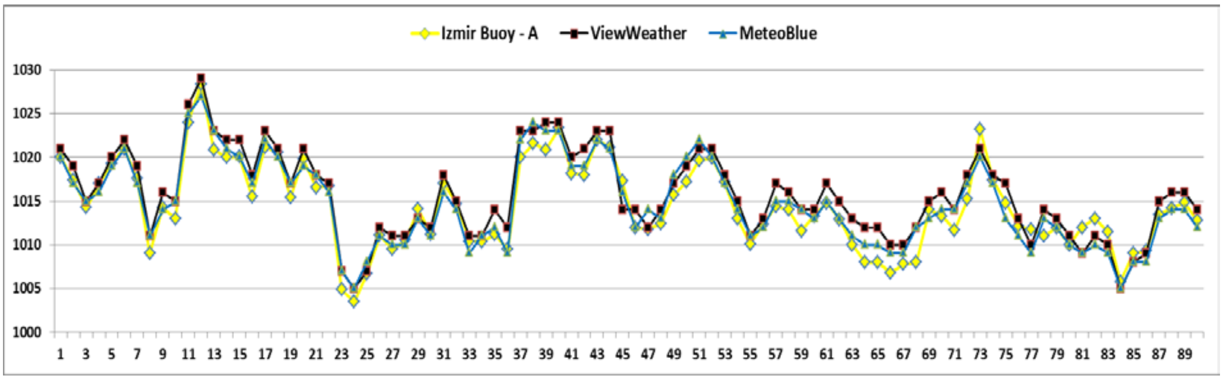

Figure 11. Comparison Table of Air Pressure Characteristics Between Stations

As it is understood from the figure, both stations present so closer values to real conditions. It is reached to the result of high reliability level of stations in pressure values scale. On Figure 12, comparison graphic of relative humidity measure values between stations are shown.

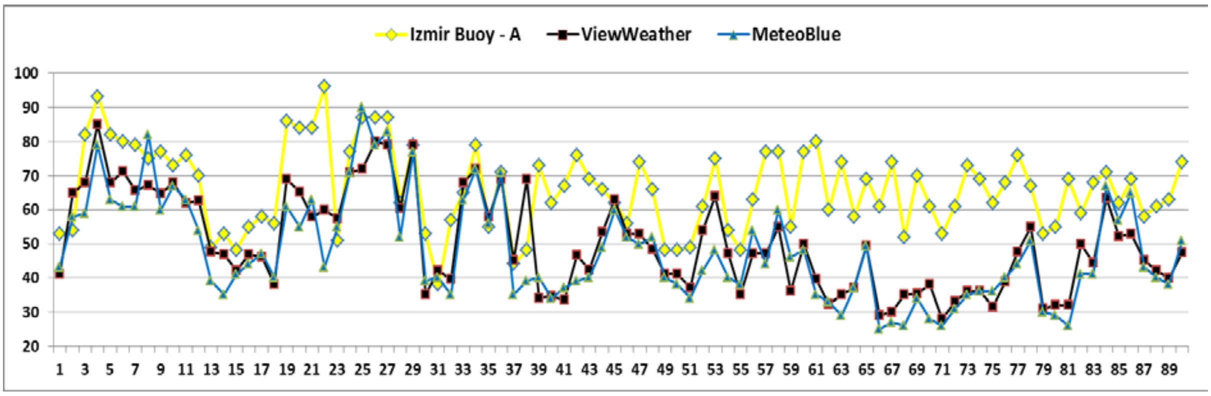

Figure 12. **Comparison Table of Relative Humidity Characteristics Between Stations**

As it is understood from the figure, it is observed that region's relative humidity values which define in the light of data received from buoy are high by comparison the other stations. Especially it is glittered about high deviations between 2nd Moon and 3rd Moon values. If there will be research on the basis of values, it is seen the values received from viewweather station have low deviation ratio than real values. It is shown comparison graphic of air temperature between stations, on Figure 13.

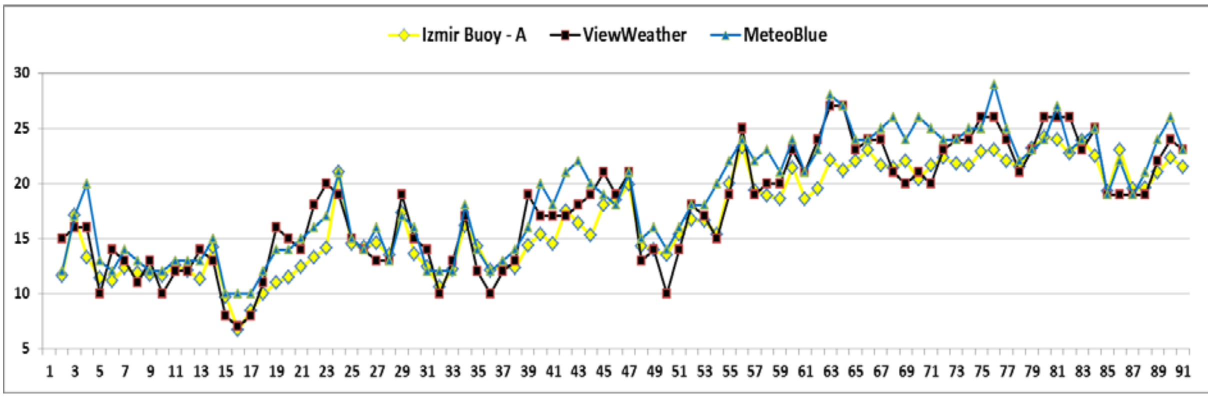

Figure 13. Comparison Table of Air Temperature Characteristics Between Stations

As it is understood from the figure, measured air temperature values in region are estimated higher than real. This issue correlated with essentially measured wet value. It is matter of feeling air temperature is relatively low by the reason of higher range of real wet values of region. Comparison graphic of sea water temperature measurement value between stations on Figure14.

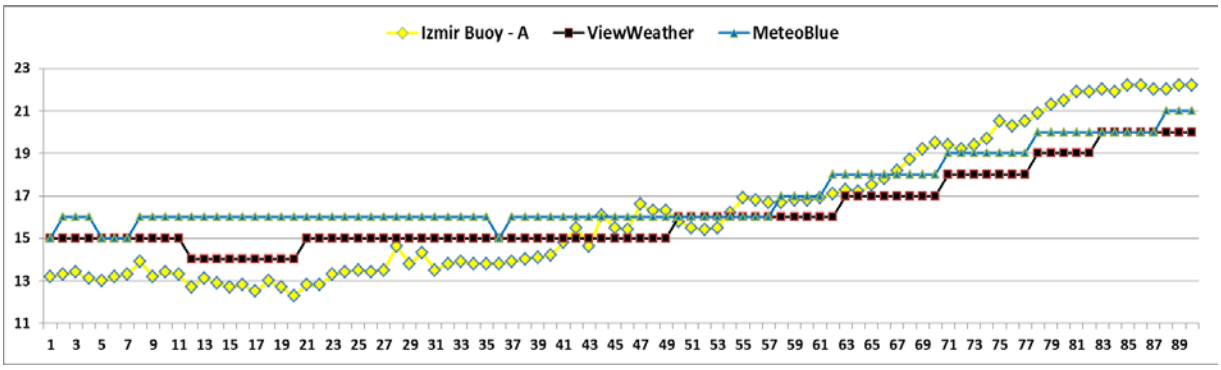

Figure 14. Comparison Table of Sea Temperature Characteristics Between Stations

As it is understood from the figure, measured sea water temperature values are increased decisively. It is seen the increasing of sea water temperature depends on increasing air temperature by the date range of receiving data. Especially, while the measured sea water temperature values between 40th and 50th days are closer to real, after 2nd month values lower than real are estimated. It is shown the comparison graphic of relative wind measurement values on Figure15.

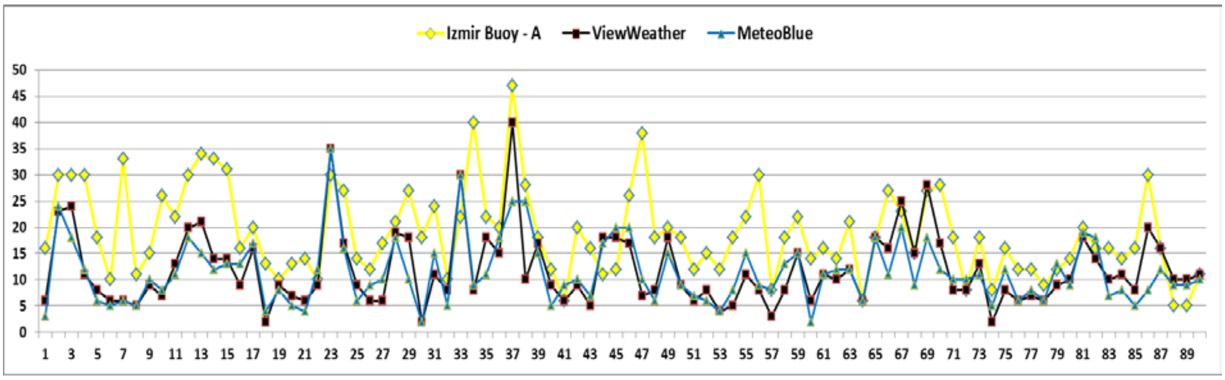

Figure 15. Comparison Table of Wind Speed Characteristics Between Stations

As it is understood from the figure, it is seen about the values received from viewweather station are the closest ones to real. But, it is seen the measured wind speed is stronger in real and the estimated one is less strong than real. This situation is related with changing in pressure. Because, the wind speed is directly related with pressure changings.

CONCLUSION AND DISCUSSION

Instant, valid and reliable regional meteorological data have crucial role in marine transportation safety. In this study initially the data provided by fixed surface meteorological station located at the entrance of İzmir bay is analyzed.

In this research, it is mainly aimed to measure reliability level of two different weather stations which carry out weather forecasting in Izmir Bay. Within this purpose comparison of weather parameters provided by remote stations are carried out with the parameters provided by fixed weather forecasting buoy in Izmir Bay.

In this context, different forecasting techniques are also analyzed and compared. Comparing the real data with estimated ones and deviation ratios are shown in this research. In this level, it is reached to the result of both stations are making reliable and real-like measurements than some data. In subjected region, these estimation station's data could be accepted as reliable.

This study can be determined as initial stage of another study. The rainfall estimation model will be constructed with the same data through Artificial Neural Network (ANN) approach for the same region. This study is restricted with 3 months data so for further studies the quantity of data can be increased. Study includes only two weather forecasting station comparisons. For further studies the region and station number can be changed.

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ANALYSIS OF METEOROLOGICAL FACTORS AFFECTING ON MARITIME TRANSPORT SYSTEMS

Gökhan Kara[1]

ABSTRACT

Maritime transport is an activity carried out between the atmosphere and the sea surface. Irregularities occurring in the atmosphere indirectly causes the formation of the negative conditions of the sea areas. Adverse conditions cause an increase in the vessel's transit time and a delay in reaching the port of destination. When environmental conditions reach a certain critical value, maritime transport is affected adversely. Therefore, during the navigation of the ship, including the port of loading and unloading operations are required to know some meteorological factors. These; wind, restricted seeing (visibility), sea ice, temperature, humidity and sea state (wave, currents, etc.). Moreover, in addition to the weather bulletin and storm warning for ships navigating in the open sea, some of the specialized services needed to help along the way before the movement of ships. For example, precautions must be taken to protect the ship load. Load influenced by the temperature falls below the freezing point or shaky. High humidity can cause damage to the carrying cargo in the warehouse. Deck cargo can be damaged from wind waves and spray. In this study, analysis of meteorological factors that cause the adverse conditions in the maritime transport is made.

Keywords − *Maritime Meteorology, Maritime Transport, Weather Conditions, Oceanography*

INTRODUCTION

In the past, unfavorable weather conditions have always made navigation difficult for the seafarers due to the facts of ship’s wooden construction, sailing with wind force, predicting atnospheric conditions instantly by experiences and the lack of navigational aids (technological equipment). During the time period until today, even instant information flow, developed navigation instruments on the ships and the growth of vessels’ tonnage, both meteorological and oceanographic factors can still create danger. These factors can be effective not only during navigation but also when loading and discharging at the ports. Maritime transportation is a high time-costing industry. For this reason, any time loss or cargo damage would cause consequent problems. Therefore, from atmospheric phenomena along the navigation to the characteristics of cargo carried on the ship, a lot of information should be known in advance and necessary steps should be taken in this direction. It is possible to avoid great loss of life and property by well known weather forecast and taking precautions before against possible negative situations.

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MARITIME METEOROLOGY AND TRANSPORT

Maritime meteorology is a branch of meteorology investigating the actual atmospheric events surrounding seas and oceans. Meteorological information in maritime transport is as important as navigational information. Because the journeys carried out under normal atmospheric conditions are only sufficient navigation information. When the ship's journey forces the meteorological conditions occur, in which case it is necessary to ward off the least cost.

The weather conditions are very important for the vessels navigating in the sea. The time is very important in modern transportation and bad atmospheric conditions increase both fuel and time cost. Heavy weather is the cause of 30% of ship losses. In sea transport, the cost of time is high. For this reason, it is necessary to complete the voyage as soon as possible. The cargo must be delivered to the destination port as soon as possible without being damaged. Maritime meteorology deals with air, wind, temperature, visibility, currents and wave forecasts for ships operating at sea.

METEOROLOGICAL FACTORS IN THE MARITIME TRANSPORT

In fact, negative impact on the other transport types of most of the meteorological elements are similar to adverse effects on marine transportation. Their most obvious difference is that the heavy meteorological weather protection in land area, it is easier than the sea. Meteorological factors affecting the maritime transport may be as follows.

Temperature and Humidity

Air temperature near the surface tends to follow that of the surface below. Thus the annual range, like the diurnal range, is greater over the interior of large continents than over the oceans. The main factors governing air temperatures at the sea are:

- Latitude. Generally warmest within the tropics and subtropics.
- Season.
- Proximity to large land masses.
- Prevailing winds.
- Ocean currents.
- Upwelling of cooler water from the depths.
- The presence of ice or snow covering [1].

Also, depending on the temperature of sea water may be changes in the draft of the ship. As a consequence, it varies the loading capacity of the ship.

As the temperature of the sample increase or decrease, so the RH value will change. Relative Humudity is defined as the ratio of the mass of water vapour present to that which could be present if the air was saturated at the same temperature. The dew-point temperature is the temperature to which a sample of air must be lowered in order to saturate it with respect to a plane liquid water surface, assuming constant pressure and water vapour content. When the temperature of the warehouse surface is lower than the temperature of the dew point, condensation occurs on the surface of the warehouse. because of its effect upon instruments, and possible damage to ship or cargo. For this reason, it is necessary to ventilate the ship's warehouse under suitable conditions.

Wind and Waves

Wind is defined as the horizontal movement of air across the surface of the earth. The effect of wind speed on ship performance is one of the most important the meteorological factors. High wind speed causes wave formation on sea surface. This effect causes the speed of the ship to decrease and the travel time to be prolonged. The results clearly indicate that strong winds and high waves can have a major impact on maritime shipping. However, the wind is not the only factor influencing the sea state, and allowances should be made for tides, currents, depth of water and precipitation, where these are seen to affect the sea state [2]. At sea, observations of wind are therefore normally made by estimation. The Beaufort scale forms the basis of wind-force estimation at sea.

Almost all waves at sea are caused by wind. The mariner lives in intimate contact with the waves of the sea and is able to realize better than most people the extent to which their size and energy, as shown by their destructive power, are related to the speed of the wind. Up to a limit, the stronger the wind, the higher will be the waves. In the open ocean the sizes of the waves depend also upon the depth of the water, the length of time the wind has been blowing and the “fetch” which is the distance to windward of the observer over which the wind has blown. Waves caused directly by the wind blowing at the time of observation are known as sea waves. By contrast, swell waves will have been created some time beforehand by winds blowing in an area some considerable distance away [3].

Forecasting Sea Waves: A forecast of the wave heights likely to be encountered on a voyage is of obvious value to the mariner. The meteorological services of several countries provide such forecasts either in terms of wave-height distribution forecasts for a given area and period, or in connection with a “weather routing” service where in the vessel may be advised to proceed on a particular route in order to avoid the higher seas expected on the normal route. The way in which such forecasts are prepared is briefly summarized as follows [4].

The height of sea waves is determined by the following variables:

- Wind speed,
- Duration of the wind
- Wind fetch

In the figure 1, significant wave height in terms of wind speed, with fetch 1000 nautical miles and duration 50 hours

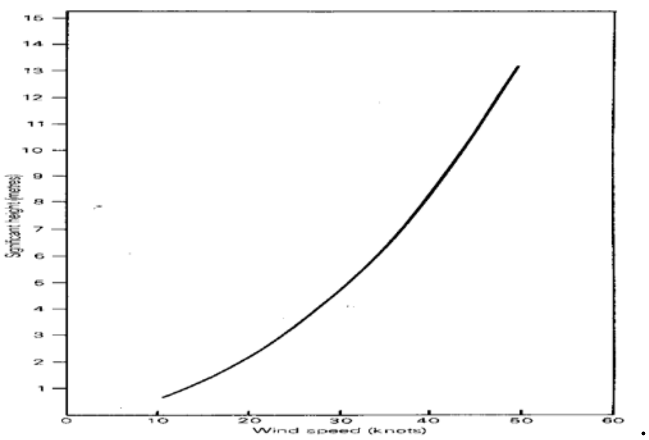

Figure 1. Wave height depend on wind speed [4].

Visibility

Actually, Visibility, in the meteorological sense, is a measure of the transparency of the atmosphere and may be defined as the greatest horizontal distance at which an object of specified characteristics can be seen by a person of normal vision under conditions of average daylight illumination. Visibility is assessed by viewing the horizon through 360o and recording the shortest distance. Visibility is reduced by the suspension of liquid or solid particles in the atmosphere. If the visibility is reduced to less than 1 km as a result of water droplets, the condition is termed fog, and if 1 km or greater it is termed mist.

Fog: Fog is caused by the cooling of air to a temperature (known as the “dewpoint”) at which it becomes saturated by the water vapour which is present within it. Fog is weather phenomena that can reduce visibility and hence influence marine transport [3].

Figure 2. Fog at the sea.

Visibility depends chiefly on the number of solid or liquid particles held in suspension in the air. It may vary in different directions because the concentration of particles varies. This may occur in the neighborhood of a large port or other industrial center due to the variation in the concentration of solid particles, or due to variations in the concentration of water droplets, as in the case of patchy fog [4]. The main causes of atmospheric obscurity are:

- Visible moisture in the atmosphere. Under this heading are cloud, mist or fog consisting of water droplets, precipitation (i.e. drizzle, rain, sleet or snow, etc.) at the observer’s level and spray blown up from the sea. Water vapour is a transparent gas and so does not affect visibility,

- Solid particles such as those produced by factories, domestic fires and forest fires, by sea spray and by sand and dust due to strong winds in desert regions, or as the result of volcanic eruptions [4].

At sea the limited availability of objects often makes the estimation of visibility difficult and a coarser scale is used (Table 1):

Table 1. Visibility scale used at sea [2].

Range Recorded in Steps			
Km	***N.mile***	***Km***	***N.mile***
<0.05	<0.03	2.0-4.0	1.1-2.2
0.05-0.2	0.03-0.1	4.0-10.0	2.2-5.4
0.2-0.5	0.1-0.3	10.0-20.0	5.4-11.0
0.5-1.0	0.3-0.5	20.0-50.0	11.0-27.0
1.0-2.0	0.5-1.1	≥50.0	≥27.0

Precipitation: In meteorology “precipitation” is a generic word embracing most forms of water deposit which are derived from the condensation of water vapour in the atmosphere. It includes rain, drizzle, snow, sleet and hail [1].

Ocean Currents

Currents flow at all depths in the ocean, but in general the stronger currents occur in an upper layer which is shallow in comparison with the general depths of the ocean [3]. Much of our knowledge of ocean currents is derived from observations made voluntarily by officers in merchant vessels. The navigator needs some knowledge about these currents because of their effect on the safety and economical operations of a ship at sea. The surface currents of the ocean can be divided into two main categories: drift currents caused directly by the wind and gradient currents caused indirectly by the wind or by density differences in adjacent areas.

Sea Ice

Sea ice is partly a meteorological and partly an oceanographic phenomenon. There are two kinds of floating ice encountered at sea: sea ice, formed from sea water; and icebergs, which break off the seaward end of glaciers and from shelf ice [3]. Ice is found at high latitudes in both hemispheres but because of their physical dissimilarities the climatic and ice regimes of the Arctic and Antarctic regions differ greatly. The distribution and seasonal variation of sea ice differ greatly from the one polar region to the other. Sea ice is a complex substance varying in shape, size, thickness and many other characteristics. The ice cap covering the Antarctic continents accounts for more than 90 % of the earth’s permanent ice. The ice constituting the ice cap is constantly moving outwards towards the coasts where many thousands of icebergs are calved each year from the glaciers and ice shelves which reach out over the sea.

Figure 3. Ice navigation.

Sea ice has posed a problem to the navigator since antiquity. Ice is of direct concern to the navigator because it restricts and sometimes controls his movements; it affects his dead reckoning by forcing frequent changes of course and speed; it affects piloting by altering the appearance or obliterating the features of landmarks; it hinders the establishment and maintenance of aids to navigation; it affects the use of electronic equipment by affecting propagation of radio waves; it produces changes in surface features and in radar returns from these features; it affects celestial navigation by altering the refraction and obscuring the horizon and celestial bodies either directly or by the weather it influences, and it affects charts by introducing several plotting problems [5].

CONCLUSION

Weather conditions are important for sea transport. Particularly commercial vessels are aimed at navigating in such a way as to be least affected by weather conditions. The ships deliver the cargo on time and have the opportunity to make more voyages. For this to happen, the captain must know and predict the weather conditions in along the route. Captains must follow the weather reports constantly and take precautions for this purpose.

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ANALYSIS OF METEOROLOGICAL FACTORS AFFECTING MARITIME TRANSPORT IN THE TURKISH STRAITS

Gökhan Kara[1] , E.Gül Emecen Kara[2]

ABSTRACT

The Turkish Straits are ones of the busiest waterways. Average 50 000 ships pass through these regions annually. In addition to this transit traffic, these regions have intensive urban maritime traffic. Also, they cause navigational challenges depending on their characteristics. Especially meteorological factors significantly affect maritime traffic in these regions and create a risk. In this study, it is aimed to analyze meteorological factors affecting maritime transport in the straits region and effects. Maritime incidents occurring in these regions are investigated for the period 2010-2015 and effect of meteorological factors is discussed.

Keywords – *The Turkish Straits, meteorological factors, marine environment, maritime transport.*

INTRODUCTION

The Turkish Straits comprise the Istanbul Strait, the Canakkale Strait and The Sea of Marmara. It is an important waterway because of connecting the Black sea to the Aegean and the Mediterranean. This seaway that approximately is 326 kilometers long has a narrow and sharp turns and powerful currents. The average width at Istanbul Strait is 1500 m, it becomes as narrow as 700 m in Kandilli. The width at Çanakkale Strait varies between 1300-2000 m. There are turning points with 45 and 80 degree and complex currents that reach to a relative speed of 4-5 knot at the Istanbul Strait [1]. In addition to these characteristics they have the highest maritime traffic. Average 50 000 ships pass through these regions annually. In addition to this transit traffic, these regions have intensive urban maritime traffic. More than 2 million people pass through these regions daily by small craft [1].

These characteristics of the straits make them one of the most difficult and potentially dangerous waterways in the world [1]. Adding to this dangerous meteorological factors significantly affect maritime traffic in these regions and create a risk. Severe weather conditions such as storms, fogs may cause to delays and maritime accidents.

In this study, it is aimed to analyze meteorological factors affecting maritime transport in the straits region and effects. Maritime incidents occurring in these regions are investigated for the period 2010-2015 and effects of meteorological factors are discussed.

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METERIAL METHOD

Vessel Traffic and Maritime Accidents in the Turkish Straits

The number of vessels that passed through the Turkish Straits between 2005-2015 years are shown in Figure 1. There is a decrease in the number of ships passing through the Straits from 2005 to 2015. The number of ships passing through the Istanbul Strait has declined to under 50000 after 2010. In the year 2015, 43544 ships passed through the Istanbul Strait and 43230 ships passed through the Çanakkale Strait. About 22% of these passing ships is carrying dangerous cargoes in the Çanakkale Strait, this value is about 20% in the Istanbul Strait.

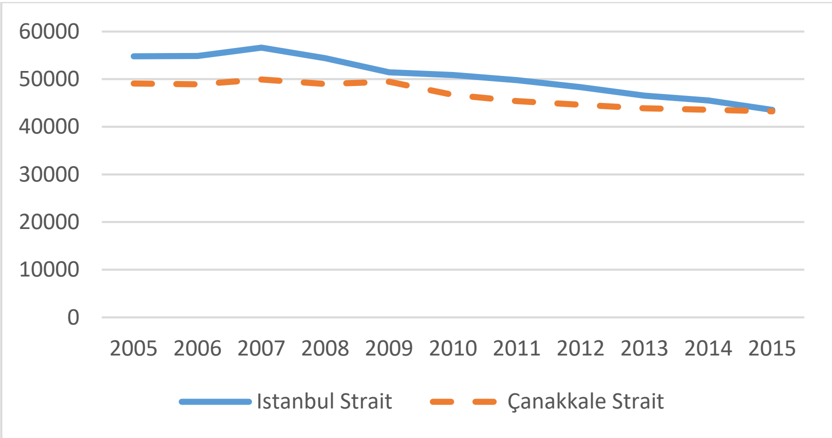

Figure 1: The number of ships that passed through the Turkish Straits between the years 2005-2015[2].

Many maritime accidents/incidents have occurred in the Turkish Straits due to characteristics of the Turkish Straits [3]. The number of maritime incidents in the Turkish Straits region between 2010-2015 years are shown in Figure 2. Maritime incidents occurring in the Istanbul Strait region are higher than Çanakkale Strait region. It is shown that the number of maritime incidents have decreased since 2010. Particularly a significant reduction in the number of maritime incidents has been in the Istanbul Strait region.

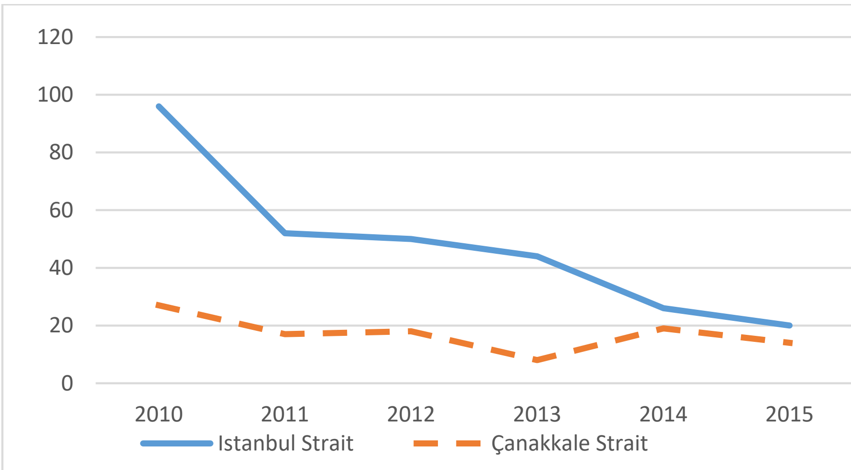

Figure 2: The number of maritime incidents in the Turkish Straits between 2010-2015 years.

Meteorological Factors Affecting Maritime Transportation

Some of the most important meteorological factors affecting maritime transportation are precipitation, wind and fog. Precipitation forms are rain, drizzle, snow, sleet and hail. Average annual precipitation is about 780 mm in Istanbul. Approximately 35% of the annual precipitation occurs in the winter season, 23% of it in the spring, 28% of it in the autumn, and 14% of it in the summer. The numbers of snowy days don't exceed 10 days [4].

Fog is an important meteorological factor because it affects the visibility at sea. The visibility is diminished to less than 1km when fog is present. Fog can be identified as radiation fog, advection fog and frontal fog according to form types. Advection fog occurs when a mass of warm air moves horizontally over a cooler surface. If the air is cooled below its dew point temperature, the mist/fogs will produce. Advection fog formed at sea is called sea fog. Radiation fog is a land based fog and it forms when the ground cools by long wave radiation during the night. Suitable conditions for the formation of radiation fog are very low wind speed, the clear sky, a high relative humidity. This fog forms most likely during the autumn and winter. Radiation fog affects visibility at sea if it drifts over estuaries and coastal waters as a result of light offshore winds [5]. This fog types occur frequently in Istanbul. The highest value of fog produces in March, April and May in Istanbul.

Another important factor is wind. According to months average wind speed and prevailing wind directions are shown in figure 3 and Figure 4. Northeaster and southwester are dominant wind directions in these regions. It is seen that average wind speed decreased after March and it increased after June in Istanbul. Average wind speeds in Çanakkale is more than Istanbul.

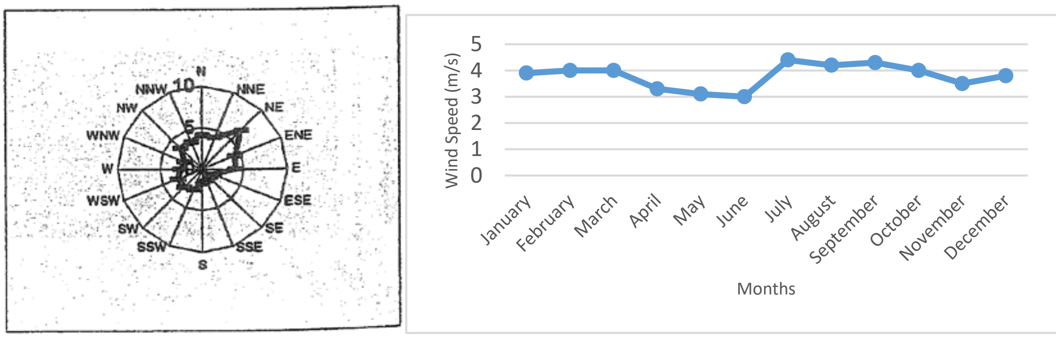

Figure 3. Average wind speed and prevailing wind directions in Istanbul (Sariyer) [6]

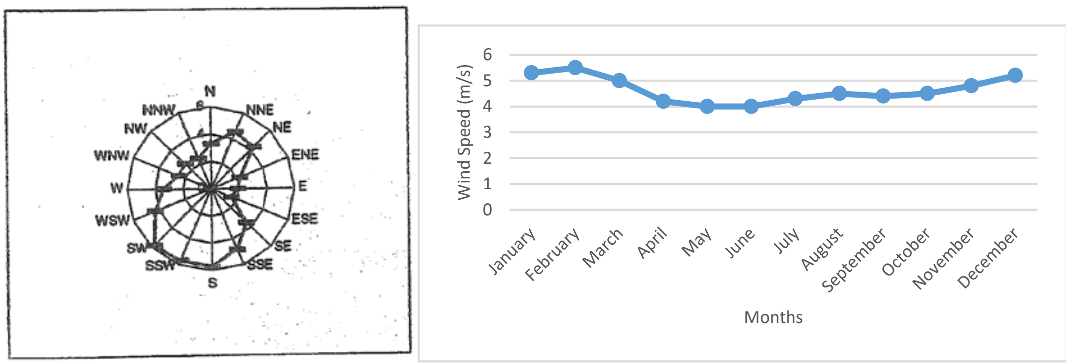

Figure 4. Average wind speed and prevailing wind directions in Çanakkale [6]

RESULTS

In this section, for analysis to effects of meteorological factors on maritime transport, maritime accidents occurring in the straits region due to meteorological factors are investigated in the period 2010-2015. Maritime accidents due to meteorological factors are analyzed according to the months and types of maritime accident for this period.

299 maritime accidents in total have occurred in this period. About 18% of these maritime accidents have occurred due to meteorological factors. About 84 % of maritime accidents occurring due to meteorological factors have taken placed in Istanbul region. All maritime accidents occurring in the straits region due to meteorological factors are given Figure 3 between 2010-2015 years. The highest value of these accidents occurred in January, October and November months. June, July and August are the months with the least accidents due to meteorological factors. The most incidents occurred in the 2010 and 2012 years. At least the incidents occurred in 2014 and 2015.

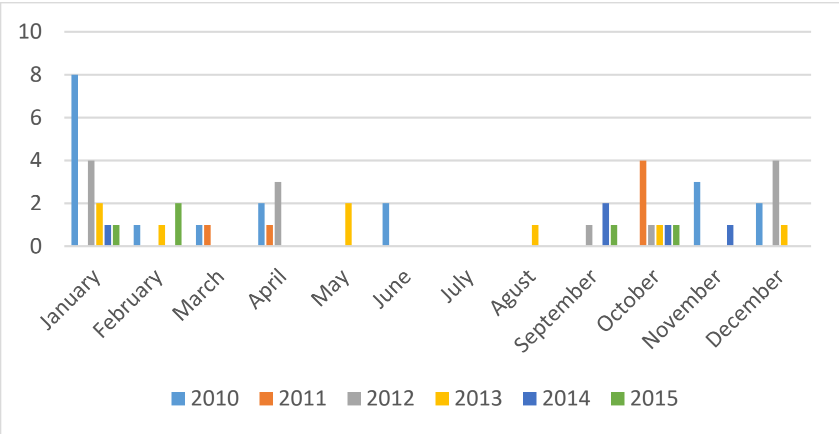

Fig. 3. Maritime accidents occurring in the straits due to meteorological factors (2010-2015).

According to types of maritime accident, maritime accidents occurring in the straits region due to meteorological factors are given in Table 3. Collision and grounding are the most occurring type of incidents. 29 % of all capsizing incidents have occurred due to meteorological factors. The other incidents with the highest percentage are respectively grounding, collusion and contact. Collision has occurred in the mooring areas in general (especially Ahırkapı).

Table 1: According to types of maritime accident, the percentage of maritime accidents occurring in the straits due to meteorological factors.

INCIDENT	(%)
Capsizing	29,0
Grounding	23,9
Collision	21,2
Contact	15,8
Listing	11,1
Drift	5,1

CONCLUSION

The Turkish Straits are among the most important waterways. Due to its characteristics they are dangerous for navigation. Meteorological factors significantly affect maritime traffic in these regions. Storms and fogs cause to maritime accidents and delays in these region. Southwester affects more common maritime transport in these regions. About 18% of all maritime accidents in the straits region have occurred due to severe weather conditions. An important part of these maritime accidents have taken placed in the Istanbul Strait region. January, October and November are months with the highest values of accidents. More than 20% of grounding and collusion incidents have occurred due to weather condition.

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A LITERATURE REVIEW ON EFFECTS OF COMBUSTION VARIABLES TO ENGINE PERFORMANCE AND EXHAUST EMISSIONS ON DIESEL ENGINES

Yiğit Gülmez[1], Mustafa Nuran[2]

ABSTRACT

Diesel engines are frequently used as prime mover and energy producer at ships and other industries due to low cost per kilowatt and reliability. But greenhouse gas emissions from diesel engines is a crucial issue. Around 1000 million tones of CO_2 ,about 2.5% of global greenhouse gas emissions, is emitted by ships annually. Moreover an increase between 50% and 250% is expected by 2050 based on future economic and energy developments. Changes in combustion variables -fuel injection pressure, temperature and timing; air temperature and humidity; compression ratio; suction and exhaust valve opening timing etc.- effects engine performance, fuel consumption and exhaust emissions. In this study, effects of changes in each combustion variables to engine performance, fuel consumption and emissions are investigated. A literature review has been made on previous experimental studies. According to findings all variables and their effect to engine performance are deduced and classified. In addition, injection strategies to reduce exhaust emissions are revealed. As it can be clearly seen according to results of the study changes in injection strategies and combustion variables can effect engine performance and exhaust emissions significantly.

Key words: Combustion, Exhaust Emissions, Engine Performance, Fuel Injection

INTRODUCTION

In the last decade, the legislated limits of exhaust emissions from engines were more and more tightened [1]. Different rules and limits is valid for various industries. For example, MARPOL Annex VI sets limits on NOx and SOx emissions from ship exhausts [2] for maritime industry. Latest amendment of MARPOL convention, which includes AnnexVI as well, involves more stringent requirements for marine diesel engine's NOx emissions [3]-[4]. As is shown in Table 1, even though Tier 2 brings tight requirements Tier 3 brings tighter requirements for ships.

Table 1: MARPOL Annex VI Emission Limits [4]

		NOx Emissions g/(kw.h)		
Phase	Valid after	n<130	130<n<2000	n>2000
Tier 1	2000	17	$45*n^{-0.2}$	9.8
Tier 2	2011	14.4	$44*n^{-0.23}$	7.7
Tier 3	2016	3.4	$9*n^{-0.2}$	1.96

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There are different methods available for reducing ship emissions to comply with the Annex VI requirements [5]. These methods to reduce emissions are listed in Table 2. All the reduction methods are suitable to reduce one or a few of the emission components. Engine parameters optimization is one of the methods that can be used to determine emissions.

Table 2: Available methods to reduce emissions [5]-[6]-[7]-[8]

Reduction Method	Potential Reduction %
Selective catalytic reduction	95
Emulsification	20-25
Humid air	70
Engine parameters optimization	50-60
Exhaust gas recirculation	15-35
Alternative Fuels	60-90
Sea Water Scrubbing	up to 95
Energy Optimization	up to 10
Electrostatic Filters	up to 85

These methods are suitable to reduce nitrojen oxides (NOx) emissions about 20-40% approximately. Yet, it has to fulfil only the tier 2. The fulfilment of tier 3 needs more reduction [9].

In addition, Carbondioxide (CO_2) emissions from ships are currently unregulated. But, according to the Kyoto protocol definite measures to reduce CO_2 emissions are necessary in order to curb the projected growth of greenhouse gases (GHG) worldwide [10]. Therefore a new regulation to reduce CO_2 emissions would seem probable for maritime industry.

Engine parameter optimization method is one of the available method to reduce emissions. However, there are numerous engine parameters, any change of which may effect emissions directly. This study aims to investigate effects of potential parameters to emissions. Thus a literature review was conducted to find out related parameters and their effect. Only experimental studies which prove the effects of any changes in engine parameters to environment and engine performance has been selected to review. Consequently, findings of each studies are used as references to find out the effects of each parameter change to each of the emissions and engine performance. This study is divided into four parts. Part 1 deals with regulations related to emission reductions in maritime industry and explains aim of the study. Part 2 details sample selection and describe the methods of analyzing the studies. Third part gives findings according to the analysis and interpretations about the findings. Finally, fourth and last part indicates the analysis that are discussed in the conclusion.

METHODOLOGY

The aim of this paper is finding out the effect of changes in related engine parameters to exhaust emissions in diesel engines. Thus a literature review is conducted. Literature review papers are often very helpful for researchers, as the reader gets an up-to-date overview of the literature in a specific area. It also heps researchers to find research gaps and this also may be very helpful for readers who plan to do research in the same area for the first time [11].

In this study an investigation was made among 178 academic articles in which an experimental research is conducted to observe the changes in exhaust emission by changing any parameter of a diesel engine. All the articles are accessed via "Dokuz Eylul University Online Library" [12]. The better part of all articles were related to fuel type changes. Changing the fuel type is an effective way to reduce emissions. Yet this study is aimed to focus to observe the effect of changes in engine parameters to exhaust emissions. Thus effects of changes in fuel type haven't considered. Investigated engine parameters in this study are; injection pressure, compression ratio, intake air temperature, intake air pressure, changes in combustion chamber design, air to fuel ratio, exhaust gas recirculation, suction and exhaust valve lifts, injection timing, pilot injection timing and pre-injection. The reduction in environmental pollution is considered according to decreases in nitrogene oxides (NO_{x}), hydrocarbons (HC), carbonmonoxide (CO) and carbondioxide (CO_2) emissions, specific fuel consumption (SFC) and smoke opacity are considered as in the study.

FINDINGS

The present study was designed to determine the effects of changes in combustion variables to emissions of engines. Therefore, experimental studies were investigated and changes in each variable were revealed. As mentioned in the methodology part, eleven different variables were examined and changes in these variables have been found out.

Variables were examined according to injection pressure of the fuel. Six experimental studies in which effect of injection pressure (IP) change to emissions was observed were examined. Thus, according to findings, NO_x emissions increase by (IP) up to 19.5%. On the contrary smoke opacity may decrease up to 19.8%. One interesting finding is changes in emissions of HC, CO, CO_2 changes irregularly. Detailed findings were given in Table 3.

Table 3: Emissions change by injection pressure

Articles	Change in IP	HC	NOx	CO	CO_2	Smoke Opacity	SFC
Agarwal et al. [13]	500 bar to 1000 bar	62.4%	19.5%	14.0%	13.6%	N/A	N/A
Sarangi et al. [14]	900 bar 1100 bar	N/A	N/A	N/A	N/A	-7.10%	-2.40%
Wamankar et al. [15]	200 bar to 240 bar	-12.5%	17.4%	-22.5%	N/A	-19.8%	N/A
Shatrov et al. [16]	1000 bar to 3000 bar	N/A	19.50%	N/A	N/A	N/A	-1.39%
Benajes et al. [17]	950 bar to 1250 bar	40.30%	0.00%	-5.40%	N/A	-10.40%	-1.20%
Sivaramakrishnan et al. [18]	190 bar to 230 bar	-36.00%	77.70%	N/A	N/A	N/A	N/A

Changes in compression ratio (CR) is one of the most frequent variables to observe the effect of increase or decrease to emissions. In this paper, six experimental studies in which CR change was observed were investigated. According to the findings, NO_x emissions increase by CR up to 92.9% while CO, HC emissions and smoke opacity decrease. Additionally, only very few studies observed changes in CO_2 by CR.

Table 4: Emissions change by compression ratio

Articles	Change in CR	HC	NOx	CO	CO_2	Smoke Opacity
Gong et al [19]	14 to 16	N/A	14.0%	-25.2%	N/A	N/A
Hosmath et al. [20]	15.5 to 17.5	-12.5%	5.2%	-37.7%	N/A	-14.9%
Chintala et al. [21]	15.4 to 19.5	-48.4%	55.4%	-39.7%	N/A	-34.0%
Wamankar et al. [15]	16.5 to 17.5	-21.1%	20.0%	-57.5%	N/A	-52.0%
Sivaramakrishnan et al. [18]	17.5 to 18.1	-55.4%	74.5%	N/A	N/A	N/A
Mohanraj et al. [22]	14 to 18	-26.8%	92.9%	-40.0%	60.0%	0.0%

Four experimental studies in which the effects change in intake air temperature to exhaust emissions was observed were examined. According to the findings it is predicable that HC and CO emissions decrease mostly while smoke opacity increase. HC emission changes up to 50% and CO emissions change up to 37.3% by force of intake air temperature. Conversely, NO_x emissions change irregularly. Detailed findings were given in Table 5.

Table 5: Emissions change by intake air temperature

Articles	Change in Int. T. (°C)	HC	NOx	CO	Smoke Opacity
Cinar et al. [23]	50 to 90	23.8%	-85.3%	37.7%	N/A
Wang et al. [24]	20 to 70	-30.3%	41.4%	-6.3%	32.1%
Changwan et al. [25]	70 to 100	-50.0%	-18.8%	-32.1%	40.0%
Polat, S. [26]	60 to 120	-26.4%	53.3%	-2.3	N/A

Only very few studies examined effects of change in constant intake air pressure (Int.P.) to emissions. One of these studies was investigated in this paper. Thus, findings of investigated study claims that both HC, CO emissions, smoke opacity and specific fuel consumption decrease. However this study hadn't examined CO_2 NO_X emissions. Findings of the investigated study were given in Table 6.

Table 6: Emissions change by intake air pressure

Articles	Change in Int.P.	HC	NOx	CO	CO2	Smoke Opacity	SFC
Sarangi et al. [14]	1.2 bar to 1.5 bar	-37.5%	N/A	-13.8%	N/A	-10.9%	-4.1%

Change of combustion chamber design is considerable popular in the studies in recent years. There are numerous alternative design changes. In this paper two of the alternatives were investigated. Detailed results of these two studies is given in Table 7. According to the findings, it is clear that change in combustion chamber design effects emissions remarkably.

Table 7: Emissions change by changes in combustion chamber

Articles	Changes in Combustion Chamber	HC	NOx	CO	CO2	Smoke Opacity	SFC
Musthafa Mohamed et al. [27]	Al_2O_3 Coating	-43.5%	10.1%	N/A	N/A	-24.0%	-0.7%
Mamilla et al. [28]	Torrodional Piston Head Design	3.7%	-4.5%	3.4%	4.9%	3.8%	N/A

Once the studies which observed the effects of air to fuel ratio (λ) to emissions it was seen that change of air to fuel ratio increases HC and NO_X emissions while decreasing CO emissions between approximately 1 and 1.4 and vice versa between 1.4 and 3. The details were given in Table 8. However, considering emissions may be depended on many other factors of test apparatus, effect of air to fuel ratio to emissions cannot be generalized.

Table 8: Emissions change by air to fuel ratio

Articles	Change in λ	HC	NOx	CO
Cinar et al. [29]	0.6 to 1.4	89.5%	32.8%	-73.8%
Polat, S. [26]	1.5 to 3	-28.6%	-42.4%	N/A
Cinar, et al. [23]	1.4 to 2	-11.5%	-21.1%	N/A

Changes in exhaust gas recirculation ratios (EGR) is one of the most frequent variables to observe the effect of increase or decrease to emissions. Numerous studies has been conducted to observes effects of EGR to emissions. In this study five of experimental studies in which the effects of changes in EGR to exhaust emissions was observed were examined. According to the findings NO_X and CO_2 emissions decrease by increase of EGR. NOx emissions decrease up to 48.1% while CO_2 emissions decrease up to 35.5.%. However HC and CO emissions smoke opacity change irregularly. Details of the findings are given in Table 9.

Table 9: Emissions change by exhaust gas recirculation

Articles	Changes in EGR	HC	NOx	CO	CO_2	Smoke Opacity
Bose et al. [30]	%20 EGR + H2	-18.0%	-18.1%	-20.0%	-35.5%	-8.2%
Saravanan et al. [31]	%25 EGR + H2	-15.6%	-21.5%	-23.2%	-16.3%	-24.0%
Cui et al. [32]	50% EGR	N/A	-48.1%	N/A	N/A	-44.6%
Senthil et al. [33]	20% EGR	N/A	-45.4%	N/A	N/A	0.0%
Banapurmath et al. [34]	10% EGR	3.5%	-37.5%	44.5%	N/A	12.5%

Only very few studies examined effects of change in suction and exhaust valves lift measures to emissions. One of these studies was investigated in this paper. Thus, findings of investigated study claims that both HC, CO and NO_X emissions decrease. However this study hadn't examined CO_2 emissions and smoke opacity. Findings of the investigated study were given in Table 10.

Table 10: Emissions change by changes in valve lifts

Articles	Change in Valve Lifts (mm)	HC	NOx	CO
Cinar et al. [29]	Suction: 5.5 to 3.5	-19.1%	-51.3%	-36.3%

Injection timing (IT) is one of the most popular variable to observe effects of change to emissions. Studies related to IT may be divided into three groups. First, studies which observed the effects of changes in IT to emissions in conventional diesel engines. In this group only one injection per cycle occurs and test engine is mono fuel diesel engine. Second group of the studies observed pilot injection timing (PIT). In this group of studies the effects of changes in timing of pilot ignition to emissions on dual fuel engines were observed. And third group of studies observed the effects of pre-ignition timing to emissions. This studies conducted on diesel engines which has a secondary fuel injection into cylinder in addition to main injection.

Table 11 gives the results of experimental studies which apllied to find out the effects of injection timings on conventional diesel engines. According to the findings HC and CO emission decrease by setting IT to an earlier crank angle. Thus changes in HC emissions up to 14.5%, NOx emissions up to 41.7%, CO emissions up to 50% can be achieved.

Table 11: Emissions change by injection timing

Articles	IT	HC	NOx	CO	CO2	Smoke Opacity
Hunicz et al. [35]	20° to 180°	0.0%	-41.7%	N/A	N/A	N/A
Hosmath et al. [20]	19° BTDC to 27° BTDC	-6.0%	12.6%	-17.4%	N/A	N/A
Agarwal et al. [13]	9.37° BTDC to 15° BTDC	-7.6%	23.1%	-32.9%	-3.4%	N/A
Benajes et al. [36]	TDC to 9° BTDC	-14.5%	-40.0%	-50.0%	N/A	0.0%
Wamankaret al. [15]	23° BTDC to 26 BTDC	-12.5%	17.4%	-22.5%	N/A	-19.8%
Shatrov et al. [16]	5° BTDC to 20° BTDC	N/A	75.10%	N/A	N/A	N/A

Table 12 gives the results of experimental studies which apllied to find out the effects of pilot injection timings on dual fuel engines. According to the finding pilot injection timing has a significant impact on HC emission. On the other hand, NO_x emissions may change up to 80% by changes inpilot injection timings.

Table 12: Emissions change by pilot injection timing

Articles	Change	HC	NOx
Cameretti et al. [37]	BTDC -40° to -10°	235%	-72%
Ryu et al. [38]	BTDC -23° to -11°	N/A	-37.5%
Yang et al. [39]	ATDC -25° to -5°	175.0%	-80.0%
Jeon et al. [40]	ATDC -50° to 0°	N/A	-57.1%

Pre-injection strategy is considered to be one of the most important ways to improve diesel engine performance, emission and combustion [41]. In this paper three of the studies in which experiments were made to find out effect of pre-injection timing to emissions were investigated. According to the findings pre-injection strategy may decrease NO_x emissions up to 7.4% and CO emissions up to 35%. However, conducted studies show that pre-injection may increase HC emissions remarkably.

Table 13: Emissions change by pre-injection timing

Articles	Change	HC	NOx	CO
Xu et al. [41]	20° BTDC to 100° BTDC	14.2%	-7.0%	-2.4%
Sarangi et al. [14]	36° BTDC to 51° BTDC	17.1%	N/A	-35.0%
Özkan et al. [42]	No pre inj. to 25° BTDC	10.4%	-7.4%	26.1%

CONCLUSIONS

The purpose of the current study was to determine the effects of changes in combustion variables to emissions of engines. Thus, experimental studies were investigated and changes in each variable were revealed. As mentioned in the methodology part, eleven different variables were examined and the effects of changes in these variables have been found out. According to the findings exhaust gas recirculation systems seems as the most satisfactory method to determine emissions. One interesting finding of the study was that in the better part of the articles authors had used single piston diesel engine. A single piston diesel engine is more useful because it is lest to be affected by environmental conditions. According to the findings of the study, effects of changes in each variable to each emission indicator is given in Table 14. Only the maximum decreases were consider while the table was created.

Table 14: Maximum decreases of emissions by changes in variables

Variables	HC	NOx	CO	CO2	Smoke Opacity	SFC
Injection Pressure	-36.0%	N.D.	-22.5%	N.D.	-19.8%	-2.4%
Compression Ratio	-48.4%	N.D.	-57.5%	N.D.	-52.0%	N.A.
Scavenge Temperature	-50.0%	-85.3%	-32.1%	N.A.	N.D.	N.A.
Scavenge Pressure	-37.5%	N.A.	-13.8%	N.A.	-10.9%	N.A.
Combustion Chamber Design	-43.5%	-4.5%	N.D.	N.D.	-24.0%	-0.7%
Air to Fuel Ratio	-28.6%	-42.4%	-73.8%	N.A.	N.A.	N.A.
Exhaust Gas Recirculation	-18.0%	-48.1%	-23.2%	-35.5%	-44.6%	N.A.
Suction& Exhaust Valve Lift	-19.1%	-51.3%	-36.3%	N.A.	N.A.	N.A.
Injection Timing	-14.5%	-40.0%	-50.0%	N.A.	-19.8%	N.A.
Pilot Injection Timing	N.D.	-80.0%	N.A.	N.A.	N.A.	N.A.
Pre-injection Timing	N.D.	-7.4%	-2.4%	N.A.	N.A.	N.A.

N.D.: No Decrease, N.A.: Not available

According to the table exhaust gas recirculation seems as the most effective way to decrease emissions. In addition, although there aren't numerous studies to observe suction& exhaust valve lift changes, it decreases the emissions significantly. On the other hand the study shows that scavenge temperature has a determining role on emissions. Finally, it is predictable to say optimization of all the variables may affect emissions seriously. A more comprehensive literature review may be conducted on further studies to determine more variables. As mentioned in the introduction part SO_X emissions will be crucial in the next years. Despite decrease of SOx emissions is mostly related to fuel type, engine parameter may also have an impact on it. Thus effects of changes in combustion variables to SOx emissions may be conducted in further studies.

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INVESTIGATION OF EFFECT OF ALTERNATIVE MARINE FUELS ON ENERGY EFFICIENCY OPERATIONAL INDICATOR (EEOI)

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ABSTRACT

Studies about emission abatement methods and technologies are in demand with the decreasing of upper allowable limits of shipboard emissions. Most importance is given to carbon dioxide emission, and intense studies are made. Energy Efficiency Design Indicator (EEDI) and Ship Energy Efficiency Management Plan (SEEMP) entered into force as a mandatory implementation to the related ships, and Energy Efficiency Operational Index (EEOI) as a voluntary implementation. In this study, liquefied natural gas (LNG), ethanol, methanol and hydrogen were used as a main or mixture fuel at a selected ship. Their combustion processes were assumed as stoichiometric combustion. Conventional fuel and alternative fuel consumptions are calculated and CO_2 emissions are found. LNG forms the least CO_2 emission with 4071,393 kg/h, while %50 ethanol mixture with heavy fuel oil (HFO) forms 4809,497 kg/h, and %5 hydrogen mixture with HFO forms 4820,305 kg/h. EEOI are calculated for a specific voyage. LNG has the best indicator rating of 0,0000063, while %50 ethanol mixture with HFO, and %5 hydrogen mixture with HFO has 0,0000074. Voyage CO_2 emissions are 1558,72, 1841,30, and 1845,44 ton/voyage respective to LNG, %50 ethanol and HFO mixture, and %5 hydrogen and HFO mixture. Top cheapest three voyages are with LNG, HFO, and %10 methanol and HFO mixture which are 105425,97, 170834,46 and 179967,56 USD/voyage.

Keywords – alternative marine fuels, CO_2 emissions, EEOI, energy efficiency

INTRODUCTION

Recent studies at maritime industry concentrate on mitigation of shipboard emissions. Especially, carbon dioxide emissions from ships have more importance than other emission types, and intense studies are made. According to International Maritime Organization (IMO), annual shipboard CO_2 emission on 2012 was 949 million tons [1]. This study shows the bigness of the CO_2 emission amount from ships.

On 1 January 2013, Regulations on Energy Efficiency for Ships in MARPOL Annex VI was entered into force by IMO [2]. With this regulation, the terms Energy Efficiency Design Index (EEDI), Ship Energy Efficiency Management Plan (SEEMP) are introduced to reduce shipboard CO_2 emissions from the beginning of the design stage of the ship to ending of the operating of the ship. In addition to these mandatory terms, there is voluntary implementation which is named Energy Efficiency Operational Indicator (EEOI). This implementation gives voyage based ship efficiency index, and aims to reduce CO_2 emissions by controlling sailing efficiency between two ports.

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Studies about energy efficiency methods and technologies are available, and also in improvement to cope with more strict CO_2 emission regulations. In a study, energy efficiency measures were grouped in detail as ship design applications, propulsion system design, engine technology, and operational measures [3]. In addition to these measures, alternative fuel use as a main fuel or mixture with conventional fuels is an another method to mitigate CO_2 emissions.

In this study, effect of alternative fuels of liquefied natural gas (LNG), methanol, ethanol and hydrogen on EEOI was investigated. CO_2 emissions from each alternative fuel were found, and finally environmental and economical comparisons were made.

ALTERNATIVE FUELS

However there are various type of alternative fuels, LNG, methanol, ethanol and hydrogen production and use by alkaline electrolysis are taken into consideration as marine fuels in this study.

Properties of Alternative Marine Fuels

Methanol and ethanol are alcohols which are in liquid state at room conditions. LNG and hydrogen are gaseous state fuel at room temperature. Properties of fuels are shown at Table 1, and more detailed information can be get from our previous study [4].

Table 1. Properties of alternative marine fuels [4].

	Diesel	Methanol	Ethanol	LNG	Hydrogen
Density (kg.m^{-3})	833-881	798	794	450	0,0838
Auto-ignition temperature (K at 1 bar)	530	743	635	810	858
Flammability limits (vol. % air)	0,7 - 5	6 - 36	3 - 19	4 - 16	4 - 75
Stoich. air-fuel ratio on mass basis	14,5	6,5	9,1	17,2	34,3
Net heating value (MJ/kg)	42,5	20,1	27,0	46 - 50,2	119,9
Flame velocity (cm/s)	30	50	41	380	265 - 325
Flame temperature (K at 1 bar)	2327	2163	2193	2233	2318
Octane number	30	109	109	120	130
Cetane number	40 - 55	< 5	8	-10	-
Fuel carbon content (wt%)	85	38	52	75	0
Fuel hydrogen content (wt%)	15	12	13	25	100
Fuel oxygen content (wt%)	0	50	35	0	0
Fuel sulfur content (wt%)	< 350 ppm	0	0	0	0
Price (USD/ton)	480 [5]	252 [6]	552	186 [7]	3597 [8]

Stena Line, Wartsila and MAN B&W has studies about using methanol as a marine fuel at their ships and main engines [9], [10], [11]. DNV GL [12], reported that there are 63 LNG fuelled ships which are operated, and another 76 are in new building process. There are not any application of ethanol use in bigger size of ships, but it is used at outboard motors of pleasure motors. Also hydrogen use at ships are in experiment stage, and are used at small tugs and inland water boats [13]. Hydrogen production by alkaline electrolysis systems are used for many years at land based facilities, but for ships it is new technology. Application procedures are indicated at previous study [14]. These studies show that mentioned fuels can be used as alternative fuels at ships, and trend increases toward the alternative fuel use onboard.

Combustion Equations of Alternative Marine Fuels

Stoichiometric combustion equations of diesel, HFO, LNG, ethanol, methanol, and hydrogen are indicated with chemical formulas from (1) to (6). Heywood [15], mentions that diesel engines operate with air to fuel ratio in the ranges between 18 and 70. Lower limit of air to fuel ratio, 18, is used, and air excess coefficient (λ) is assumed as 1,255 at combustion calculations. In addition to this all combustion efficiencies of fuels are assumed as 0,5. Some other assumptions are shown at Table 2.

Table 2. Combustion calculation assumptions.

Fuels	Chemical formula	LHV (MJ/kg)	Molecule weight (kg)
Diesel	$C_{12}H_{23}$	42,500	167
HFO	$C_{50}H_{102}$	40,500	702
LNG	CH_4	48,632	16
Ethanol	CH_3OH	27,000	32
Methanol	C_2H_5OH	20,100	46
Hydrogen	H_2	119,900	2

<u>Diesel:</u>

$$C_{12}H_{23} + 19{,}75\ (O_2 + 3{,}76\ N_2) \rightarrow 12\ CO_2 + 11{,}5\ H_2O + 74{,}26\ N_2 \quad (1)$$

<u>HFO:</u>

$$C_{50}H_{102} + 77{,}5\ (O_2 + 3{,}76\ N_2) \rightarrow 50\ CO_2 + 51\ H_2O + 291{,}4\ N_2 \quad (2)$$

<u>LNG:</u>

$$CH_4 + 2\ (O_2 + 3{,}76\ N_2) \rightarrow CO_2 + 2\ H_2O + 7{,}52\ N_2 \quad (3)$$

<u>Ethanol:</u>

$$CH_3OH + 2\ (O_2 + 3{,}76\ N_2) \rightarrow CO_2 + 2\ H_2O + 7{,}52\ N_2 \quad (4)$$

<u>Methanol:</u>

$$C_2H_5OH + 3{,}5\ (O_2 + 3{,}76\ N_2) \rightarrow 2\ CO_2 + 3\ H_2O + 13{,}16\ N_2 \quad (5)$$

<u>Hydrogen:</u>

$$H_2 + 0{,}5\ (O_2 + 3{,}76\ N_2) \rightarrow H_2O + 1{,}88\ N_2 \quad (6)$$

Some of these alternative fuels can be used as main fuel, but some of them have to be mixed with conventional fuel to be burned. LNG and methanol has applications which are used as main fuel on marine diesel engines. On the other hand, ethanol and hydrogen has not have these kind of application. Especially, hydrogen cannot be used as sole fuel on marine diesel engines due to its burning properties [4]. For this reason in this study, stoichiometric combustion equations of LNG and methanol are used for calculating CO_2 production ratio and specific fuel consumption. Ethanol and hydrogen are mixed with HFO at different proportions. Also methanol is mixed with HFO at different proportions, and CO_2 production ratio and specific fuel consumptions are found.

Stoichiometric combustion of mixture of fuels are shown with chemical equations from (7) to (9).

<u>HFO and Ethanol:</u>

$$(M_{HFO}\ .\ C_{50}H_{102}) + (M_{CH3OH}\ .\ CH_3OH) + d\ (O_2 + 3{,}76\ N_2) \rightarrow a\ CO_2 + b\ H_2O + 3{,}76c\ N_2 \quad (7)$$

<u>HFO and Methanol:</u>

$$(M_{HFO}\ .\ C_{50}H_{102}) + (M_{C2H5OH}\ .\ C_2H_5OH) + d\ (O_2 + 3{,}76\ N_2) \rightarrow a\ CO_2 + b\ H_2O + 3{,}76c\ N_2 \quad (8)$$

HFO and Hydrogen:

$$(M_{HFO} \,.\, C_{50}H_{102}) + (M_{H2} \,.\, H_2) + d\,(O_2 + 3{,}76\, N_2) \rightarrow a\, CO_2 + b\, H_2O + 3{,}76c\, N_2 \quad (9)$$

To calculate the CO_2 emissions and the other elements at the chemical equation, mole numbers of HFO and burned alternative fuel have to be found. By solving (11) and (12) together, mole numbers of HFO and used alternative fuel are found. But first, mass ratio of alternative fuel has to be determined and entered to the equation (12).

$$(P_{ME} \text{ x } 3{,}6) / LHV_{HFO} = m_{HFO} \quad (10)$$

$$(MW_{HFO} \text{ x } LHV_{HFO} \text{ x } M_{HFO}) + (MW_{ALT.FUEL} \text{ x } LHV_{ALT.FUEL} \text{ x } M_{ALT.FUEL}) = (m_{HFO} \text{ x } LHV_{HFO}) \quad (11)$$

$$(MW_{ALT.FUEL} \text{ x } M_{ALT.FUEL}) / [(MW_{ALT.FUEL} \text{ x } M_{ALT.FUEL}) + (MW_{HFO} \text{ x } M_{HFO})] = MR_{ALT.FUEL} \quad (12)$$

P_{ME} is desired main engine power, LHV_{HFO} is lower heating value of HFO and m_{HFO} is mass of HFO in kg needed to provide desired engine power at Formula (10). MW_{HFO} is molar weight of HFO, M_{HFO} is mole number of HFO, $MW_{ALT.FUEL}$ is molar weight of mixed alternative fuel, and $LHV_{ALT.FUEL}$ is lower heating value of mixed alternative fuel at Formula (11). $M_{ALT.FUEL}$ is mole number of mixed alternative fuel at Formula (12). After the mole numbers are found, a, b, c, and d coefficients can be found.

Combustion Calculation Results

In this section, carbon content, specific fuel oil consumption (SFOC), specific alternative fuel consumption (SAFC), and CO_2 emissions by the use of alternative fuels are calculated. For the calculation, it is assumed that a ship has main engine with the power of 10000 kWh.

Methanol and ethanol is mixed with HFO up to % 50 at fumigation method, and hydrogen is mixed with HFO up to % 5, due to the reduction at effectiveness and forming knocking problems at the engine [4]. For these reasons, ethanol and methanol is mixed by the proportions of % 10, 30, and 50 with the HFO by the mass basis, on the other hand hydrogen is mixed by the proportions of % 0,01, 0,03, and 0,05 with the HFO by the mass basis in this study. Calculation results are shown at Table 3.

Table 3. Combustion calculations of alternative fuels.

Fuels	**Carbon Content**	**CF (t-CO_2/t-fuel)**	**SFOC (g/kWh)**	**SAFC (g/kWh)**	**m_{CO2} (kg/h)**
Diesel	0,875	3,2060	169,412	-	5200,547
HFO	0,850	3,1144	177,778	-	5571,383
LNG	0,750	2,7500	-	148,051	4071,393
Ethanol	0,375	1,3750	-	-	-
Methanol	0,521	1,9130	-	358,209	6852,693
Hydrogen	0	0	-	-	-
0,1 Eth + HFO	0,807	2,958	165,517	18,391	5440,024
0,3 Eth + HFO	0,711	2,606	138,272	59,259	5148,113
0,5 Eth + HFO	0,615	2,254	106,667	106,667	4809,497
0,1 Met + HFO	0,821	3,012	168,487	18,721	5638,347
0,3 Met + HFO	0,755	2,768	146,597	62,827	5796,116
0,5 Met + HFO	0,688	2,523	118,812	118,812	5996,372
0,01 Hyd + HFO	0,846	3,103	172,616	1,744	5409,614
0,03 Hyd + HFO	0,829	3,040	162,866	5,037	5104,048
0,05 Hyd + HFO	0,812	2,977	153,812	8,095	4820,305

As a result of the calculations, general trend is the reduction at carbon content by the addition of the alternative fuel to the combustion process. Also reduction at carbon content affects CF ratio, and decreases it. SFOC values are reduced by introducing alternative fuels. SAFC values are also shown at the Table 3. By the LNG use as main fuel, fuel consumption is reduced from 177,778 g/kWh to 148,051 g/kWh. On the contrary, methanol use as main fuel increases fuel consumption to 358,209 g/kWh, due to lower LHV than HFO. Calculations indicate that by the use of ethanol and methanol as mixture fuel with HFO, total fuel consumption is increased. Hydrogen use as additive to HFO decreases total fuel consumption by the result of higher LHV than HFO. CO_2 production amount decreases by the use of LNG as main fuel, ethanol and hydrogen by mixture fuels. Methanol use affects CO_2 production amount negatively and increases.

ENVIRONMENTAL AND ECONOMICAL CALCULATIONS

Last calculations are about environmental and economical effects of alternative fuel use on ships. EEOI calculation is done for environmental comparison, and voyage fuel price calculation is done for economical comparison.

EEOI Calculation for Alternative Fuels

EEOI is voluntary implementation which assists ship owners, ship operators to evaluate the performance of their fleet by considering CO_2 emissions. CO_2 emissions are directly related with fuel consumed, and this implementation can give indications about fuel efficiency. EEOI calculation is done by using Formula (13) [16].

$$\mathrm{EEOI} = \frac{\sum_j (\mathrm{FCj \times CFj})}{(\mathrm{Mcargo \times D})} \tag{13}$$

where j is fuel type, FCj is the mass consumed fuel j at a voyage, CFj is the fuel mass to CO_2 mass conversion factor for j fuel, Mcargo is cargo carried in tons, and D is the distance in nautical miles. EEOI is found as tons CO_2/(tons . nautical miles).

To see effect of alternative fuels on EEOI, a ship is selected with the main engine power, 10000 kWh, and with the cargo carrying capacity of 50000 mts. It is assumed that vessel sails with constant speed of 13 knots. Voyage of the ship is considered as from Istanbul to New York which is 4977 nautical miles. EEOI calculations and CO_2 emissions for each fuel at designated voyage is shown at Table 4.

Table 4. Voyage based EEOI values and CO_2 emissions.

Fuels	EEOI (tons CO_2 / tons . nautical miles)	CO_2 (tons / voyage)
Diesel	0,0000084	2079,37
HFO	0,0000085	2119,71
LNG	0,0000063	1558,72
Methanol	0,0000105	2623,47
0,1 Eth + HFO	0,0000084	2082,69
0,3 Eth + HFO	0,0000079	1970,94
0,5 Eth + HFO	0,0000074	1841,30
0,1 Met + HFO	0,0000087	2158,62
0,3 Met + HFO	0,0000089	2219,02
0,5 Met + HFO	0,0000092	2295,69
0,01 Hyd + HFO	0,0000083	2071,05
0,03 Hyd + HFO	0,0000079	1954,07
0,05 Hyd + HFO	0,0000074	1845,44

According to calculation results, it can be seen that EEOI at LNG use as sole fuel, and ethanol and hydrogen use as mixture fuel with HFO is lower than EEOI value of HFO. On the other hand, methanol use as sole fuel or mixture fuel with HFO increases EEOI which is the indication of reduction at voyage energy efficiency. CO_2 emissions are also reduced by using LNG as fuel from 2119,71 tons/voyage to 1558,72 tons/voyage. By substitution of ethanol with HFO from %10 to %50, CO_2 emissions decreases from 2082,69 tons/voyage to 1841,30 tons/voyage. Same trend is seen at hydrogen substitution with HFO from %1 to %5. CO_2 emissions reduces to1845,44 tons/voyage from 2071,05 tons/voyage by increasing hydrogen addition. CO_2 emissions are 2623,47 tons/voyage at methanol use as sole fuel, and 2158,62, 2219,02, and 2295,69 tons/voyage at %10, %30, and %50 methanol substitution with HFO, respectively.

Voyage Fuel Expenses

Fuel expenses are calculated according to determined voyage. For the mixture fuels, costs of both fuels are taken into consideration and calculated. LNG, methanol and ethanol are supplied from bunker traders, and hydrogen is produced onboard by alkaline electrolysis system, and supplied to the main engine. For this reason, bunker costs for LNG, methanol and ethanol, and production expenses for hydrogen are used to calculate voyage fuel expenses. Costs of LNG, methanol, ethanol and hydrogen at Table 1 is used at calculations. HFO cost is taken as 251 USD/ton for calculations [5]. Voyage fuel expenses are shown at Table 5.

Table 5. Voyage fuel expenses.

Fuels	**Conventional fuel expense (USD / voyage)**	**Alternative fuel expense (USD / voyage)**	**Total fuel expenses (USD / voyage)**
Diesel	311321,48	-	311321,48
HFO	170834,46	-	170834,46
LNG	-	105425,97	105425,97
Methanol	-	345590,08	345590,08
0,1 Eth + HFO	38865,49	159052,77	197918,26
0,3 Eth + HFO	125233,23	132871,25	258104,48
0,5 Eth + HFO	225419,82	102500,68	327920,49
0,1 Met + HFO	18061,26	161906,30	179967,56
0,3 Met + HFO	60613,97	140871,35	201485,32
0,5 Met + HFO	114626,41	114171,55	228797,96
0,01 Hyd + HFO	165874,16	24011,05	189885,21
0,03 Hyd + HFO	156504,64	69365,77	225870,41
0,05 Hyd + HFO	147804,27	111480,16	259284,43

Highest voyage fuel expenses are at methanol use as a sole fuel which is 345590,08 USD/voyage. Second one is %50 ethanol mixture with HFO, and third highest voyage fuel expenses are diesel which are 327920,49 and 311321,48 USD/voyage. Lowest expenses are formed with LNG use which is 105425,97 USD/voyage. LNG is seem to be the most effective fuel. Second cheapest fuel is HFO, and third one is %10 methanol use with HFO, but reduction at CO_2 emissions and increase at energy efficiency has to be considered before selecting fuel. Hydrogen is seem to be the most expensive fuel, but it is used up to %5 mixture with HFO, and these costs can be acceptable when positive environmental effects of hydrogen are considered.

CONCLUSION

In the study, various alternative fuels which are LNG, methanol, ethanol and hydrogen are mentioned. Their properties and stoichiometric combustion equations are shown. According to their stoichiometric combustion equations, conventional fuel and alternative fuel consumptions are found both for sole alternative fuel use and mixture of alternative and conventional fuels. Mixtures are formed as %10, 30 and 50 for methanol and ethanol, and %1, 3 and 5 for hydrogen. In addition to fuel consumption amount, CO_2 formation amounts are found. EEOI calculations and voyage fuel expense calculations are found in the framework of environmental and economical calculations.

As the results of the calculations, LNG, ethanol and hydrogen use as a sole or mixture fuel highly effective for reducing CO_2 emissions. On the other hand, methanol use as a sole or mixture fuel has negative effect on CO_2 emissions. Voyage calculations are also parallel with CO_2 emission calculations. CO_2 emissions are more lower at LNG, ethanol and hydrogen than HFO and diesel, and higher at methanol use as a fuel. Voyage fuel expenses are affected by the higher costs of the alternative fuels, and decreased cost of HFO for 1 year.

LNG is a trend nowadays, and this study proofs it. Methanol is applied to some ships but it is seen at this study that it is ineffective for CO_2 reduction. Second trend can be become hydrogen use by alkaline electrolysis. Hydrogen is produced onboard and directly use. Environmental effects of hydrogen is taken into consideration, and more studies should be done about hydrogen.

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INVESTIGATION OF EXHAUST EMISSIONS IN A BIODIESEL PILOT FUELED NATURAL GAS ENGINE WITH STOCHASTIC REACTOR MODEL

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ABSTRACT

During ship navigation, marine engines produce exhaust emissions composed in the wake of combustion. These emissions have generally a detrimental characteristic to atmosphere. Thus, legislative regulations were put into effect related to exhaust emissions and have still maintained the validity. The legislative regulations for ships' exhaust emissions were defined by International Maritime Organization and all ships have to obey the regulations. Researchers have investigated to produce marine engines satisfying the regulations in recent years. In this study, the influences of different biodiesel pilot fuel injection timings on exhaust emissions were investigated by stochastic reactor model (SRM) approach and SRM Engine Suite software was utilized based on this approach. This software hinged upon chemical kinetic mechanisms of fuels as a basis. 'Methyl decanoate/methyl-9-decenoate/n-heptane' reduced chemical kinetic mechanism containing 71 species and 217 reactions were defined as biodiesel surrogate fuel kinetic mechanism to represent biodiesel fuel. Experimental data are needed to show simulation data accuracy. The experimental data were obtained from literature. Two different pilot fuel injection timings (17° and 20° BTDC) were run. The results of simulation showed that NO_X and CO_2 emissions got closer values to experimental emission data in comparison to CO and HC emissions. Consequently, biodiesel surrogate fuel reduced chemical kinetic mechanism cannot fully represent biodiesel fuel, crevice volume (%) is roughly calculated and used, and initial pressure, initial temperature and heat transfer parameters are predicted using trial and error method to converge simulation and experimental pressure curves.

Keywords – Dual Fuel Engines, Exhaust Emissions, Internal Combustion Engines, Probability Density Function, Stochastic Reactor Model

INTRODUCTION

In the course of navigation, ships release harmful emissions such as NO_X, CO and UHC. These emissions are connected with quality of combustion occurred in marine engines. From past to present, marine engines has been continually developed by scientists dealt with this subject to emit less detrimental emissions.

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According to intended purposes, marine engines vary from two-stroke low speed diesel engines to four-stroke high speed diesel engines. All marine engines must be designed regarding regulations defined by IMO from the point of exhaust emissions. MARPOL Annex VI restraints the main air pollutants contained in ships exhaust gas, comprising sulphur oxides (SO_X) and nitrogen oxides (NO_X), and forbids intentional emissions of ozone depleting substances (ODS) [2]. MARPOL Annex VI became valid on 19 May 2005 and the Marine Environment Protection Committee (MEPC) decided to revise MARPOL Annex VI to meet strengthening emission limits [2]. In October 2008, MEPC 58 adopted the revised MARPOL Annex VI and the associated NO_X Technical Code 2008. The aim of the revised MARPOL Annex VI are to progressively reduce in emissions of SO_X, NO_X and particulate matter on a global scale and to introduce emission control areas (ECAs) [2]. The revised MARPOL Annex VI includes new fuel quality requirements beginning from July 2010, Tier II and III NO_X emission standards for new engines and Tier I NO_X requirements for existing pre-2000 engines [1]. Tier I emission limit for marine engines prevailed ship constructed on or after 1 January 2000 and is over the range 9.8 – 17.0 g/kWh. Tier II emission limit for marine engines prevailed ship constructed on or after 1 January 2011 and was over the range 7.7 - 14.4 g/kWh. As from 1 January 2016, Tier III emission limit has come into play and is over the range 2.0 – 3.4 g/kWh [2], [3]. Whereas SO_X and particulate matter emission limits were reduced from 1% to 0.10% on 1 January 2015 inside an ECAs, these emissions limits will be effectively decreased from 3.5% to 0.5% on 1 January 2020 for outside an ECAs [2], [4]. Most of available marine engines cannot obey IMO Tier III standards (Regulation 12 and 13 of MARPOL Annex VI). Thereby, innovative considerations are required to improve marine engines.

There are various innovative considerations, called as low temperature combustion methods, such as HCCI (Homogeneous Charge Compression Ignition), PCCI (Premixed Charge Compression Ignition), RCCI (Reactivity Charge Compression Ignition) and DFC (Dual Fuel Combustion) techniques. Nowadays, low temperature combustion methods are developed to provide better combustion of the fuels and to meet emission regulations. One of the new trends in marine engines is dual fuel engines. The working principle of dual fuel engine is combusted together with gas and liquid fuels in combustion chamber. The gas fuel controls combustion process such as engine torque, brake power, but pilot fuel provides ignition gas fuel/air mixture.

Diesel fuel is mostly utilized as a pilot fuel to ignite main fuel in dual fuel engines. From an environmental point of aspects, however, usage of biodiesel as a pilot fuel are more plausible. Because biodiesel has better ignitability property than diesel fuel due to relatively high cetane number compared to diesel fuel [5], [6]. Biodiesel have some major advantages. Biodiesel fuel decreases and does away with the generation of sulphur dioxide (SO_2), CO, HC and particulate matter emissions because of not sulphur content and approximately 10% oxygen content [5]. However, it can be considered that NO_X emissions are generally increased since it has oxygen content in constituent.

Natural gas (NG) is mostly utilized as a primary fuel in dual fuel engines. The reasons are that it has lower greenhouse gas emissions and higher auto-ignition temperature with regard to other hydrocarbon fuels [5]-[8]. Furthermore, as NG amount in the combustion chamber is enhanced, oxygen amount in the combustion chamber enabling combustion process is gone down.

There have been various investigations with reference to exhaust emissions on biodiesel pilot fuelled natural gas engines and have mostly based on experimental studies [5]-[7]. Nevertheless, it could be not found any theoretical study based stochastic reactor model on natural gas engines with biodiesel pilot fuel in available literature. In this study, a theoretical model is developed and exhaust emissions in dual fuel engine, having biodiesel as a pilot fuel and natural gas as a main fuel is investigated by using a Stochastic Reactor Model (SRM).

METHODOLOGY

Model Description

Stochastic Reactor Model (SRM) is a spatially zero dimensional model depend on the opinion which real fluid particles and homogeneity inside the cylinder is substituted the unreal stochastic particles and statistically homogeneity [9], [10]. Each unreal particle has mass, chemical composition, and temperature. In addition, these particles also own the capability of mixing with other particles alongside exchanging heat with cylinder walls.

Cylinder substances depend on pressure and volume changes, chemical reactions, heat transfer, mixing and fuel injection. These are independent from the space. All parameters of interest are estimated from these processes. These are subdivided as global and local parameters and obtained by solving the SRM equations using Monte Carlo particle method [11].

In the SRM model, global parameters possess invariant value in the combustion chamber and come into existence total mass, volume, mean density and pressure. They are assumed to remain stable spatially in the combustion chamber. If engine geometry (volume), density and equation of state (pressure) are known, global parameters can be predicted [10], [13]-[16]. Local parameters modified in the combustion chamber are mass fractions and temperatures for each species. They can be deemed as random variables which can modify in the combustion chamber and identify the substances of the gas mixture in the cylinder. These variables are clarified using the mass density function (MDF) [13].

Solution Method

SRM model is based on statistical homogeneity postulated to be the same along engine cylinder of the probability density function (PDF). However, Mass Density Function (MDF) has been utilized rather than the PDF as the in-cylinder density changes throughout an engine cylinder. The MDF pertain to the PDF by:

$$\mathsf{F}\left(\psi;t\right)=\rho\left(\psi\right)f\left(\psi;t\right) \tag{1}$$

In Equation (1), ρ is the mass density. The variation of the MDF on the time is described by the following PDF transport equation:

$$\begin{aligned}\frac{\partial}{\partial t}\mathsf{F}(\psi;\mathrm{t}) &= \underbrace{-\sum_{j=1}^{N_S+1}\frac{\partial}{\partial\psi_j}\left[G_j(\psi)\mathsf{F}(\psi;\mathrm{t})\right]}_{chemical\ reaction}+\underbrace{\sum_{j=1}^{N_S+1}\frac{\partial}{\partial\psi_j}\left[A_j(\psi)\mathsf{F}(\psi;\mathrm{t})\right]}_{turbulent\ mixing} \\ & \underbrace{-\frac{1}{V}\frac{dV}{dt}\mathsf{F}(\psi;\mathrm{t})}_{piston\ movement}\underbrace{-\frac{\partial}{\partial\psi_{N_S+1}}\left[U(\psi_{N_S+1})\mathsf{F}(\psi;\mathrm{t})\right]}_{convective\ heat\ transfer}+\underbrace{\frac{\mathsf{F}_C(\psi;\mathrm{t})}{\tau_{crev}}-\frac{\mathsf{F}(\psi;\mathrm{t})}{\tau_{cyl}}}_{crevice\ flow}+\underbrace{\frac{\mathsf{F}_f(\psi;\mathrm{t})}{\tau_f}}_{fuel\ injection}\end{aligned} \tag{2}$$

In Equation (2), the initial conditions are described by:

$$\mathsf{F}\left(\psi;0\right)=\mathsf{F}_0\left(\psi\right) \tag{3}$$

The right hand side of Equation (2) informs the physical in-cylinder processes of chemistry, turbulent mixing, heat transfer, piston movement, crevice flow and fuel injection [13].

Equation (2) is solved by a Monte Carlo stochastic particle method [11]-[13]. An ensemble of N_{par} stochastic particles form a statistical scheme of the PDF:

$$f(\psi;t) \approx \frac{1}{N_{par}} \sum_{i=1}^{N_{par}} \delta\left(\psi - \psi^{(i)}(t)\right) \tag{4}$$

Operating splitting technique, which each term can be treated separately [9], [11], [17], is operated so as to solve Equation (3).

Gas-Phase Emissions Model

The accepted chemical kinetic mechanism of the fuel or fuel model identifies chemical species, their corresponding thermochemistry data and reaction rates in the simulation. At each time step, the development of every chemical species is notified for a full-scale mass fraction, molar and mole fraction composition [13].

Embraced chemical kinetic mechanism must include chemical species called NO and NO_2 and an adequately precise description of nitrous oxide emission formation chemistry to simulate NO_X emissions. In the NO_X emissions are gained by:

$$X_{NO_x} = X_{NO} + X_{NO_2} \tag{5}$$

This is output as an exhaust gas emission for the cycle in parts per million (ppm).

$$NO_x[\mathrm{ppm}] = 1x10^6.X_{NO_x} \tag{6}$$

In the same way, it is significant that the adopted chemical kinetic mechanism encompasses chemical species including hydrogen and carbon atoms and an adequately certain definition of unburned hydrocarbon emission formation chemistry to simulate unburned hydrocarbons (*u*HCs) emissions. The *u*HCs emissions are achieved by summing the mole fractions of all the chemical species [13].

$$X_{uHC} = \sum_i X_{HC,i} \tag{7}$$

Then, when it is converted to parts-per-million (ppm):

$$uHCs[\mathrm{ppm}] = 1x10^6.X_{uHCs} \tag{8}$$

For the cycle, some of the species mole fractions (X_i) comprising CO are also output in parts per million (ppm) vis-à-vis the following equation [13].

$$Emission_i[\mathrm{ppm}] = 1x10^6.X_i \tag{9}$$

Chemical Kinetic Model

The working principle of SRM engine suite software is elementarily based on chemical kinetic mechanism of relevant fuel. Development of chemical kinetic mechanisms for every biodiesel is new. Thereby, available biodiesel surrogate fuel chemical kinetic mechanisms were utilized. Initially, these mechanisms were enhanced as detailed chemical kinetic mechanism, but usage of these mechanisms has been many time-consuming. In order to solve this problem, reduced chemical kinetic mechanisms of the fuel was employed using some reduction methods. As a result of exploiting reduced chemical kinetic mechanism, simulations in CFD or SRM Engine Suite software have been very fast. In this study, 'methyl decanoate/methyl-9-decenoate/n-heptane' biodiesel surrogate reduced chemical kinetic mechanism, called as ERC-Multichem+Bio mechanisms [18], was utilized to represent biodiesel fuel.

RESULTS AND DISCUSSIONS

In this study, the effect of different stochastic particle numbers on exhaust emissions was analyzed for two different biodiesel pilot fuel injection timings (17° and 20°BTDC). For model validation process, it was used both optimum pilot fuel injection timing (17°BTDC) and optimum pilot fuel injection pressure (120 MPa) in terms of cylinder pressure. Fig. 1 shows the variation of cylinder pressure on crank angle for two optimum cases. As shown in Fig. 1, it was observed that it is existence of concord between experimental and simulation cylinder pressure values for two optimum cases [19]. The established theoretical model was ensured in terms of the model validity.

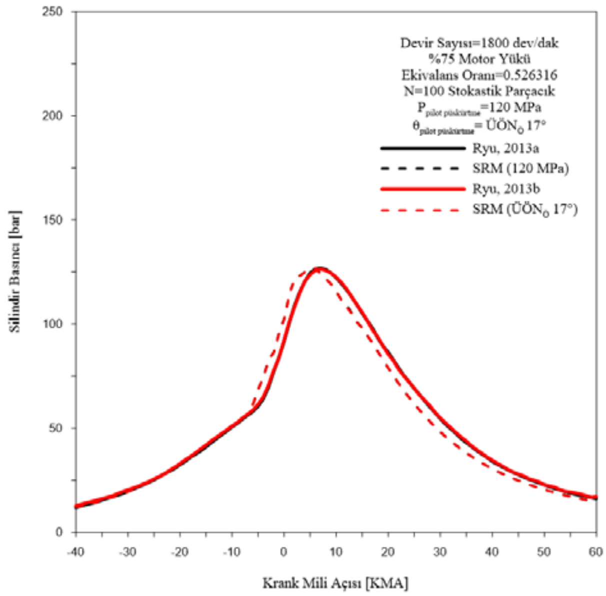

Figure 1. Model Validation Process for Two Optimum Cases

The obtained NO_X, CO_2, CO and HC emissions for two different pilot fuel injection timings are shown in Figures 2-5, respectively. In terms of exhaust emissions, optimum stochastic particle numbers in 17°BTDC pilot fuel injection timing are defined as 200 (for NO_X), 75 (for CO), 100 (for CO_2) and 25 (for HC) and optimum stochastic particle numbers in 20°BTDC pilot fuel injection timing are defined as 50 (for NO_X), 175 (for CO), 100 (for CO_2) and 75 (for HC). However, optimum stochastic particle number is defined as 100 because simulation results give better results in this particle number. For the 100 stochastic particle number condition, 17°BTDC pilot fuel injection timing gives better result 20°BTDC pilot fuel injection timing when compared to simulation and experimental NO_X emission values, 20°BTDC pilot fuel injection timing give better result 17°BTDC pilot fuel injection timing when compared to simulation and experimental CO emission values, 20°BTDC pilot fuel injection timing gives better result 17°BTDC pilot fuel injection timing when compared to simulation and experimental CO_2 emission values and two different pilot fuel injection timings get values very close to each other when compared to simulation and experimental HC emission values. Note that experimental exhaust emission values for both two pilot fuel injection timings are different from each other and these values do not change according to stochastic particle numbers [19].

In conclusion, NO_X and CO_2 emissions get closer values to the experimental emission data in comparison to CO and HC emissions in this study since biodiesel surrogate fuel reduced chemical kinetic mechanism cannot fully symbolize biodiesel fuel, crevice volume (%) is approximately calculated and used, and initial pressure, initial temperature and heat transfer parameters are predicted using trial and error method to converge simulation and experimental pressure curves [19].

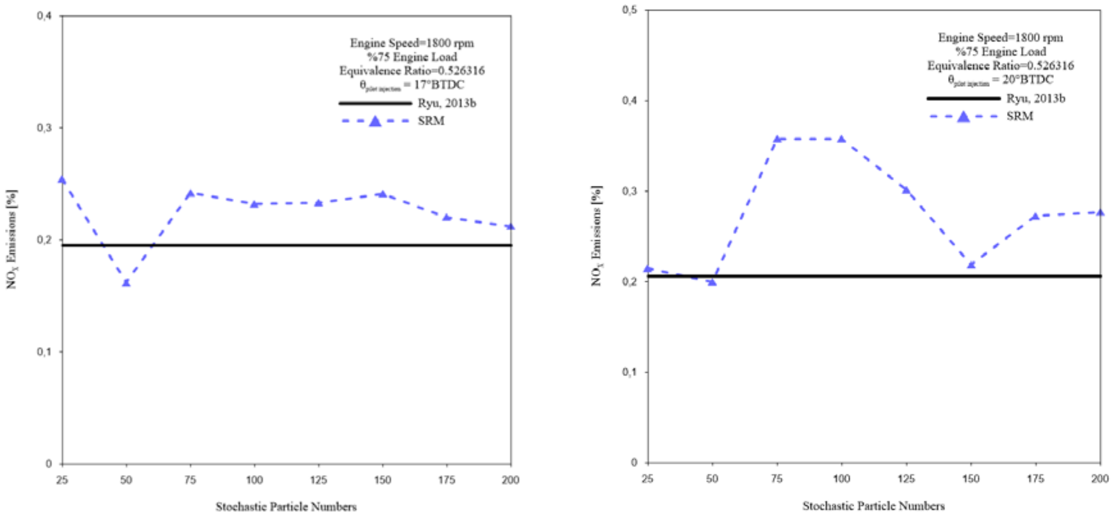

Figure 2. NO_X Emissions for Two Different Pilot Fuel Injection Timings

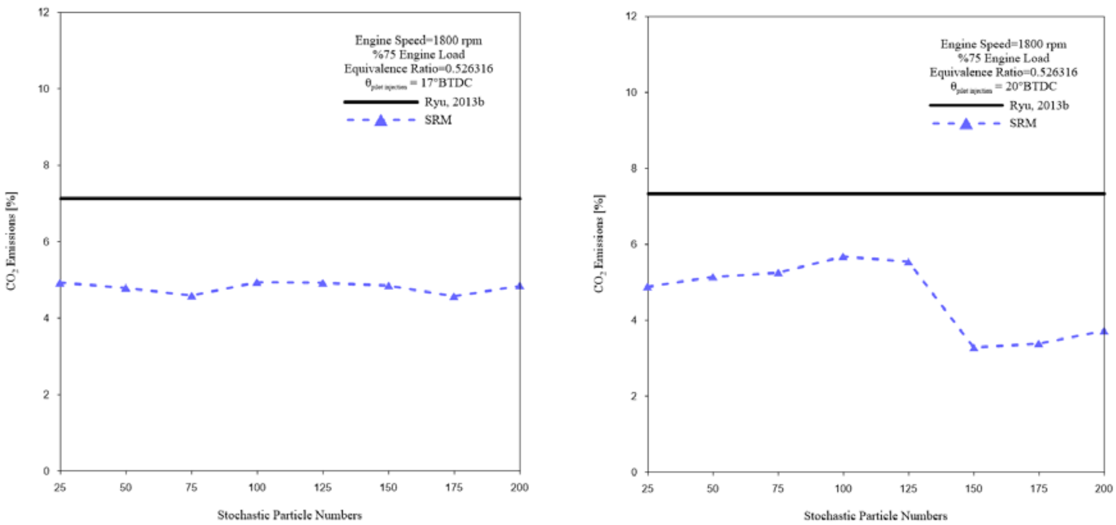

Figure 3. CO_2 Emissions for Two Different Pilot Fuel Injection Timings

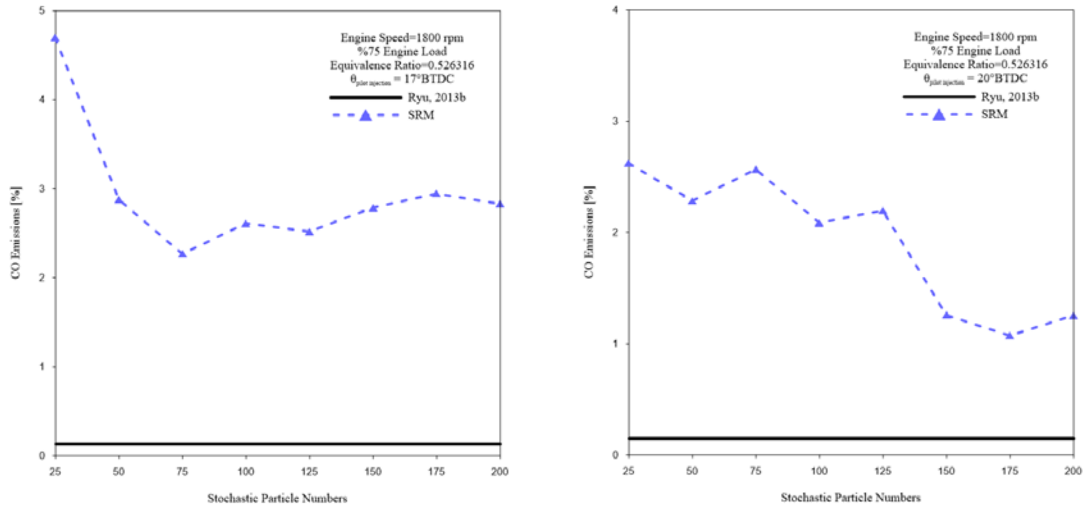

Figure 4. CO Emissions for Two Different Pilot Fuel Injection Timings

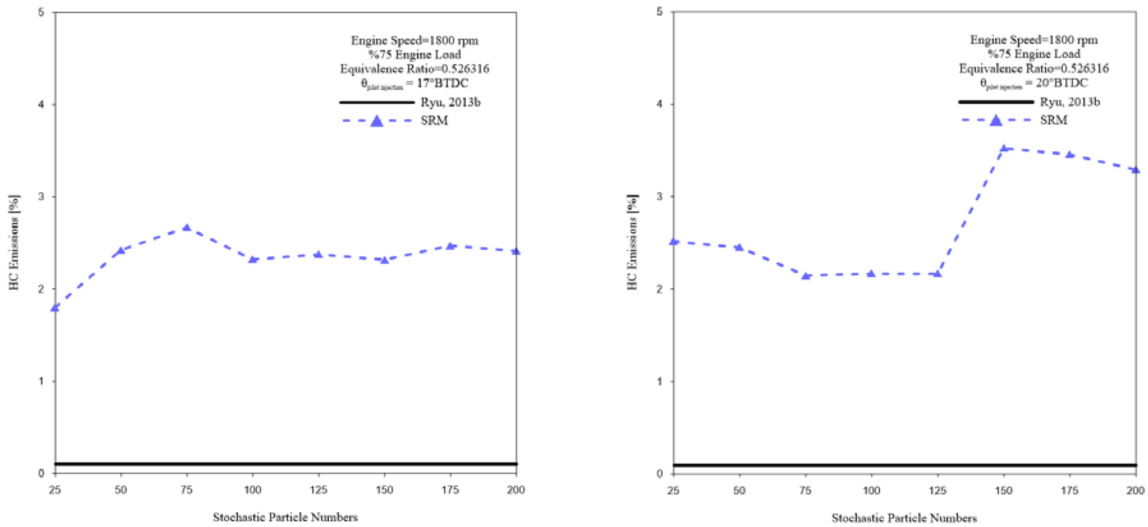

Figure 5. HC Emissions for Two Different Pilot Fuel Injection Timings

CONCLUSIONS AND FUTURE WORK

In this study, an authentic dual fuel-SRM model depend on the probability density function (PDF) was theoretically used to simulate biodiesel pilot fueled natural gas engines for the first time. This model was executed with ‘kinetics & SRM engine suite’ software. In this software, as some parameters such as inlet temperature, heat transfer parameters etc. are not definitely determined, it was roughly foretold with ‘trial-and-error’ method. In addition, crevice volume (%) parameter was approximately defined by benefitting engine geometry.

The results of simulation observed in good agreement in terms of NO_X and CO_2 emissions, but CO and HC emissions are not valid the same condition since biodiesel surrogate fuel reduced chemical kinetic mechanism cannot fully symbolize biodiesel fuel and some unknown operating parameters of engine demanded by this software.

If chemical kinetic mechanisms for each biodiesel (soy bean, canola, rapeseed methyl esters) are worked up, it can be acquired better agreement in experimental data. Thus, these chemical kinetic mechanisms can use with other alternative gaseous fuels.

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EXPERIMENTAL INVESTIGATION OF CYCLIC VARIATIONS IN DIESEL ENGINE USING ETHANOL-DIESEL FUEL BLENDS

Samet GÜRGEN[1], Bedir ÜNVER[2], İ. ALTIN[3]

ABSTRACT

Cyclic variation is a significant parameter on the fuel consumption and exhaust emission. One of the effective parameters on the cycle to cycle variation is both fuel and its properties. This study investigates the effects of using ethanol-diesel fuel blends on cyclic variations, engine performance and exhaust emissions. Diesel and two kinds of diesel–ethanol blended fuels (E5 and E10) were used to research combustion stability. A naturally aspirated, four-stroke and single-cylinder direct-injection diesel engine was used to evaluate cyclic variation of engine at two different speeds (1000 and 2000 rpm) and full load condition. The coefficient of variation (COV) of IMEP was used to evaluate cycle-to-cycle variation. 35 consecutive cycles are recorded. Diesel–ethanol blended fuels show higher cycle-by-cycle fluctuations than that of neat diesel fuel. In addition, NOx and CO emissions of ethanol diesel fuel are lower than neat diesel fuel, while brake specific fuel consumption and effective efficiency is greater than neat diesel fuel.

Keywords – Cyclic variability, Diesel engine, Engine performance, Exhaust emission

INTRODUCTION

Implementation of alternative fuels in internal combustion engines has been an important research area in recent years because of the high demands to lower dependency on fossil fuels. Alcohols have been evaluated in compression ignition engines as alternatives to substitute petroleum fuels. would be produced from various plants. It is obvious that combustion of oxygenated alcohol fuels, such as ethanol and n-butanol, does not cause additional CO_2 emission and global warming problem since plants absorb carbon dioxide (CO2) during growth [1], [2].

There have been numerous studies on alternative fuels including ethanol blends in diesel engine [3]-[6]. However, there are fewer studies of cyclic variability of ethanol [7], [8]. Cycle to cycle variation has long been accepted as a constrictive factor in engine performance, fuel efficiency, and exhaust emissions [9]. In general, pressure and burn related parameters are used for measuring cyclic variability. The common method used in evaluating cycle-to-cycle variations is a statistical analysis of the combustion parameters, such as the Coefficient of Variation (COV) or the Standard Deviation (SD). Other techniques like Continuous Wavelet Transform, Short Time Fourier Transform and Mean

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Instantaneous Frequency, Proper Orthogonal Decomposition used in the study of combustion cycle-to-cycle variations [10].

The aim of this paper is to evaluate the diesel engine cycle to cycle variation with ethanol-diesel fuel blends.

MATERIAL AND METHOD

This study was completed by commercial diesel fuel and ethanol (99% purity). Experimental studies were conducted in a naturally aspirated, single-cylinder, four-stroke direct-injection diesel engine using neat diesel fuel, 5% blended ethanol-diesel (E5) and 10% blended ethanol-diesel (E10). Engine main technical specifications are given in Table 1 [11].

Table 1. Main Technical Specifications of the Engine

Motor type	Air cooled, 4-stroke diesel engine
Cylinder number	1
Bore	88 mm
Stroke	76 mm
Connecting Rod Length	124 mm
Engine Capacity	462 cm^3
Compression Ratio	20.5
Absolute Maximum Power	7.3 kW @ 3600 rev. min^{-1}

For measuring the emissions of NO_x and CO, Bilsa Mod 2210 exhaust gas analyser was utilized. The accuracies of CO and NO_x measurement are within ±0.001% vol. and 1 ppm, respectively.
The important parameters on the cyclic variability is the fuel. Fuel physico-chemical properties can impact combustion cyclic variation [9]. Table 2 shows the major fuel properties of diesel fuel and ethanol.

Table 2. Fuel Properties

	Diesel	Ethanol
Chemical formula	$C_{14}H_{24}$	C_2H_5OH
Molecular mass (kg/kmol)	192.346 [b]	46.069 [b]
Density at 15°C (kg/m^3)	834.4 [a]	796 [a]
Kinematic viscosity 40°C (mm^2/s)	2.932 [a]	1.092 [a]
Cetane number	59.8 [a]	5.05 [a]
Lower heat value (MJ/kg)	42.60 [c]	27.42 [c]
Flash point (°C)	59 [a]	13 [a]

[a] measured in laboratory
[b] calculated from chemical formula
[c] calculated from Mendeleyev formula

For determine the cycle to cycle variaiton, coefficients of variation in indicated mean effective pressure (imep) was used. Coefficients of variation in indicated mean effective pressure ($\overline{imep}$) is the standard deviation in imep divided by the mean imep [12] and defined as follow,

$$COV_{imep} = \frac{\sigma_{imep}}{imep} \times 100 \qquad (1)$$

RESULTS AND DISCUSSIONS

BSFC is shown in Figure 1 for diesel fuel and fuel blends. The trend of the increament of fuel consumption with the increament amount of ethanol in the blends can be seen in the results. This is due to the fact that ethanol blends present lower calorific value than that of neat diesel fuel [6],[13].

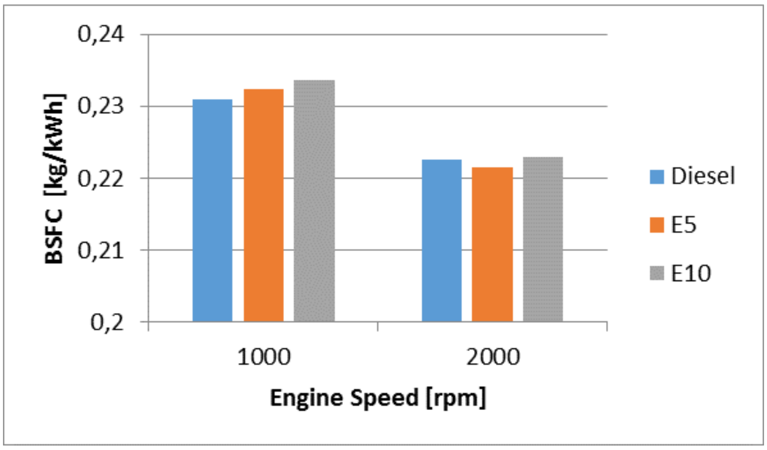

Figure 1. Variation of BSFC with engine speed

Figure 2 shows the effective efficiency. It is observed that effective efficiency is very slightly higher or equal to the corresponding pure diesel fuel with ethanol amount increases in the fuel blend. More percentage of combustion's constant volume is the result of smaller cetane number of ethanol on behalf of much more premixed combustion. The another reason is lower heat loses due to the lower cylinder temperature [5],[14].

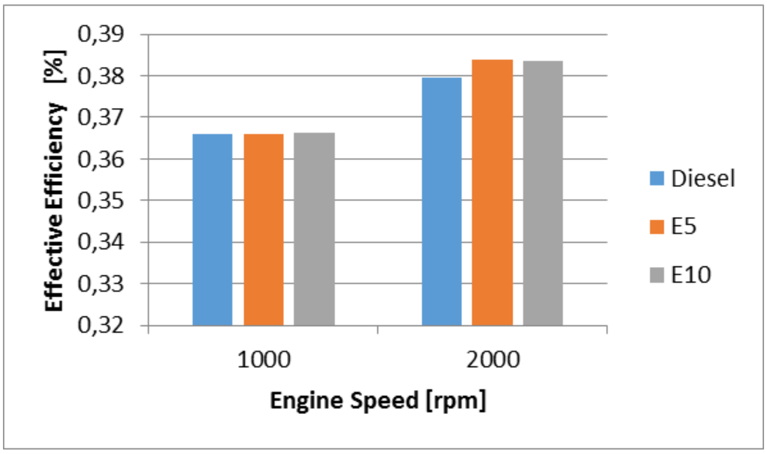

Figure 2. Variation of effective efficiency with engine speed

NO_X emissions are shown Figure 3. The formation of NO_X highly depends on in-cylinder temperatures, the oxygen concentration and residence time for the reaction to take place [13]. As shown in Fig. 5, NO_X emissions decreased with addition amount of ethanol in the blends. Lower heating value and higher latent heat of evaporation of the fuel decrease combustion temperature while lower cetane number (longer ignition delay) of the fuel increases combustion temperature. It is clear that heating value and latent heat of evaporation are more effective than cetane number [14].

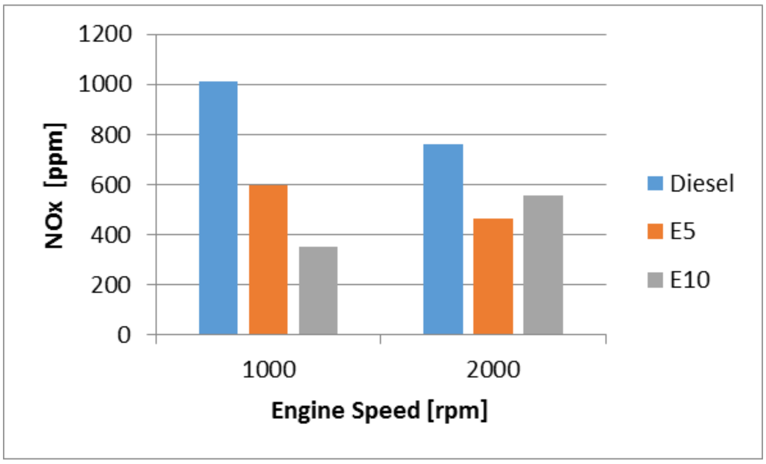

Figure 3. Variation of NO_X emissions with engine speed

CO emissions at two engine speeds are presented in Figure 4. The CO emissions diminished with increasing the percentage of ethanol in the fuel mixtures. Lowering CO emission for ethanol blends can be explained by the higher oxygen contents which allow to more complete combustion.

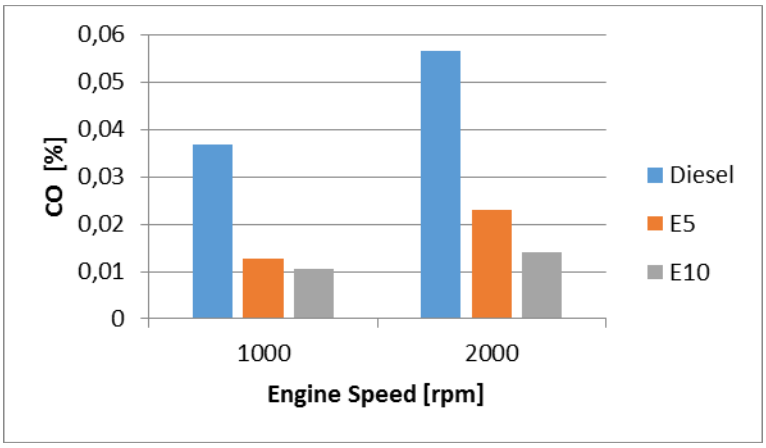

Figure 4. Variation of CO emissions with engine speed

Figure 5 presents COV_{imep} collected from the engine test at 1000 and 2000 rpm for 35 consecutive cycles. The results have indicated that cyclic variability exhibits an increasing trend according to an increament in the ethanol blending ratio. The highest COVimep was obtained from E10 at 1000 rpm due to low cetane number. Also, cyclic variability exhibits an decreasing trend according to an increament in engine speed. This is due to process of fuel–air mixing is enhanced since higher piston velocities make the air swirling more efficient.

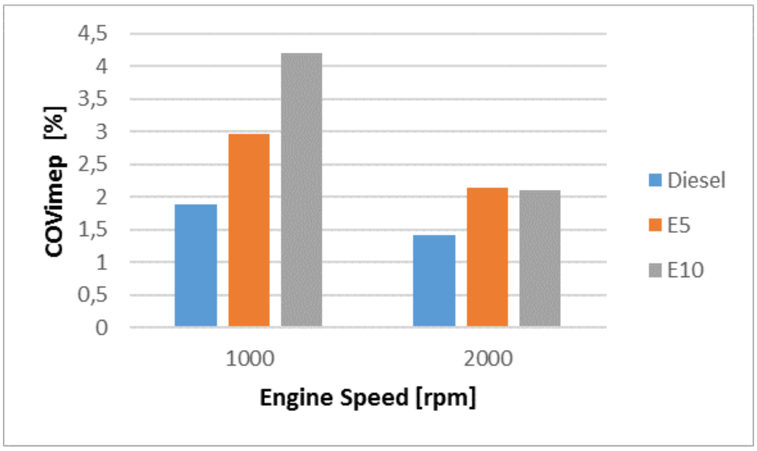

Figure 5. Variation of COV_{imep} with engine speed

CONCLUSIONS AND FUTURE WORK

In this work, cyclic variability, engine performance and exhaust emissions of a diesel engine using mineral diesel fuel and diesel-ethanol blended fuels were experimentally investigated. The conclusions of the present study can be summarized as follows.

- BSFC and effective efficiency of ethanol-diesel fuel blends are greater than neat diesel fuel. Among the blends, the highest BSFC was obtained from E10 at 1000 rpm. Also the highest effective efficiency was obtained from E5 at 2000 rpm.
- NO_X and CO emissions of ethanol-diesel fuel blends are lower than neat diesel fuel. Among the blends, the lowest NO_X emission was observed as 353.25 ppm for E10 at 1000 rpm. In addition, the lowest CO emission was obtained from E10 at 1000 rpm.
- Diesel–ethanol blended fuels show higher cyclic variability than that of neat diesel fuel for the all engine speeds. COV_{imep} was observed as 1.883, 2.9593 and 4.2013 for pure diesel fuel, E5 and E10 at 1000 rpm engine speed, respectively. At the high speed of 2000 rpm, COV_{imep} was observed as 1.4147, 2.1447 and 2.1110 for pure diesel fuel, E5 and E10, respectively

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INTERMITTENT HUSBAND SYNDROME ANALYSIS FOR SEAFARERS AND THEİR FAMILIES

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ABSTRACT

Objective - To examine the psycho-social impact of working and living away from home on the partners of a group of Turkish seafarers who work on several type of vessel in different contract duration and positions. Methods - Questionnaires addressing demographic characteristics, marital satisfaction, social support, subjective health and psychological well-being were applied to seafarers' partners. For this purpose, 67 items questionnaire was polled to 225 (193/225) seafarer's partners enhanced inspired by the "Intermittent Husband Syndrome" questionnaires. Results - Especially, researches in order to understand the psychological state of seafarers' partners in Australia, Norway, China, India and England shows similarities with the psychological condition of the seafarers' wives in Turkey. Although nations' lifestyles, family life and the possibilities and opportunities of seafarers on board are different, results showed that the seafarers' partners share the same emotions and concerns.

Keywords – *Intermittent husband syndrome, Seafarers, Seafarer' wife, Psycho-social impact.*

INTRODUCTION

Researches involving the impact of home and away occupations have tended to focus on especially who leave, rather than who stay at home. Thus, the effects of regular partings and reunions on wives and family members left at home has been less frequently acknowledged. According to Morrice and Taylor (1978) home and away occupations are characterized by a parting and reunion cycle providing a recurring crisis and a uniform pattern of feelings. This recurring cycle includes tension and tearfulness on a husband's departure, return to normal, followed by feelings of depression, sadness, anger and recrimination towards a husband during the cycle and on his return [1]-[2].

International shipping is characterized by the seafarers' absence from home for many months to years at the time. Such a life style can be a problem both for the seafarer and his family. Study results indicated that while the general health profiles were similar in on-shore and off-shore wives, the off-shore wives experienced increased levels of anxiety and depression related to frequent separations from their husbands. In most situations, the wives were able to successfully cope with their husband's absence and thus, the anxiety and depression were not significantly problematic [3]-[4].

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However, approximately 10 percent of off-shore wives exhibited ineffective coping strategies and were classified as suffering from ‘Intermittent Husband Syndrome’ (IHS) [5]. This term was coined by Morrice and Taylor (1978) and describes a triad of symptoms: anxiety, depression and sexual difficulties, which occur as a result of frequent partings and reunions between a wife and husband [1].

The aim of this study of the profession, is to make assessments about the psychological and physiological condition of the spouses by identifying the positive and negative aspects of the sailors on their wives. demographic survey of spouses in marriage to satisfy, there are questions about the psychological and physical health. As a result of the survey analysis sailors assayed to determine the problems they have been made a general assessment of their partners.

METHODS

The Questionnaire

The questionnaire was prepared to utilizing the platform offered by the Google service. The most of the questionnaire were shared on social networks which a member of the seafarers and sea wives. Also, e-mail and private massages were sent to seafarers’ partner.

The description and purpose of the research given to first part of the survey. After the description part, questionnaire divided three parts; multiple-choice questionnaire, short-answer and multiple-choice question table, including 67 question. The questionnaire was developed to address the following issues among the wives: demographic characteristics, marital satisfaction, social support, subjective health and psychological well-being, particularly the experience of anxiety and depression.

Response Rate

A total of 225 wives/partners of Turkish seafarers participated in the study, giving a response rate of 85 percent (193/225).

RESULTS

Table 1. Demographic Characteristics

Variable	percent
Sex	
Male	8
Female	92
Age	
Less than 45 years	94
45 years and older	6
Level of education	
Elementary school	5.1
High School	16.5
Technical School	13.4
University Graduate	49.2
Postgraduate Degree	13.9
Employment status	
Currently employment	78
Marriage age	
Less than 20 years	2.6
Between 21-35 years	96.4
35 years and older	1
Children	
No child	50.3
At least one child or more (1-4)	49.7

The socio-demographic characteristics of the participants are shown in Table 1. The table reveals approximately 92 percent of the sample were male. The majority of the participants were aged 45 years and younger. The participating in the study were well educated, with over 63 percent having a university or postgraduate qualification. The majority of the sample was employed (approximately 78 percent). Also approximately 96 percent of the sample marriage age were aged between 21-35 years. Just 49 percent of the study participants have a child or more.

Table 2. Communication with Their Children

*	5 (%)	4(%)	3(%)	2(%)	1(%)
Responses	59	29	12	0	0

***** defined as scores 1-5 on a scale ranging from 'very good' = 5 to 'very bad' = 1.

The table reveals the majority of the participants were in good communication with their children (with 59 percent).

Table 3. Who Shows Love and Affection Between Partners

	Me (%)	My partner (%)	Both equally (%)
Responses	28	17	55

The table shows that 55 percent of the participants were both equally shows their love and affection between them.

Table 4. The Situation of Exposure to a Kind of Crime or Violence by Their Partners

	Yes (%)	No (%)
Responses	10	90

The majority of the participants stated that they have not exposed any violence or crime.

Table 5. Status of Being a Member of a Social Group

	Yes (%)	No (%)
Responses	62	38

More than half of the participants, according to the results in this section are seen to be a member of a social group like other seafarers' partners. One third felt that a support group of partners would sometimes help them cope with the circumstance.

Impact of Seafarer Family Life Style

Table 5. The Distribution of Scores Regarding the Effects of Stress on the Life of the Children and Wives

	strongly disagree	disagree	not sure	agree	strongly agree
You have stress about the length of your partner's on-shore periods.	%60.1	%17.3	%8.3	%4.8	%9.5
You have stress over uncertainty about your partner's time of departure.	%23.3	%11.9	%9.1	%14.8	%40.9
Think your children are stressed when dad/mom is due to return.	%46.9	%17.3	%9.9	%9.9	%16

Think your children are stressed when dad/mom arrives home.	%50.6	%24.7	%7.4	%8.6	%8.6
You have concern over household security.	%32.7	%22.6	%14.3	%14.9	%15.5
Find that loneliness is a concern.	%26.8	%18.5	%14.3	%20.8	%19.6
You have concern over having to attend to crises on your own?	%31.3	%19.9	%15.7	%18.1	%15.1
You feel yourself restless and stressed when your partner was away.	%22.7	%17.1	%14.4	%19.3	%26.5
You feel yourself alone when your partner was away.	%25	%10	%7.2	%19.4	%38.3

Participants have little concern for the length of the partner's periods at home and at sea. Most of participants felt often stressed just prior to their partners' departure and over uncertainty about their partners' time of departure. And they thought that their children are less stressed than themselves for their mother/father's departure and on his/her return. Most partner were not concerned about household security and loneliness. Approximately 31 percent partner's concern was attending to crisis situations while their partners were away and also they feel restless and stressed during this period.

Table 6. Distribution of Coping with Stress During Their Partners' Absence

	strongly disagree	**disagree**	**not sure**	**agree**	**strongly agree**
You use medication to help you cope.	%58.3	%22.1	%8	%4.9	%6.7
You are smoking because of your partner job	%63	%13.9	%9.3	%7.4	%6.5
You are drinking alcohol because of your partner job.	%66.3	%15.8	%5.9	%4	%7.9
You tend to eat more.	%43.5	%24.4	%6	%9.5	%16.7

The majority of partner (58%) admitted to strongly disagree using medication during their partner's absence. Very few reported that they strongly agree with smoking or using alcohol because of partner's job. 43.5 percent of the participants strongly disagree tended to eat more.

Table 7. Distribution of Examining the Impact of Seafarers' Work Schedule

	strongly disagree	**disagree**	**not sure**	**agree**	**strongly agree**
You feel your relationship is strongly at risk because your partner is working away from home (e.g. adultery).	%46.1	%25.1	%8.4	%4.8	%15.6
You wish your partner had a shore-based job	%17.8	%8.3	%10.6	%11.7	%51.7
You find that your partner's work disrupts your sleep	%40.5	%28	%9.5	%9.5	%12.5
You find that your partner's work limits your social life	%38.5	%19.5	%14.4	%9.2	%18.4
You find that your partner's work limits your career and work	%46.7	%18.9	%14.8	%6.5	%13
You find that additional free time you are able to spend with your partner after a tour of duty is a positive aspect of his/her work	%18.3	%8.6	%9.1	%19.4	%44.6
You enjoy having time to pursue your own interests	%16	%5	%5	%17.7	%56.4
You find that the decisions you make cause problems when your partner returns	%31.4	%17.4	%20.9	%14	%16.3
You find that you give in following a fight because you know your partner is about to go away	%29.2	%16.4	%10.5	%22.2	%21.6
You find that the home and away basis of your partner's work is stimulating to your relationship	%31.4	%17.4	%20.9	%14	%16.3

One fifth of the participants felt that their relationship was at risk because their partners was working away from home. Most of the partners (%51.7) wished that their partner had a job on shore. One fifth felt that their social relationships limited, and 13 percent reported that their career was limited because of his/her job. 12.5 percent had often disturbed sleep because of his/her job.

For the majority of the partners, 'having two lives' had some benefits, like more time to pursue their own interests in their partner's absence, and only 16.3 percent found the seafarer life style stimulating to their relationship.

DISCUSSION AND CONCLUSION

Our study includes not only female but also male participants with the increasing number of women on board in Turkey. Most of the male participants have concerns for the future. Also they fell stressed but not feel too depressed themselves when their wives at sea. They are not sure about getting psychological support. Male participants agree with the idea of going aboard with their wives. They do not have stress about the length of their wives on shore period. However, they have stress over uncertainty about their wives' time of departure. They do not find the worrisome to loneliness also not concern about depressed time when their wives at sea. For this reason, they do not need to use medication. Their adaptation period shorter than women when their wives go aboard.

The rate of female participant more than male participant as might be expected. Most of the female participants were aged between 26-35 years. Female participants in the study were well educated, with just over 63 percent having a university or postgraduate qualification. The majority of the them were employed (approximately 78 percent). Their smoking and alcohol usage frequency is less than male participants. 'The Intermittent Husband Syndrome' symptoms such as anxiety, depression and stress generally are shown in first week when their husbands go away. Female participants indicate that their husbands' wage satisfy them emotionally.

In conclusion, Turkish seafarers' absence from home in several months shows similarities with the psychological condition of the seafarers' wives in Australia, Norway, China, India and England. Although nations' lifestyles, family life and the possibilities and opportunities of seafarers on board are different, results showed that the seafarers' partners share the same emotions and concerns.

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ENVIRONMENTAL AND SAFETY-RELATED ASPECTS IN MARINA OPERATIONS: A CASE STUDY

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ABSTRACT

In recent times, people become more aware of environmental issues and this situation affect the business operations. Marinas are one of the businesses that may generate pollution due to a variety of activities including boating, fueling, hull repair, engine maintenance, etc. and these facilities can be maintained to minimize environmental impacts and protect water quality. In addition, marina operations cover different kinds of safety risks and the safety-related issues have great importance for preventing loss of life and property. In this study, a case study has been performed in a marina. Environmental and safety-related matters of this marina have been analyzed and evaluated in the light of semi-structured interviews with department managers.

Keywords – Environment, marina facilities, pollution, safety.

INTRODUCTION

Together with the pressure created by the intense city life, people's longing for sea and nature, the urge to have active preoccupations, the reaction against the standard life, the increase on the economic prosperity and technological developments have rapidly improved yachting and so the marinas all around the world [1]. Marinas are modern waterfront facility for recreational boats and generally provide a variety of services for boats and boat owners [2].

A variety of routine activities in marinas can cause pollution such as boatings, paints, oil and gasoline, and other hazardous materials generated through boat operation and maintenance are seriously dangerous to humans and marine life. In addition, sewage released by yachts contains bacteria that can make people sick and contaminate shellfish resources [3]. Recently, people become more aware of environmental issues and consumers are favoring businesses that contribute to protecting natural resources and environment. In addition, environmentally sound business practices increase operating efficiency of the businesses [4]. In addition; businesses need to respond appropriately to emergencies, coordinate safety maintenance of all facilities, and ensure that safety drills and exercises are scheduled and completed. The safety-related issues have great importance for preventing loss of life and property that may be occurred during the marina operations.

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In this study, it is aimed to analyse, group and evaluate "environmental and safety-related" matters roughly in the process of the marina operations within the scope of a case study. This paper is organised as follows. Section 2 gives the definition and specification of the marina facilities and marina-related literature. Section 3 introduces the case study based on the environmental and safety-related matters of *A Marina.* Section 4 presents the findings and the evaluation of some specific operations of A Marina regarding the subject of the study. The final section discusses the results together with suggestions.

THE MARINA: DEFINITION, SPECIFICATIONS AND RELATED LITERATURE

International Council of Marine Industry Association (ICOMIA) has defined marinas as the facilities that are run by public or private sector organisations located nearby the seas and provide protection services in return for a certain price for recreational yachts especially in seas (berthing, anchoring, etc.) and on land (drydock area, etc.), and that provide one or more of certain services or products related with yachts like fuel, toilet-shower, maintenance-repair, waste water collection, yacht markets, etc. The services that are provided in marinas can be classified as the Core Services, and the Supportive/Facilitative Services. The Core Services encompass sea berthing, lifting-launching, ashore parking. The Facilitative Services facilitate the use of Core Services by the customers like fuel, electricity-water, and maintenance-repair. The supportive services are the social facilities, cafés-restaurants, etc. which are provided for the purpose of increasing the value of the given services or differentiating from the competitors [5] [6]. Today, marinas generally sited in desirable locations offer similar services and for being competitive in the market, they need to offer much more supportive services [7]. For example, there are increasing trend for providing services for super and mega-yachts because these boats spend much more than the other smaller yachts.

Marina service groups determine the works that are conducted by different departments in the companies. Although the departments or the management levels to which these departments are connected in marinas vary from marina to marina, the basic works performed in the companies show similarities to each other [1]. The major departments/teams and the works that are carried out by these departments in marinas in terms of work organisation are given in Table 1.

Marinas are one of the businesses that may generate pollution because of several activities including hull repair, engine maintenance, and fueling, etc. In addition, marina operations cover different kinds of health and safety risks and the management teams have to establish safe and environmentally friendly working conditions. Boat owners also want to be able to see which facilities are much more available to them. Within the Marina sector, there is no single international standard against which to judge marinas regarding environmental and safety-related specifications of the companies but there are a number of programs with varying degrees of sophistication. Among the most popular programs are Blue Flag by Foundation for Environmental Education (FEE), Gold Anchor Award Scheme by The Yacht Harbor Association (TYHA), Blue Star by International Marine Certification Institute (IMCI), ICOMIA Clean Marina Program by International Council of Marine Industry Associations (ICOMIA), etc. The Blue Flag, Blue Star and Gold Anchor programs all incorporate the ICOMIA (International Council of Marine Industry Associations) scheme into their programs [7].

Table 1. Work and Department Categories in Marinas

Department/Team	Basic Works
Management	- ensuring the general coordination and order - weekly and monthly reporting - customer meetings - participating in the fairs - representation and introduction of the marina
Front Office	- all reservation and registration work - document tracking about sea operation - invoicing and collection - ensuring VHF and internal radio communication - informing the guests about the marina
Commercial Area Department	- customer meetings, rental contracts, bidding - ensuring the general order and discipline of the mall
Finance/Accounting Department	- general accounting, tax accounting, payments, budgeting, reporting
Technical Department	- maintenance and repair of land facilities and marina equipment - providing non-stop electricity-water for the yachts - acting in accordance with the regulations on fire and security of life - environmental cleaning (bilge collection, collecting grey and black water, treatment unit), landscaping
Berthing Masters	- secure berthing of the yachts coming to the marina - mooring assistance service with pilot boat, yacht towing - ensuring the order and control in the sea-side area - ensuring VHF and internal radio communication - tracking the sea operation documents - diving
Drydock Team	- lifting and launching the yachts in a safe and sound manner, and washing the bottom of the yachts with pressure water - organising the necessary documents related with the operation - ensuring the general order of the dry dock area - technical maintenance-repair
Security Personnel	- ensuring 7/24 security, field observation of the surveillance cameras - controlling of the fire warning and extinguisher system
Cleaning Department	- cleaning of the marina area and the facilities

Source: Koc and Karatas Cetin, 2015 [1]

The studies conducted on marina have generally focused on marketing and the environmental effects of them. Klein and Zviely [8] examined the developments on coastal areas in recent years, especially the decrease in the amount of sand in the bottom of the sea and the erosion and the coastal changes caused by marina facilities whose number increased in a fast pace with every passing year. Webb and Keough [9] performed an empirical study in two marinas located in the same area and near to each other. They investigated the level of the pollution at the bottom of the sea and the influence of this pollution on the amount of several sea organisms. Atlay Isık [6] conducted a study that purposed to develop the differentiation strategies for Turkey within the framework of a holistic marketing approach in the light of the data obtained with the evaluation of the perceptions of the marinas and other yacht businesses, which are yacht tourism businesses, on their holistic marketing attitudes. The most important characteristics of this study are that it provides an insight in the literature for the sector by providing data of certain topics such as yachting in the world and Turkey. It also describes a theoretical framework of yacht tourism for Turkey. Sari [10] made business oriented analysis on marinas in order to find out the significant points to make right orientations and future positioning in marina management. In accordance with this aim, she interviewed with five different marina managers in Turkey and one in Britain. Rivero et al. [11] conducted a study to determine the negative effects of the buildings constructed parallel to increasing population on shores for the purpose of providing services for yachting, diving and fishing.

METHODOLOGY

In this study, a case study was conducted in a marina for the purpose of analysing, and evaluating "Safety and Environmental" conditions of the "Marine Operations Activities". The face-to-face semi-structured interviews, review and analysis of the documents and observation in the existing departments were used together as data collection tool in performing the case study. In the scope of the study, "A Marina" was visited between the dates 27.03.2016 and 29.03.2016, and the authorized people in the marinas, whose information is given in Table 2 were interviewed.

Table 2. Interviewees in A Marina

Interviewee	Place	Date	Time/min
Front Office Manager	Front Office	27.03.2016	10:30-12:00
Fuel Station Manager	Fuel Station Office	27.03.2016	13:30-14:45
Front Office Chief	Front Office	27.03.2016	12:30-13:10
Boatyard Service Manager	Boatyard Service Office	28.03.2016	14:00-15:15
Technical Manager	Technical Office	28.03.2016	16:00-17:30
Port Service Manager	Port Service Office	29.03.2016	11:45-13:30

Semi-structured interviews were performed with the managers in *"A Marina"* during the three days of the visit, and observations were made at the marina area. In addition, the whole area of the marina was visited accompanied by the Port Service Manager and detailed information related with the subject was obtained especially from Front Office Manager, Port Service Manager and Boatyard Manager.

In the scope of the study, some documents were also examined in a detailed way. The documents of the company were especially operation documents such as daily harbour checklist, lifting/launching control form, daily boatyard checklist, re-fuelling acceptance form, etc.. The documents of the company were beneficial for detailing and analysing about safety and environmental aspects in marina operations.

FINDINGS

"A Marina" is on the southern tip of the Aegean Sea, with the capacity for mega and giga yachts as well as for sail boats and motor yachts of various lengths. Marina attaches importance to have quality certificates in recent years and it has below certificates;

- 5 Golden Anchors by The Yacht Harbour Association (TYHA)
- Blue Flag by The Foundation for Environmental Education (FEE)
- 5 Blue Stars by International Marina Certification Institute (IMCI)
- ISO 9001:2008 by Lloyd's Register Quality Assurance

As per the case study findings, it is possible to make some specific comment about A Marina regarding the subject of the study. Establishing and maintaining a safe and environmentally friendly work environment is one of the primary concern for *A Marina* because marina operations can cause personal injury and/or serious damage to boats and especially to the environment. It is the direct responsibility of each supervisor to manage the operation safely for preventing from accident or pollution and to train employees to perform their works safely. Marina regularly conducts fire drills and other safety trainings (such as first aid) of all staff. First-aid equipment, fire-fighting equipment, spill kits, fuel absorbent bundings are available and safety precautions and information are posted at the marina area. Emergency plans in case of pollution, fire or other accidents are prepared and applied by Marina Management. Facilities for disabled people are in place within the marina area.

Within the scope of the case study, environmental and safety-related conditions of *A Marina* are evaluated under the four main marina operation activities as *Mooring Operations*, *Boatyard Operations, Fuel Operations, Waste Discharge Operations.*

Mooring Operations

Mooring operations cover the processes such as providing guidance to the yachts that arrive/departure for berthing/un-berthing with the pilot boat, ensuring that they are moored/unmoored in a safe and secure manner [1]. This process is carried out mainly by the berthing masters in *A Marina*. Mooring operations cover many risks, especially physical risks and safety measures are substantial for people and also for the environment. As per the interviews conducted with Port Service Manager, A Marina Management takes some precautions in case of any injury to personnel as below:

- Mooring staff have to wear, life jacket, non-slip gloves and shoes.
- Mooring boat must be covered with non-slip cover in order to prevent slipping and falling situations.
- Mooring staff have to put emergency stop engine cable on their arms during the mooring operation.
- Mooring boat must not stay between berth and yacht during the mooring operations. Also mooring boats have to maneuver with low speed out of operation.
- All equipment which are used in mooring operations should be under control.
- Adequate and well signposted lifesaving, first-aid equipment and fire-fighting equipment must be present.

Berthing masters (mooring staff) work in shifts and they have shift control system to control the whole sea area. They use “Daily Harbor Checklist” and this list also covers safety and environmental issues as seen in Table 3. Each berthing master team in a shift have to do periodic control and fill this checklist. Piers/pontoons, mooring ropes, mooring lines, mooring boats and pedestals, fire hydrant boxes, bridges, signboards, lightings and general cleaning of the marina are controlled by mooring staff for several times during the day.

Table 3. Daily Harbor Checklist of A Marina

DAILY HARBOR CHECK LIST			
CHECKING PIER/PONTOON		**CHECKING EMERGENCY EQUIPMENT COUNT**	
Checking the ropes and chains of the pontoon		2 12l portable fire extinguishers	
Checking the cleat and bollard		1 electrical submersible pumps	
Checking pedastal		4 life jackets	
Checking electric and water installation		2 10m rescue ropes	
Checking the bridges and fasteners		2 25m hauling line	
Checking general order and cleanliness of pontoons		2 flashlights	
Checking pontoon connectors		1 defibrillator/first aid kit	
CHECKING BOATS		**CHECKING MOORING BOAT**	
Checking boat's mooring point		Compression control of boat tubes	
Checking boat's mooring ropes		Checking bow/stern painter	
Checking gangway and fenders		Checking the outboard motor of the mooring boat	
Checking mooring line and boat connection		Checking the occupancy rate of the fuel tank	
Checking cables and hoses between boat and pontoon		Checking general order and cleanliness	
Checking of boat's buoyancy and trim		Checking boat's coverings	
Checking boat's fire safety		Checking the electric circuits	
Checking general order and cleanliness of boat		Is there an automatic engine stop spiral ?	
CHECKING MOORING ROPES		**CHECKING MOORING LINE**	
Checking convenience of rope's thickness for boat's tonnage		Checking thimble of mooring line	
Checking contact point of rope, bollard and cleat		Checking buoy of mooring line	
Checking of duly connecting of ropes		Checking the number of mooring line	
		Checking the convenience of mooring lines for the boat's size	
CHECKING SIGNBOARD AND LIGHTING		Checking guide link of the mooring line	
Is there any broken signboard and lighting ?		Checking the shipworm condition for the mooring line	
Is harbor entrance lights on ?			
Is the physical cleanliness maintained ?		**CHECKING BRIDGES**	
Is the lamp glasses of the lightings solid ?		Checking pontoon-bridge links	
		Checking bridges' pillars	
CHECKING PEDASTAL		Checking life buoys on the bridges	
Are all the pedastals fixed on the pontoons ?		Checking bridge ramp	
Checking elecktric, plug, socket		Checking pontoon ramp	
Checking water battery		Checking pontoon/dock contingency covers	
Checking satellite/TV output			
Checking inputs and outputs of telephone connection		**CHECKING CLEANING**	
Checking general order and cleaning		Is there any waste material on shore and on the pontoons ?	
		Is there any unused rope ?	
FIRE HYDRANT BOXES CONTROL		Is there any stuff belongs to the boats on the pontoons ?	
Checking protective cover		Is there any defermation on the pontoons' covering ?	
Is fire hose solid		Is there any left property around pedastal ?	
Checking nozzle providing water flow		Is the general cleaning made ?	

As it is known, safety issues are not only the responsibility of the marina management. All stakeholders of the marina have to be aware of them as well. Marina management of A Marina asks his customers to obey below specific issues in order to sustain safety standards.

- A mooring chain and/or rope shall be provided at the berth for mooring the boat on sea and the marina administration shall recommend that such chain or rope be tied to the appropriate point on the boat in order to ensure its safety.
- Anchoring or sailing within the marina area of the marina is strictly prohibited.
- The boat owner shall inform the marina administration and obtain its approval before his boat enters or leaves the marina or changes its place in the marina.
- Speed limits to be observed in the marina are shown on signs. If there is no such sign, the speed limit is 3 nautical miles per hour for marine vehicles and 10 km per hour for land vehicles.

Boatyard Operations

Boatyard operations mainly cover lifting/launching services and boat repair & maintenance activities. Lifting/launching services are provided in an area called *"dry dock area"* in order for the maintenance-repair operations of the boats to be made in an area outside the sea. These operations may cause personal injury and/or damage to the boats and the environment if the necessary precautions are not taken by the Marina Management. Some specific issues related with boatyard operations by Boatyard Manager as below;

- Lift operator and boatyard employees have enough training to provide safety operations.
- Before lifting/launching operation, lift operator should survey the boat whether the boat is damaged or not.
- Lift operator should control the real boat size and the boat size written on the certificate of registry.
- All equipment which are used for lifting/launching process such as travel lift's ropes should be controlled before the start of the process.
- Boatyard Employees should check that the boat owner provides that his/her boat is suitably inclined and trimmed before the start of lifting/launching process.
- Weather and sea conditions should be available for lifting/launching process.
- There should not be any person on board during the lifting/launching process.
- There should not be any dismantled boat parts which may affect travel lift's ropes.
- Before the boat is launched, waste created and generated by the boat should be removed by the boat.
- Before the lifting and launching operations, "Lifting/Launching Control Form" (Table 4) is filled by the lift operator for carrying out smooth, safety and environmentally friendly operations.
- Boatyard workers (marina employees or outside technicians) should use safety equipment such as; helmet, safety belt, headphone, flasher vest etc. and obey the boatyard area rules strictly.
- Adequate and well signposted lifesaving, first-aid equipment and fire-fighting equipment must be present on the boatyard.
- "Daily Boatyard Checklist" should be filled by boat yard staff in order to sustain routine control of dry dock area every day (Table 5).
- Hull bottom high pressure washing of fouling organisms should be done over land on a hard surface with drains and solid collection traps.
- Boat repair & maintenance service providers must be fully aware of safety and environmental issues during their operations and obey all the rules determined by A Marina Management. No pollution must enter the sewage system, marina land and water or the natural surroundings.

Table 4. Lifting/Launching Control Form of A Marina

LIFTING/LAUNCHING CONTROL FORM

BOAT INFORMATION	NAME: TYPE:		
DATE: This part will be filled by the marina office.	LOA: Beam: Depth: Flag:	M M M	Note:
Land Storage Period: This part will be filled by the marina office.	LIFTING:	LAUNCHING:	

Lifting Operations This part will be filled by the lift operator.	Yes	No	NOTE Please make explanations for reqired parts
Are the boat sizes correct ?			
Is bottom washing done ?			
Is captain/owner of boat on board ?			
Is there any significant damage on the boat ?			
Did you receive oral/written information about the boat's belt marking ?			
Did you receive information about buttressing up points of the boat ?			
Were ladder/scaffold given to you ?			
Is electric/water connection done ?			

Lifting Operations Administrative Controls This part will be filled by the marina office.	Yes	No	NOTE Please make explanations for reqired parts
Is there any contract and is it signed ?			
Is the payment made ?			
Is there valid insurance of the boat ?			
Is there bottom washing demand ?			
Is there any known problem ?			
Will boat be taken for wintering			

Launching Operations Administrative Controls This part will be filled by the marina office.	Yes	No	NOTE Please make explanations for reqired parts
Has land park contract period been exceeded ?			
Is there any unpaid charges related with boatyard services ?			
Is there any unpaid charges related with other marina services ?			
Is there any inconvenient situation for launching ?			
Is boat removed from wintering ?			

Launching Operations This part will be filled by the lift operator.	Yes	No	NOTE Please make explanations for reqired parts
Is there any particular damage which causes an obstacle for launching ?			
Is captain/owner of the boat on board ?			
Is cleaning done around parking area ?			
Is there any problem for launching operation ?			

Table 4. Daily Boatyard Checklist of X Marina

DAILY BOATYARD CHECK LIST			
FIELD CONTROL		**OFFICE/WORKSHOP CONTROL**	
Boatyard is constantly checked for occupational health and safety and cleanliness.		Boatyard operation, planning and contol is done.	
Pedastal		Checking boatyard's calendar	
Lighting and signboard		Current occupancy	
Fire and safety equipment		Reservation list	
Showers and toilets		Checking equipment maintenance forms	
Office for rent			
Workshops		**FIXTURE AND EQUIPMENT CONTROL**	
Waste-oil tank		Be sure that all equipments and fixtures are ready to use and undamaged.	
Bilge/waste collection station		Moving boat crane	
Garbage containers		Boat carriers	
		Garbage containers	
BOATS CONTROL		Sledges	
Be sure that each boat's safety and security controls is done.		Forklift	
Wedge, buttress, tripod and sledge		Pallets	
Electric and water connects		Concrete field	
Safety checks (alarm,sound,smoke etc.)			
General order, cleaning			

Fuel Operations

Fuel operation can be described as fuel transfer to the boat and this operation may cause any damage to people, environment and marina. There are many necessary measurements to prevent any events such as explosion, fire and environmental pollutions. Necessary steps during fuel supply were explained with details by Fuel Station Manager as below;

- Boats are berthed securely to the fuel transfer area.
- Equipment which are used process of refueling should are controlled.
- Captain should know that how much fuel will be transferred.
- Beginning of the refueling, fuel transfer should be slowly. This method provides understanding whether there is any leak or not.
- No smoking during fuel operation.
- There should be available weather conditions for refueling.
- In case of any undesired conditions such as oil spill; fuel station must have some specific equipment such as oil spill kit, Abc type KKT tube, signposted lifesaving, first-aid equipment and fire-fighting equipment.

Before fuel transfer starts, yacht captains generally ask to receive fuel analysis because captains decide to buy or not buy according to fuel analysis report. Then, refueling acceptance form which is given below are signed by captain and employee of fuel station. Thus both parts accept their own responsibility for this operation.

Table 4. Refueling Acceptance Form of A Marina

REFUELING ACCEPTANCE FORM

1. FIRM NAME:
2. FIRM OFFICIAL:
3. TANK PLATE:
4. CONTACT PHONE:
5. BOAT NAME:

ON BEHALF OF BOAT

I let refuel my boat above mentioned from the fuel tank or fuel stations. I know that security and safety measures in/on boat should be taken by us about the work to be done. I accept responsibility of all damages to marina, environment or third parties arising from equipment on my boat and or personal omissions during refueling.

BOAT NAME	NAME/SURNAME	DATE/SIGNATURE

ON BEHALF OF FUEL STATION

I read and accept the occupational health and safety protocol. I commit that I will work within the marina and boatyard rules and I will obey all rules and I will be ready to use below mentioned equipments during operation according to the protocol, I accept that marina official have the authority to stop refueling because of job and environmental safety.

1. No-Spill
2. Oil Spill Kit
3. 2 6 kg ABC type KKT tube
4. 18 kg FP 3% foam chemical (fluoroprotein foam concentrate)

I accept to pay…………………………………amount in exchange for marina area usage for refueling.

NAME/SURNAME	DATE/SIGNATURE

			
NO SPIL APARAT	OIL SPILL KIT	ABC TYPE FIRE-EXTINGUISHER	FOAM CHEMICAL

Waste Discharge Operations

For Waste Discharge Operation, Blue Card System is used by A Marina since 2014. With Blue Card System; waste collection taken by waste type and the quantity of waste and some other information can be monitored online. Thus, illegal bilge, sewage and waste discharging into the sea can be controlled by the government [12]. 244 ton waste was collected in 2014 and 712 ton waste collected in 2015 by A Marina.

Marina has well-managed garbage containers and facilities for receiving recyclable waste materials; such as bottles, cans, paper, plastic, organic material, etc. Bilge/waste collection station, and garbage containers are daily checked and documented through “Boatyard Area Checklist” every day.

Within the marina there is a boat which is used collecting waste from yachts as a portable pump-out device, so the yachts don't need to berth to pump-out facility. Also the maintenance of this boat is done every day. A marina and Coastal Guard work with together accordingly to prevent illegal discharging into the sea.

CONCLUSION AND RECOMMENDATIONS

In today's conditions it is obvious that the number of the marinas are increasing rapidly all around the world and various kind of services which are provided by the marinas are expanding with the different boat types. In order to operate the marina by using appropriate and sustainable methods, conducting the marina operations activities in safely and environmentally friendly ways is as important as other business functions such as marketing and financial activities.

In this study, *A Marina* have been analysed in terms of environmental and safety-related specifications under four main marina operations and it is found that in spite of written and verbal statements given by Marina Management regarding safety measurements as above, these declared measurements are not practiced entirely. For example; mooring employees don't obey the rules like using life jacket or non-slip gloves, putting emergency stop engine cable on their arms during the mooring operation and there is not any control mechanism to prevent these situations. On the other hand, it has been observed that the safety procedures regarding boatyard and waste discharge operations are properly designed and applied properly. In addition, *A Marina* gives importance to have the international quality certificates to become a sustainable and green marina and these certificates also cover some safety and environmental standards.

For being much more sustainable marina facility, the management teams need to establish safe and environmentally friendly working conditions. Regularly scheduled training sessions (about first aid qualifications and updates, fire training, hazardous chemical training, emergency response training including emergency response drills, safety at sea training including shipboard safety, pump-out staff training) for employees may help the staff learn what to look out for at the marina. Because they are the frontline for communicating with customers, staff actions and attitude can greatly influence boaters' behavior. In addition, designing and applying checklist procedure for all operations may help to achieve compliance with safety and environmental standards. Demonstrating emergency response procedures and reviewing these plans and response procedures with staff at the beginning of each boating season is another alternative in this context.

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ANALYSIS OF PSC INSPECTIONS AND DEFICIENCIES OF PSC SYSTEM IN TURKEY

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ABSTRACT

Inspections of vessel are a key actor in order to prevent loss of life and property and also pollution at sea. Inspections have been stand out named as port state control and flag state control at interstate levels. In conjunction with arising port state control, vessels have been inspecting by visited states for standard transportation. Maritime Authorities of these states sign Regional PSC memorandums (MOU) agreed to implement a harmonized system of Port State Control. Turkey have adhered Mediterranean and Black Sea MOU due to the its coastline in nine MOU of the world and inspected vessels according to these MOUs and domestic legislation. At this point, inspection of foreign flagged merchant vessels are applied by port state control officers named marine survey engineers in Turkey. In this study, port state control has explained cognitively and to compare inspection performance between adhered to memorandum organizations with statistical data of port state control which implemented through foreign flagged vessels in Turkish ports. The key disputes of Turkey Port State Control System has tried to find out according to opinions of marine survey engineers depend to Republic of Turkey Ministry of Transport, Maritime Affairs and Communication by applied delphi method.

Keywords- Vessel Inspection, Port State Control, Port State Control Inspections, Delphi Method.

INTRODUCTION

Port state control (PSC) has become a very significant inspection net with regards to the prevention of negative results that flag state inspections bring about and the elimination of deficiencies in term of the inspection of ships engaging in commercial activities. Especially with Paris MoU's entry into force, the countries in other regions took this agreement as an example and formed inspection mechanisms among themselves. The examples to this mechanism that could be encountered at the international level are the existing 9 regional agreements on PSC – Europe and the North Atlantic (Paris MoU); Asia and the Pacific (Tokyo MoU); Latin America (Acuerdo de Viña del Mar); Caribbean (Caribbean MoU); West and Central Africa (Abuja MoU); the Black Sea Region (Black Sea MoU); the Mediterranean (Mediterranean MoU); the Indian Ocean (Indian Ocean MoU); and the Riyadh MoU–and the United States Port State Control (USCG inspection) System. Being a port state due to its location, Turkey is a party to the Mediterranean and Black Sea MOU.

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In the studies carried out on PSC, evaluations were made about the general efficiency of the inspection system and about maritime security and safety while recommendations were provided about an inspection network model for countries. In the present study, it is aimed to evaluate the situation of Turkey within the framework of PSC, which is a significant inspection network in maritime trade, and to determine the problems in the PSC system that has been implemented in our country with the help of port state control officers (PSCO). In addition, the inspection and detention data of at least nine years belonging to foreign-flagged ships visiting Turkey have been revealed and information has been provided on inspection ratios. The “Delphi” method used in the present study has given effective results in determining the problems in port state control system. This study method is rarely used in academic maritime studies.

The productive implementation of the PSC will result in carrying out high-standard maritime activities in terms of the safety of life, property and environment. In maritime trade, countries inspect foreign-flagged ships within the scope of their port state authorities and thus prevent the loss of life and property and environmental pollution. In this regard, the present study is important in terms of determining the problems within the port state control network and seeking solutions to take it further.

PORT STATE CONTROL

Maritime transport is the most effective way of transportation today among transportation methods. Merchant ships play an important role in this activity. Internationally, these ships performing marine adventures between the seas, should comply with a number of conditions in terms of life, property and fulfillment of the environmental safety. From past to present, the relevant conditions appear as flag state controls first and then as port state control because of that Paris MOU entered into force and partaking in United Nations Convention on the Law of Sea dated 1982. While port state control has a control system on seas such as flag state control; it is not accidental that it gains more importance day by day. At this point, “Port state control is often named as the last safety net”. Port state control is a concept which is created to strengthen this net after the old sea safety net which is formed by flag state with its classy organizations however does not work effectively [1]. International society introduced its port state jurisdiction as an additional defense line to the international law of the sea by reasons of the fact that the documents given by flag states to the ships do not reflect the accurate physical condition of ship sometimes and especially easy flag states do not fulfill regularly control of ships [2]. Chiu and others [3] support this with the opinion of “if all of flag states performed their duties successfully, there would be no need for port state controls”.

The concept of port state control appeared to develop the compliance of ships for internationally accepted standards with the ways of applying controls, executing corrective measures (for example; detention for rectification) through commitments of port authorities for foreign-flagged ships being in the visitor position [4]. IMO defines the port state control as investigating conditions of foreign-flagged ships situated in a national port and also process of inspecting the ships for their operation and management in accordance with international regulations [5].

By confirming the decision “Regional Cooperation in Control of Ships and their Wastes” November 1991, IMO aimed at removing sub-standard ships and suggested that Port State Controls are established in all over the world by modeling the Paris Port State Control founded in European region in 1982. The decision calls the other countries being a party to Paris MOU and port state control to be helpful for development of inter-regional cooperation for harmonizing the exchange of information systems and Port State Control information [6]. The movement of control regime starting with Paris Memorandum has spread to many regions. The "The Latin American Agreement on Port State Control of Vessels" signed in November 1992 (Acuerdo de Vina del Mar) and the "Memorandum of Understanding on Port State Control in the Asia-Pacific Region" (Tokyo MOU) became first links for chain of control under the care of IMO [7].

PORT STATE CONTROL REGIONAL AGREEMENTS

Today, there are 9 pieces regional Port State Control agreements as of Paris, Tokyo and Latin America MOU's, Caribbean MOU, West and Central Africa (Abuja MOU), Black Sea MOU, Mediterranean MOU, Indian Ocean MOU, Arabian Gulf (Riyadh MOU). In addition, a Port State Control named Coast Guard in USA (USCG) has been applied effectively.

Paris Memorandum of Understanding is the first regional Port State Control Agreement and is a model for others [8]. While there are various features which makes these regional memorandum of understandings different, basically they all are similar regulations prepared in the light of Paris MOU [2]. Geographic area of Paris Regional Agreement covers European coastal states and North Atlantic coastal states extending from North America to Europe [9]. Today, it expanded with the participation of European Union states as of Canada in West and Russia in East [10]. Member states of Paris Regional Agreement are; Germany, Belgium, Bulgaria, Denmark, Estonia, Finland, France, Southern Cyprus, Croatia, Netherlands, Canada, Great Britain, Ireland, Spain, Sweden, Italy, Iceland, Latvia, Lithuania, Malta, Norway, Poland, Portugal, Russian Federation, Romania, Slovenia and Greece [11].

In the Far East, another regional group is formed which is known as Asia-Pacific or Tokyo MOU and including the other part of Canada and Russia. It extends from Asia Pacific in West to the China in North, Australia and New Zealand in South. Tokyo MOU was established in early 1990s after 10 years from the Paris MOU [10]. In Tokyo Regional Agreement, there are 21 authority as full member in committee. These are; Australia, Canada, China, Fiji, Hong Kong (China), Indonesia, Japan, Republic of Korea, Malaysia, New Zealand, Papua New Guinea, Philippines, Peru, Russian Federation, Singapore, Thailand, Vanuatu, Vietnam, Solomon Islands, Chile and Marshall Islands [12].

When looking at Southern America, Latin America Regional Agreement (Viña del Mar) appears. It was accepted in November 5, 1992 in Chile with the motion no.5 in 6th meeting of effective net (ROCRAM) for regional cooperation between South America states, Cuba, Panama Maritime administrations. The Agreement was formed with participation of Argentina, Brazil, Colombia, Chile, Ecuador, Mexico, Panama, Peru, Uruguay, Venezuela at first, for this reason it attracts the attention as an important international stage because of being the first developed region for reaching such an operation agreement. In later times, number of members has reached up to 15 with the participation respectively Cuba in 1995, Bolivia in 2000, Honduras in 2001, Guatemala and Dominican Republic in 2012 [13].

Caribbean MOU created by countries of Caribbean Sea was signed in February 9, 1996 in Barbados with participation of Antigua and Barbuda, Barbados, Dominica, Grenada, Guyana, Jamaica, Netherlands Antilles, Surinam and Trinidad&Tobago; and number of members has reached up to 23 today. These are; Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Bermuda, Cayman Islands, Curacao, Dominica, Grenada, Guyana, Netherlands, British Virgin Islands, Jamaica, Cuba, Montserrat, Saint Lucia, Saint Vincent and Grenadines, Surinam, Saint Kitts and

Nevis, Trinidad and Tobago and Turk and Cocoa Island also Netherlands Antilles was dissolved October 10, 2010 [14].

Abuja MOU including African countries was signed in October 22, 1999 by maritime authorities of 16 countries situated in Central and West Africa region, which is organized by IMO and hosted by Nigeria. There are 15 full members according to Port State Control Agreement of Abuja Region today. These are; Angola, Benin, Republic of Congo, Gabon, Gambia, Ghana, Republic of Guinea, Guinea Bissau, South Africa, Nigeria, Sao Tome and Principe, Senegal, Sierra Leone, Togo and Cape Verde Islands [15].

When predicating Turkey on, Black Sea and Mediterranean MOU's appear. With a common approach in main principles about Port State Control, ports situated in coasts of Black Sea are taking part in geographic scope of Black Sea MOU created by 6 countries of Black Sea (Bulgaria, Georgia, Romania, Russian Federation, Turkey, Ukraine) in 2000 [8]. The agreement was signed in April 7, 2000 in Istanbul with the aim of eliminating sub-standard ships coming to the ports, increasing safety at sea and preventing marine pollution and providing its control [9].

On the other hand, international studies performed in November 28, 1995 in Barcelona about increasing maritime safety and preventing maritime pollution, and a cooperation project financed by European Union under umbrella of IMO and ILO as a result of Europe-Mediterranean Partnership (EUROMED), have been announced. This announcement was developed according to STCW 95 and conduced to an international partnership agreement toward South and Eastern Mediterranean about effectiveness of the role as an international port state control. Preparation of this agreement was carried out in 25-29 March 1996 in Tunisia firstly, in 10-14 December 1996 in Casablanca / Morocco, and the third meeting which is the last preparatory meeting for setting up port state control system was held in 8-11 July 1997 in Valletta / Malta. At the end of meeting, Mediterranean Regional Agreement was signed by 8 Mediterranean states (Algeria, Southern Cyprus, Egypt, Israel, Malta, Morocco, Tunisia and Turkey) [16]. Member states of Mediterranean Regional Agreement; Algeria, Morocco, Israel, Southern Cyprus, Lebanon, Malta, Egypt, Tunisia, Turkey, Jordan. Finally, Jordan became a member in the same year after signing agreement and then Lebanon became a member in 1999.

Another Port State Control Cooperation Agreement the Indian Ocean Regional Agreement made between the dates of 20-22 January 1999 and signed by Australia, Eritrea, India, South Africa, Sudan, Tanzania. This agreement entered into force on April 1, 1999. After countries signed the agreement; Mauritius, Sri Lanka, Iran, Kenya, Maldives, Oman, Yemen, France (La Reunion), Ethiopia, Bangladesh, Comoros and Mozambique have joined to the union. 18 countries became a member of union in September 2013 [17]. Memberships of Djibouti, Seychelles and Myanmar states have not been accepted yet [18].

The last part of regional union the Riyadh MOU is one of many regional agreements signed by maritime authorities under cover of IMO in terms of port state control. The agreement was signed by 6 states (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and U.A.E.) at a meeting in Riyadh in 2004 with the purpose of providing safe, secure and efficient maritime transportation possibility within the boundaries of maritime jurisdiction in Gulf Region [19]. As mentioned above, member states of Riyadh Regional Agreement are Kingdom of Bahrain, Kuwait, Sultanate of Oman, Qatar, Kingdom of Saudi Arabia and United Arab Emirates [20].

Finally, USA decided not to be included in any regional agreement group. USA undertakes the unilateral control measures for port state control program [10]. Port state control in USA has been performed by USA Coast Guard in terms of international agreements and compliance with Federal legislation. In 1994, United States Congress decided to take measures towards elimination of sub-standard ships for safety of ports, waterways and marine environment because of high number of foreign-flagged ships came to the country. The congress charged USA Coast Guard about developing program for cleaning sub-standard ships from USA waters and presenting annual reports obtained from this program [2].

PSC STATISTICS IN TURKEY

Number of ships which are members of Mediterranean and Black Sea Regional Agreement and visited the ports of Turkey between the years of 2005-2013, and ratio of control performed on ships are shown in Figure 1. Also annual reports of 2013 have been shown as final in table.

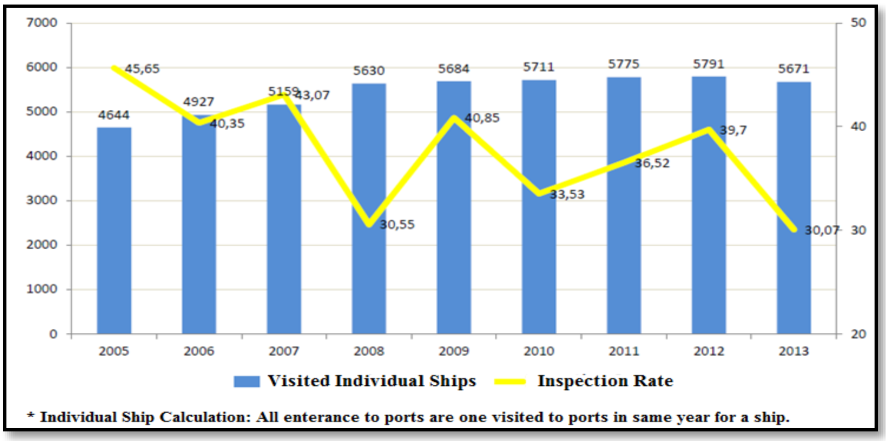

Figure 1. PSC Statistics Performed in Turkey in scope of Mediterranean and Black Sea MOU [21]

Accordingly, the number of incoming ships by year between the numbers of approximately 4600-5800. When examining 2005, 4644 different ships entered in Turkey and 45.65% of these ships was inspected. In 2006, number of entranced ships increased in comparison to previous year and became 4927 however inspection ratio decreased and became 40.35%. Number of ships and ratio of inspection in other years including 2013 presented an up-and-down graphic. By looking at obtained data, when examining the last two years, it can be seen that number of entranced ships is 5791 in 2012, ratio of inspection corresponds to 39.7% and while 5671 ships visited Turkey in 2013, ratio of inspections related to port state control of ships carried out as 30.07%. When considering the relevant inspection ratio in amount of 30.07% in 2013, it is seen that the given 9-year between 2005-2013 got the minimum value in statistics table. According to the calculation from a different angle, 1705 inspected ships attract the attention when proportioning the value of inspection percentage in context of the number of foreign-flagged ships.

PCS Statistics of Turkey in scope of Black Sea MOU

The number of port state controls performed in Turkish ports between the years of 2003 and 2013 in scope of Black Sea MOU has been given in Figure 2. Annual reports of 2013 have been shown as final in table.

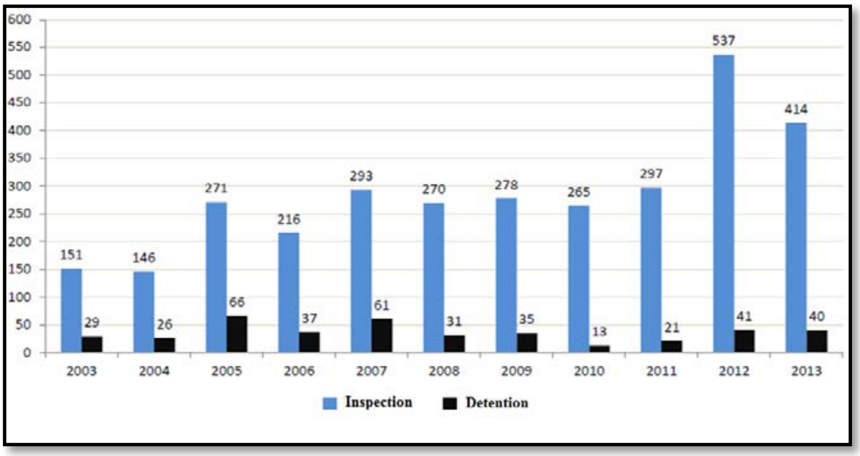

Figure 2. PSC Statistics of Turkey in scope of Black Sea MOU [21]

Accordingly, 151 inspections was performed in 2003 and 29 inspected ships were detained. Finally in 2013, ratio of inspections performed on foreign-flagged ships visiting Turkish ports is 414, 40 of them resulted in detention.

When examining Table 1 including more detailed information about Turkey in terms of Black Sea Regional Agreement, it is possible to have an idea about inspections of the region. Here, grand total of state parties of Black Sea Regional Agreement and Turkey's condition of 2013 are given.

Table 1. Comparison of Black Sea MOU with PSC Data of Turkey for 2013 [22]

Data of 2013	Number of Entranced Individual-Ships	Inspection Number of Entranced Individual-Ships	Inspection Number	Number of Inspection Having Deficiencies	Number of Inspection Left for Follow-up	Number of Deficiencies	Detention Number	Number of Detained Individual-Ships	Inspection Ratio (2)	Detention Ratio (3)
Turkey (1)	1007	346	414	301	225	1983	40	37	34.36	10.69
Black Sea	5786	3681	5080	3306	1581	19022	184	169	63.62	4.59

Note: (1): It includes information of Black Sea ports only. (2): It is inspection percentage of number of entranced individual-ships (3): It is detention ratio of number of entranced individual-ships.

According to Table 1, 5786 different ships visited all MOU countries of Black Sea in 2013, 3681 of them were inspected. Number of inspections performed regardless of ship differences namely by considering that a ship should be controlled more than one was 5080, 3306 of these inspections was determined as deficient, 1581 of them reached the end of release with the condition of follow-up, 19022 deficiencies conditions were written in total, 169 of 184 detentions were applied to different ships, by considering different ship basis the inspection ratio was 63.62% and detention ratio was 4.59%.

In the same table, when looking at condition of Turkey, 1007 different ships visited in 2013 and 346 of them were inspected. Without discriminating ships, namely by considering that a ship is controlled more than one, number of performed controls became 414, and 301 of them were determined as deficient, 225 of them were released on condition of follow-up, 1983 deficient conditions were written in total, 37 of 40 detentions were applied to different ships, by considering the basis of different ships, inspection numbers were 34.36% and detention ratio was 10.69%.

When these statistics are examined, serious differences between Turkey and Black Sea MOU attract the attention. In scope of regional agreement, while control ratio is 63.62%, this ratio is performed in a way to be almost half of the whole region with 34.36% in Turkey. Decrease in here attracts the attention. On the other hand, while detention ratio is 10.69% in Turkey, 4.59% in the whole region. In this point, it is determined that the result of detention of port state controls performed in Turkey is more than two times in comparison to the whole region.

Table 2 includes the details of port state controls performed in Turkish ports having coast to Black Sea in 2013.

Table 2. PSC Statistics of 2013 Performed in Black Sea Ports in Turkey [22]

Inspection Port	Number of Enteranced Individual Ships	Number of Inspected Enteranced Individual Ships	Inspection Number	Number of Control Having Deficiencies	Number Of Controls Left for Follow-up	Number of Deficiencies	Detention Number	Number of Detained Individual-Ships
Bartin	188	28	30	21	6	124	5	5
Fatsa	34	5	5	4	1	8	0	0
Giresun	28	5	5	5	7	27	0	0
Hopa	68	10	11	8	3	31	0	0
Eregli	306	71	71	39	15	214	19	19
Ordu	18	4	4	1	0	4	0	0
Rize	28	5	5	4	2	14	0	0
Samsun	548	101	106	70	40	567	7	7
Sinop	1	1	1	1	1	15	1	1
Tirebolu	4	2	2	2	0	7	0	0
Trabzon	206	131	168	142	147	945	7	7
Unye	76	2	2	0	0	0	0	0
Zonguldak	134	3	4	4	3	27	1	1

According to Table 2, Samsun port attracts the attention among ports of Turkey's Black Sea region as being the most frequent destination of individual-ships with its 548 number. The least frequent one was Sinop port. When data of Trabzon port were examined, 206 individual-ships came to this port, 131 of them were controlled and its individual-ship control ratio caught the top rate in comparison to other ports with about 63.59%. When considering the total number of controls, it was

168, 142 of these controls were given inappropriateness result, 147 of them were left for follow-up, 945 inappropriateness article were written in total, 7 detentions were carried out and each of these detentions was applied to different ships.

As a result, port state controls that Turkey applied to foreign-flagged ships in terms of Black Sea Region in 2013 were carried out in 13 ports, it is possible to determine the details of controlling port, number of incoming individual-ships, control number of incoming individual-ship, total number of control, number of controls having inappropriateness, number of controls left for follow-up, article number of total written inappropriateness, detention number and number of detained individual-ships.

PSC Statistics of Turkey in scope of Mediterranean MOU

The number of port state controls performed in Turkish ports between the years of 2003 and 2013 in scope of Mediterranean MOU has been given in Figure 3 .

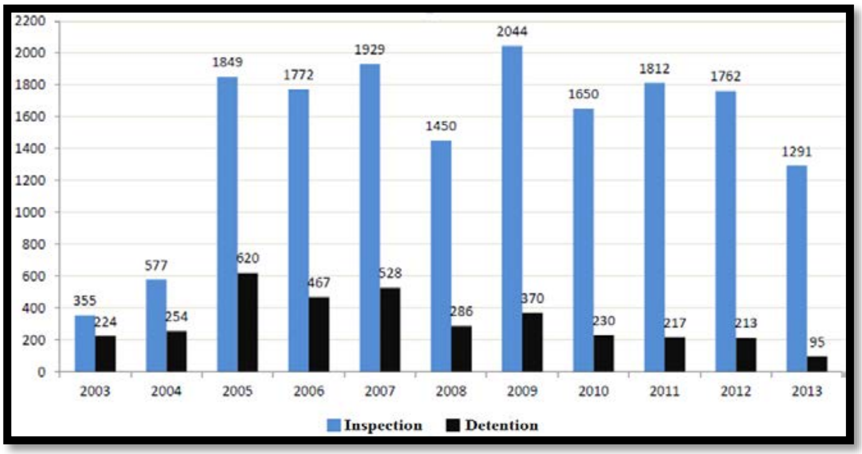

Figure 3. PSC Statistics of Turkey in scope of Mediterranean MOU [21]

Accordingly, 355 controls were performed in 2003 and 224 controlled ships were detained. One year later, in 2004, 254 detentions were carried out as a result of 557 controls. By the time, it was observed that control numbers increased and changed by years. While port state controls applied to foreign-flagged ships in 2012 were 1762, 213 detentions took place in these controls and finally control number decreased up to 1291 in 2013, 954 of them resulted in detention.

When examining Table 3 including more detailed information about Turkey in terms of Mediterranean Regional Agreement, it is possible to have an idea about all controls of the region. Here, grand total of state parties of Mediterranean Regional Agreement and Turkey's condition of 2013 are given.

Table 3. Comparison of Mediterranean MOU with PSC Data of Turkey for 2013 [23]

Data of 2013	Number of Incoming Individual Ships	Control Number	Number of Controls Having Deficiencies	Number of Controls Having No Deficiencies	Detention Number
Turkey	5670	1266	487	779	105
Mediterranean	22330	4698	2550	2148	262

Note: Algeria is shown as "0 (Zero)" for all values in 2013 statistics. Therefore, the values calculated for the whole region were made by considering this situation.

According to Table 3, 22330 different ships visited all countries of Mediterranean MOU in 2013, 4698 of them were inspected. While 2550 deficient conditions were found in these controls, any deficient condition was not determined in 2148 of them. In addition, 262 of performed inspections resulted in detention.

When looking at the condition of Turkey in the same table, 5670 different ships visited in 2013, 1266 of them were inspected. As a result of these inspections, 487 deficient results occurred, 779 deficient conditions were found and 105 of these inspections resulted in detention. It should be noted in particular that in data obtained from Ministry of Transport, Maritime Affairs and Communications, inspection and detention numbers of port state controls performed in Turkey in 2013 differ according to this chart. This is because, even if it is not stated in publications, that total calling number of a ship visited Turkish ports in Ministry statistics for the year was taken as a basis by us however it is thought that it results from usage of the expression of "entranced individual ships" no matter how much the ships visited the port during the year in terms of Regional Agreement.

When examining the Table 3, it is possible to make a comparison between the inspection results of Turkey and Mediterranean MOU. Accordingly, while detentions are about 5,6% as a result of controls for the general of Mediterranean Regional Agreement, this number was calculated as about 8% for Turkey, in addition, number of inspections applied to incoming individual ships is about 21% for Mediterranean MOU, this number is about 22% for Turkey. These determinations reveal that both of them are close to each other. However, when looking at these data from a different perspective, it is possible to show some differences in terms of Turkey and Mediterranean MOU. It is seen that it corresponds to 25% of grand total of Regional Agreement in terms of number of ships visited Turkey, 27% in terms of inspections and 40% in terms of detention with these data.

AN INVESTIGATION INTERMS OF PSC SYSTEM PROBLEMS IN TURKEY

Methodology

In our research, it is tried to determine main problems of Port state control system created in line with Mediterranean and Black Sea MOU which are being applied in Turkey. The purpose of our research is to determine the problems of port state control system problems of Turkey and offer recommendations regarding solutions of these problems. 3-stage Delphi technique is used as research technique. The universe of this research is 121 units of controllers that are working in connection with the Ministry of Transport, Maritime Affairs and Communications for the port state controls that are being applied in Turkey. The sample is the 49 maritime surveyor engineers that are authorized on the port state controls that are working at the places of duties of Ankara, İzmir, Trabzon, Gemlik, İstanbul, İskenderun and Sinop which are ministerial. However, investigation was performed with 20 port state control officers by uninterrupted. The open-ended question that has been addressed to the experts is as follows:

- What are the most important problems for the port state controls that are being applied in Turkey in your opinion?

For the analysis of the data the frequency distribution, median, bandwidth analysis difference between quartiles (Q3 – Q1), arithmetic average and standard deviation values were being used. In order to test the reliability of the scale, the reliability index (Cronbach Alpha) was being evaluated. The measures of consensus have been stated in Table 4. For the analysis of the research question; median, bandwidth, differences between quartiles (Q3 – Q1), arithmetic average, frequency distribution and standard deviation values were found. Here:

- (Mdn) Median Value: It represents the value for which 50% of observations a lower and 50% are higher.,
- Analyze of Ranges: Differences of quartiles (DQ=Q3-Q1),
- Frequency: 1-3 frequency; percent of marking 1.2 and 3 values/4 frequencies; percent of marking 4 value/ 5-7 frequencies; percent of marking 5.6 and 7 values,
- X : Arithmetic mean
- SD : Standard deviation value

Table 4: Measures of Consensus [24]

Consensus	**Consensus Indicators**
Match Criteria	If median ≥ 5 and DQ ≤ 1.5 If median ≥ 5 and DQ ≤ 1.5 and 5-7 frequency $\geq$ %70
Non Match Criteria	If median ≤ 3 and DQ ≤ 1.5 If median ≤ 3 and DQ ≤ 2.5 and 1-3 frequency $\geq$ %70

Findings

In this part our research, the findings arising from the analysis of the data that have been obtained with Delphi technique is being included.

First Consensus Findings

When looking at the marine titles of the port state control experts that are being included in our research three of them are oceangoing chief officer/engineers, seven of them oceangoing first officer/second engineers, nine of them are oceangoing maters and one of them is vessel construction engineer and when looking at the sea experience of such individuals two of them are experienced between 0-2 years, six of them are experienced between 2-4 years, seven of them are experienced between 6 -10 years and finally two of them are experience for ten or more years. The result of the question for the evaluation of the surveyor ship experience the results are one of them is experienced for 0-2 years, five of them are 2- 4 years, two of them are experienced for 4-6 years, five of them are experienced for 6-10 years and seven of them are experienced for ten or more years.

On the other hand, Cronbach's Alpha reliability (consistency) index for the first questionnaire that have been applied has been found as 0.723.

During the first consensus tour, the arithmetical average, standard deviation, median, DQ, frequency distribution detail of answers of the participants for the question of "What are the most important problems for the port state controls that are being applied in Turkey in your opinion?" is stated in the Table 5.

Table 5: The Results of First Consensus Tour with Regard to PSC System Problems

No	**Answers**	$\overline{X}$	SD	Mdn	DQ	Frequency		**Consensus**
						1-3	5-7	
1	Inability of Branching	5.9	1.59	6.5	6	10	90	N/M
2	Lack of Expert Staff	5.1	1.86	5	6	10	65	N/M
3	Technical Incompetence	4.45	1.54	4	6	10	40	N/M
4	Safety Substructure	4	1.92	4.5	5	25	50	N/M
5	Inspections by Different Department	3.25	1.74	3.5	6	50	25	N/M
6	Inadequacy of Education	4.35	2.41	5.5	6	40	60	N/M
7	Deficiency of Updated Legislations	5.1	1.71	6	6	10	70	N/M
8	Illegal Force from Others	4.55	1.85	5	6	25	65	N/M

Note: While DQ is increasing, participant opinions show variabilities. N/M: Non matched

Between the experts, regarding the most important problems for the port state controls that are being applied in Turkey, considering the consensus measure, it can be seen that there are not any consensus. Considering the arithmetic average value, with 5.9 “Inability of Branching” article is the article that have the most points among the control problems of the port states and with this, considering the likert scale, 90% of the participants has given value between 5 and 7 and on the other hand, “Inspections by Different department” article has 3.25 arithmetic average and it is therefore the problem with the least points.

Second Consensus Findings

In the second consensus tour of the questionnaire it has been found that the Cronbach's Alpha reliability index is 0.759. On the other hand the details of the responses for the question of “What are the most important problems for the port state controls that are being applied in Turkey in your opinion?” that have given again is stated in Table 6.

Table 6: The Results of First Consensus Tour With Regard to PSC System Problems

No	**Answers**	$\overline{X}$	SD	Mdn	DQ	Frequency		**Consensus**
						1-3	5-7	
1	Inability of Branching	6.5	0.51	6.5	1	0	100	M
2	Lack of Expert Staff	5.35	1.39	5	4	5	65	N/M
3	Technical Incompetence	4.55	1.32	4	5	10	40	N/M
4	Safety Substructure	4	1.92	4.5	5	25	50	N/M
5	Inspections by Different Department	3.85	1.14	4	5	45	25	N/M
6	Inadequacy of Education	4.80	1.96	5.5	6	25	60	N/M
7	Deficiency of Updated Legislations	5.10	1.71	6	6	10	70	N/M
8	Illegal Force from Others	4.95	1.15	5	4	10	85	N/M

Note: While DQ is increasing, participant opinions show variabilities. N/M: Non matched. M: Matched

Between the experts, regarding the most important problems for the port state controls that are being applied in Turkey, considering the consensus measure, it can be seen that there are only one consensus one the subject of first article, inability of branching. Considering the arithmetic average value, with 6.5 “Inability of Branching” article is the article that have the most points among the control problems of the port states and with this, considering the likert scale the 100% of the participants have valued this subject between 5 and 7 and on the other hand, “Inspections by Different department” article has 3.25 arithmetic average and it is therefore the problem with the least points.

RESULT

Port state control has become an important inspection network with regard to prevention of negative consequences of the flag state control and elimination of deficiencies in terms of commercial activity involved in the inspection of ships. In particular, entering into force of the Paris MOU and followed by the States in other regions by taking the example of the said agreement has resulted in the setting up inspection mechanisms amongst themselves. In this study, examples of applications that can be found in the international arena included with general information in 9 regional agreements consisting of Paris, Tokyo, Mediterranean, Black Sea, Riyadh, Abuja, the Caribbean, Latin America and the Indian Ocean regional MOU’s and the US port state control system.

Turkey, which is a port state due to it’s location, is a member of Mediterranean and Black Sea MOU’s that are amongst the Regional MOU’s exist in the world. In the study, giving an overview of port state control, Regional MOU’s in the world are briefly touched upon. The relations of Mediterranean and Black Sea Regional MOU’s which Turkey parties as a port state are emphasized. The statistical data of foreign flagged ships inspected at Turkish are put forward and the detentions in the result of inspections carried out on the foreign flagged ships visiting our Country given. In addition, the tables that allow the evaluation of the performance of our country in the Black Sea and the Mediterranean MOU 's are formed. Our study provides this data for many years and aims to make an assessment with regard to the point that has been arrived throughout the years.

In the research which was done in the framework of inspection officers that carry out the Port State Controls, the problems of inspection system were identified in the light of the opinions given by experts. Research was carried out with the participation of 20 port state control officers working at the stations of Transportation, Maritime Affairs and Communications Ministry located in Ankara, İzmir, Trabzon, Istanbul Gemlik, Sinop and Iskenderun districts. In the first consensus round Delphi technique no consensus could be reached with regard to the question of port state control and by the application of second round of reconciliation, an agreement was made on the "Inability of Branching" issue. The “Inability of Branching” was put forward as a problem by all of the port state control officers. However, coming up of the DQ value as "1" indicates that there was very little change of opinion. "Inability of Branching" means that port state control officers take part in a variety of tasks, it is the fact that their professional job is not only the inspection of foreign flagged ships. On the other hand, defined as a problem of port state system "among jurisdictions of the objects of control," the average score of the substance remained below 4 percentage points, the group has issued the results of inconspicuous as a major problem in terms of the overall average. At the end of the study, it was seen that Delphi technique served the obtained target and “Inability of Branching” attracted attention as the most important issue of port state control system.

Turkey has an active role in the maritime trade due to Strait of İstanbul and Strait of Çanakkale located within her territory and also due to it’s location as a bridge between Asia and Europe; and in order to inspect and supervise this trade at the highest level, port state inspections are carried out by experts affiliated to the Ministry. Thus in the result of the study; efforts to resolve the problems of port state control as expressed by the experts which constitutes an important chain in the inspections should be done or should be accelerated. Consequently, in order to minimize the risks associated with maritime transportation that has the largest share in the international trade with regard to life, property and environment or in order to prevent or minimize the bad consequences; port states inspect the ships at their ports with the authority granted to port states by Paris MOU and United Nations Convention on the Law of the Sea. The said ports states, by appropriately carrying out the inspections and performing them during which no prejudice is attained to a certain flag state, should support the port state inspection system which is the latest maritime safety network.

Today, gaining importance of the harmonized survey improvements in the standards of all the activities carried out in the maritime sector, show that the port state control reached to a striking level. It should be noted that the disasters with regard to life, property and environment in the maritime commerce which has a wide variety of application areas could only be prevented by an inspection mechanism which functions smoothly, effectively and efficiently.

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MARITIME LABOUR FORCE AND TURKEY

Mehmet KAPTAN[1], Özkan UĞURLU[2], Murat ÖZKÖK[3]

ABSTRACT

Shipowner companies had difficulty in managing their vessels because of the fact that there was big increase in World shipping fleet from 2003 to 2007 and recently there was lack of seamen both in the world and in our country. These companies tried to reduce the problems by employing seamen from different countries to their vessels. This World wide problem was facilitated by some of the countries. These countries exported seaman to the countries where was not enough seaman and their country had significant income thanks to this exportation. There is no legal organization or law to regulate the law of global maritime labour force. The demand of seamen dynamically changes from country to country based upon the market requests. Seamen requests involve stuff expenses, quality of seamen's background education, past work experience, the importance of seamen's nationality and their references. This study aims at explaining how the characteristics of maritime work force have been shaped. Besides, Philippine, Polish, Germany, Turkish maritime work forces will be analyzed and general maritime policies will be discussed. The main goal of this study is to give advise about the necessary precautions in order to shape our country' s future policy and regulate the market of maritime labour forces.

Keywords - *seafarer, maritime labor, maritime education*

INTRODUCTION

The World fleet is increasingly growing day after day since the new vesseles are added. In particular, Maritime Workpower Market has been a demanding market over the last 10 years [1]. Rising on vessel quantity has increased the demand to seaman and this situation has caused the instability between the supply and demand of seaman from time to time. Due to the fact that the seaman vacation is a hard one as well as the vessel enhancement and the other obstacles on vacation has shortened the sea life time of seaman. This case uncovers the concept of qualified seaman which is one of the fundamental issues of the maritime transportation in our day [2]. The studies which has been performed about this topic also proved the current situation [3]

Workforce demand on world maritime transportation can be calculated by considering world merchant fleet. But, seaman supply is the part that is not defined as quantity. This is because, the number of active and non-active seaman cannot be determined [4]. Passive seaman can be defined as the seaman who took education and training at maritime school in the past but not worked at sea or worked at sea but had a break for a while.

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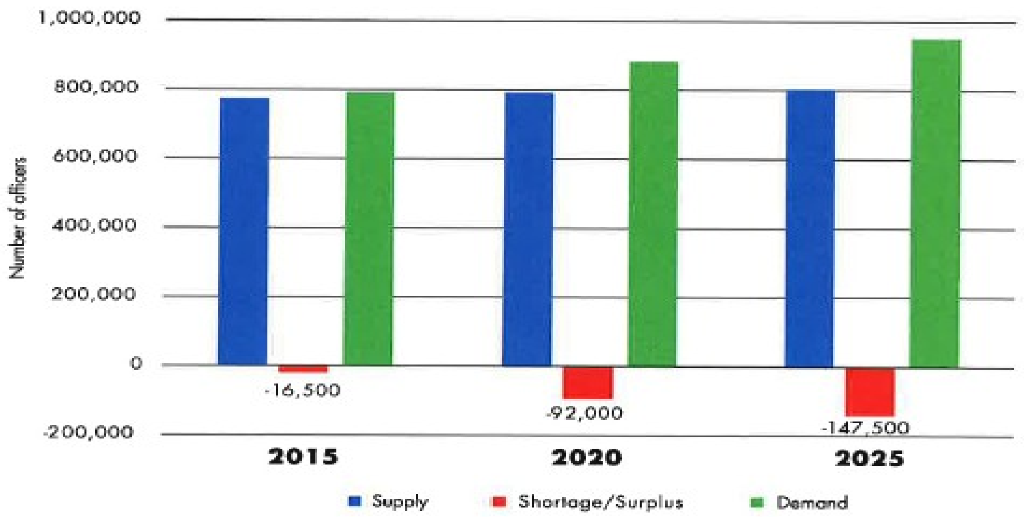
According to the latest published BIMCO 2015 manpower report, there are 68723 vessels all around the world. The number of seaman is estimated as 1 647 500. In this number, 774000 shows the number of officiers and 873500 represents crews (ratings). Between 2010- 2015 years, while the demand to officiers increased 24,1%, the demand to crew increased 1% [3].

Table 1: Bimco-İcs Manpower report: 2015 demand and supply stability

	OFFICERS	RATINGS	TOTAL
Supply	774,000	873,500	1,647,500
Demand	790,500	754,500	1,545,000
Shortage/Surplus	-16,500	119,000	102,500
%	**2.1%**	**15.8%**	**6.6%**

*Source: 2015 estimates

Table 2: Maritime workforce demand and supply case estimated in future (Source: Bimco-Ics Manpower report)



Since the maritime workforce market is a global one, it does not belong to just a country or association. Market is not managed according to regulations and politics. It is formed in accordance with demand and supply stability as well as it has a dynamic structure [1].

Maritime workforce market differs from country to country. While some countries export seamen to all around the world, the others import seamen from the different countries. In this study, the current situations of some of these countries were investigated. The purpose of this study is to investigate the maritime workforce market of the countries chosen as example and present some recommendations to be able to remove the obstacles in the seamen export of Turkey. In this contex, the interview was performed with the officer candidates who are still under education at universities and Turkish officiers who are working for Turkish and multi nations vessels. Total 55 persons were participated in the questionnaire. The study is built up with 6 main titles and the data achieved from the study was sequenced according to titles.

Phillippines

96% of seamen from Phillippines have been working for foreign flaged vessels. They earn 4.4 billion American dollars from semen export per year. The seamen from Phillippines begin maritime operations by being associated with maritime agencies. According to 2002 statistics, there are 417 crew agencies in only Manila and 209953 seamen find job by means of these agencies. Together with the legal regulations performed in 1994, these agencies work under control of Phillippines Overseas Employment Administration (POEA). The quality of agencies is defined as the ones which work with the low and high qualified seamen [5]

In Phillippines, there are 95 training centers which ensure the standarts and majority of these schools are operated by private sector. Besides, these training foundations are supported by maritime companies, international associations, Japan and Norway. Around 12000 seamen graduate from these schools every year [1]

In Phillippines, prior to maritime training, fundamental education obligation of 10 years is available. After this education, seamen are able to work as rating. This training can be completed in a span of 4 years and seamen can begin working as officer. In Phillippines, maritime training language is English. So, the seamen have no difficulty in language [5]

Poland

In Poland where is the one of Middle European countries, there are 35000 seamen working actively. Only 10% of the active seamen work for the ship owners who are from Poland.

In Poland, in terms of maritime education and training, there are 2 maritime universities, 1 Naval Academy, 5 secondary maritime schools, 3 post secondary maritime school and 4 training ships. Average 2500 seamen per year are trained. As the prosperity rate of the country is growing, the number of seamen is decreasing. Despite of this, Poland is one of the most significant EU countries where supply seamen for European Union [6].

Germany

In Germany, German Shipowners' Association plays an important role in the training and apprenticeship of seamen. Maritime training capacity and quality is extremely high. 12 maritime universities which educate officiers are available. But, since the economics level of the country is very high, the salary of German officiers is also too high. That's why, German ship owners prefer to import officiers from other countries where are paid less salary than Germany. This case influences the number of the trained officiers [1].

Turkey

Turkey is one of the countries where train the seamen the most. So, there is a great deal of registered seamen. According to official registration, total 170000 Turkey citizened seamen are available, who have adequacy certifications in different level. 40000 of the total seamen number are officiers.

Between 1996 and 2009 years, the student number of maritime education and training foundations were increased dramatically. Althought it was necessary that the enhancement of student number of maritime foundations and the number of maritime educated lecturers had to be in the same level, this was not the case. The enhancement rate of the maritime educated lecturers remained under the enhancement rate of maritime schools [7]. In Turkey, there are currently 13 universities which have long-distance adequacy. These associations have the capacity of 858 decks and 469 ship machine students [8].

Turkish ship owners have 1530 ships which have native and foreign flags and these ships have capacities 100 GRT and over [9]. As the number is considered, it can be seen that the demand is high and the supply is low. Furthermore, Turkey export seamen in a less level in comparison with the other countries dealing with maritime.

OBSTACLES THAT TURKISH OFFICIERS WORK FOR VESSELS WITH MULTI NATIONALITIES

Education and Training

In Turkey, maritime education and training cannot be entirely implemented in terms of STCW standarts. The main reasons of that are the wrong state politics, lack of infrastructure, insufficient number of lecturers in comparison with number of student, insufficient support to lecturers etc., Turkish officiers who the necessary training is not sufficiently given according to STCW rules are unlikely to fulfill their tasks and adapt to foreign vessels.

English Level

If an officier who has insufficient English level works for a company abroad, he/she may face personel conflicts, lack of social relations with the other ship personnel and disputes. And also, when an order comes, he/she may have difficulty in understanding so it makes a communication problem. Due to the lack of education and training or insufficient English level, the students in our country dont prefer to work for an international companies.

Stores

As is known, each country has different cooking cultures and tastes. One of the most important problems that seamen in foreign companies may face is stores. Pork is a great example for this situation because it is banned in Islam religion. So, it is not prefered among Muslim countries. Morever, breakfast, lunch and dinner cultures are also different. That’s why, Turkish officiers have difficulty in these issues. This is one reason why Turkish officiers don’t prefer to work for international maritime companies.

Culture Differences

When Turkish seamen prefer to work for a foreign companies, they face culture shock since the crew’s culture on vessel are different. The fact that a person stays in a foreign setting causes stress and this case leads to mental and emotional troubles. Fast alteration makes physical and psychological needs uncertain and unpredictable Unfeeling, loneliness, anxiety, complex emotions and indifference can be seen in seamen [10].

Missing of Self-Confidence

Lack of self-confidence is one of the most significant problems for people who work for foreign companies or other sectors. Self-confidence can frequently seen in a known environment especially when a person stays with the known people. The reason of that is not only a person feels foreigner in an environment but also a person feels that he/she makes a mistake at any time and feels that the others show reaction against him/her. Removing this is on the hands of Turkish officiers. This can be easily solved once a Turkish officier stays in this environment. On the other hand, making the first step for Turkish officiers is a difficult process.

High Ego

As every body may have, seamen may also have ego. It is usually a problem for each person who says that "I know and do everything the best and there are no mistakes in my doings". This ego can reach to the top level when a seaman works in foreigner environment because he/she wants his/her doings to be appeared in the front. These behaviours causes problems in the setting and damages the relations with the other people and he/she remains alone on vessel.

CONLUSION

The most significant reason which obstruct to take task in foreign maritime companies for Turkish seamen and especially officiers who have long-distance licence is the English insufficiency. So, language education and training is an issue to take consideration. On the other hand, the sufficiency and number of lecturers in education and training associations is te other significant issue. In Turkey, this is the question that awaits answer: More seamen? (It is the current politics) or sufficient seamen with more qualified?

In Turkey, in order to improve the qualifications of the seamen and officiers in particular and in order for maritime education and training to reach the desired level:

- The number of the association giving maritime education and training (long-distance) should be reduced and it should not be allowed that the associations which cannot meet the STCW conventions take students,
- The number of maritime educated and trained lecturers per student should be increased,
- In order to improve the qualifications of maritime educated and trained lecturers, it should be allowed that they can work at sea apart from education and trainin periods,
- In order to ensure the qualified education and training, the number of students in maritime faculties should be reduced to convenient level,
- Education and training language should be in English at the associations giving maritime education and training and the abroad language education of lecturers should be supported in order to remove English insufficiency.
- Whole maritime faculties should be supported with equal standarts by not only Higher Education Board but also ministry and private sectors.
- Apprenticeship issue for seamen and especially long-distance officiers should be solved. For this, the opinions of maritime faculties should be taken and new strategies should be developed by ministry.
- The maritime educated and trained lecturers should be employed with rotations at the other faculties in order to ensure standart education and training.
- Whole faculties giving long-distance education and training should be converted to maritime faculties.
- The number of seamen equipping firms should be increased in order to ensure that the seamen can work for foreign maritime companies.
- So as to improve the qualifications of the seamen in maritime transportation, maritime business actors, education and training associations, ship owners, ship and port firms should be together and they should know the expectations from each other. The concept of qualified seamen is the fundamental issue not for only Turkey but also for all around the world. So, the solution recommendations should be not only national but also international.

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ASSESSMENT OF RECENTLY INTERNATIONAL RULES ON BALLAST WATER MANAGEMENT

Ersoy Kacmaz[1]

ABSTRACT

International Maritime Organization (IMO) has prepared Ballast Water Management Convention in order to avoid environmental problems with reducing aquatic nonindigenous species in 2004. Ballast management plan has been applied on ships that sails worldwide according to this convention. Main attitude on plan is an efficiency of 95 per cent volumetric exchange of Ballast Water on open seas before arriving ports.
Ballast Water Management (BWM) Convention rules new requirements and equipment with technological development about ballast water treatment incrementally between 2012 and 2016.
This study assesses and compares ballast exchanging system and ballast treatment system and their environmental effects. In addition to this applications and regulations in Turkey have been analyzed.

Keywords − *Ballast water, BWM convention, marine environment, maritime transport.*

INTRODUCTION

70-80 percent of all cargoes are carried by maritime transportation. During sailing, loading and discharging operations, vessels might cause pollution in the marine environment. Solid or liquid wastes arising from vessels might cause marine pollution.

Vessels take sea water to her ballast tanks to provide vessel’s stability at discharging ports. Vessels must discharge this water at next ports for cargo loading operations. This sea water that is taken and discharged is named ballast water and it’s operations are named ballast operations. Ballast water is essential for maintain adequate trim, propeller immersion and sufficient stability of ship to proceed safely on a voyage with ballast condition. Ballast water is usually between 30-45 percent of the carrier’s deadweight carrying capacity.

In general, worldwide cargo transfer is done between oceangoing ports. These ports and seas own different ecologic conditions. If vessels have been made ballast operations without any precautions at ports, they would have been carried nonindigenous species globally everywhere and this situation would have been appeared serious environmental problems.

The International Convention for the Control and Management of Ships’ Ballast Water and Sediments (BMW Convention) was adopted in February 2004 by the International Maritime Organization (IMO) in order to avoid environmental problems with reducing aquatic nonindigenous species. According to

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this convention, administrations have to take joint measures to ensure prevention, reduction or elimination of transportation of harmful marine organisms by appropriate management of ships' ballast water and sediments [2]. This convention will come into force (subject to ratification of the Convention) between 2009 and 2016, depending on the ballast water capacity and age of the ship [5]. Convention's requirements are provided by two methods. These methods are Ballast Water Exchanging Plan (BWM) and Ballast Water Treatment System (BWTS). Presently, Ballast Water Exchanging Plan (BWM) is applied on ships that sails worldwide according to this convention. Ballast Water Treatment System (BWTS) would have been obligated to apply after 2016.

In this study Ballast Water Management (BWM) Convention rules and requirements are investigated. Ballast exchanging system and ballast treatment system are compared and their environmental effects are dıscussed. Existing regional blast water management applications are evaluated.

BALLAST WATER MANAGEMENT REQUIREMENTS

According to BWM Convention's requirements, provided methods have to carry out by vessels. The phase-in of the two methods is shown in Fig. 1.

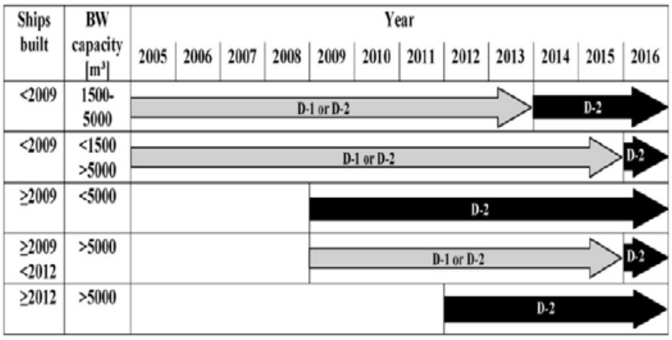

Fig. 1. Time Process of BWM Convention's [8].

Ballast Water Exchanging Plan

Ballast water Exchange plan is a procedures. Plan advices ballast water exchanging under safety and efficiency. This plan has been applicated till 2016 within International Convention for the Control and Management of Ships' Ballast Water and Sediments part D-1. Main operation topic is exchanging of ballast. Ballast water exchanges several norms that's written in BWMP accordance to convention. These norms are 200 meters depth and 200 nautical miles from the nearest shore. If weather is bad condition, vessels could make exchanging of ballast at 200 meters depth and 50 nautical miles from nearest shore [9].

Methods of ballast Exchange;

- Sequential
- Flow through
- Dilution

Sequential method is realized all ballast tanks emptying and refilling with regional waters completely and sequently. Stability of vessel is changeable and must be paid attention in this method. Flow through method is steadier than sequential method. This method realized ballasting in full ballast tanks at three times. Full tanks brim over an overflow during operation. Last method is dilution. While all ballast tanks are discharged, tanks fill on the top of tanks with regional ballast water [1].

Ballast Water Treatment System

International Convention for the Control and Management of Ships' Ballast Water and Sediments part D-2 ordered, vessels have to establish and conduct Ballast water treatment system until 2016. BWTS treats ballast water at port without exchanging. System works three types;

- Mechanical
- Physical
- Chemical

Mechanical methods treats ballast water with filtration, separation, hydro cyclone and carbonation technics. Physical methods are thermal, ultraviolet, ultrasound and electrolysis technics. And last is chemical methods what are oxidants, biocide, de-oxygenation and electronically generated cooper and silver technics [3].

Each treatment technology has different characteristics and features and differs from others by several Aspects. Understanding the differences and limitations between the treatment technologies used by the ballast water treatment systems available on the market could be the first step in starting to select ballast water treatment system for a ship, even if almost all the systems on the market make use of more than one technology to overcome possible technology limitations and to reach full compliance with the D-2 Standard on BWM Convention in 2004.

Some parameters are stood out selection of type for BWTS. They're price, convenience, safety, capacity, conversation, consumption etc. various results given for types as below:

- Filtration; Unsafe condition hasn't been observed. It's lethality for harmful marine organism at treatment operation. Reduction of sediments realized into the ballast. Working principle is Pressure drops and reduced flow rate.
- Cyclonic Separation; Unsafe condition hasn't been observed. It's lethality for harmful marine organism at treatment operation. Reduction of sediments realized into the ballast. Working principle is Pressure drops and reduced flow rate. System needs minimum maintenance.
- Coagulation/flocculation; There isn't any report for safety. Reduction of sediments realized into the ballast but it's not effective for harmful marine organism.
- Ultra Violet; Ultra Violet light exposure could be harmful. It's lethality for harmful marine organism at treatment operation. Efficiency is dependent on water quality. System needs high maintenance but Energy consumption is increased.
- Ozonation; this system isn't safe due to toxicity. It's lethality for harmful marine organism at treatment operation for 15 hours. Ballast water neutralization before discharge. It might be polluted air.
- Electrolytic/chlorination/electrolysis; this isn't very safely. System works chemical exposure and toxic gas is generated by electrolysis. Efficiency is dependent on water quality. System needs high maintenance but Energy consumption is increased.

COMPARE OF THE BWM PLAN AND BWTS

Marine and it's environment are being more polluted gradually depending on the volume of trading is increased. Regulations and practices about environment have been changed since decades because of the growing importance for environmental protection. Both of BWM Plan and BWTS are made to protect the marine and marine environment. BWTS has been performed on the previous applying BWM Plan. Ballast exchanging is considered, this operation doesn't harm to marine and there isn't nonindigenous species in regional water. The method of BWTS prevents to discharge harmful marine organism in regional water with technical equipment and systems. At the same time this method is easier and more useful. Furthermore, ballast operations take less time. However, install of BWTS is more costly. Steps of BWE Plan and BWTS are presented fig. 2 as follow.

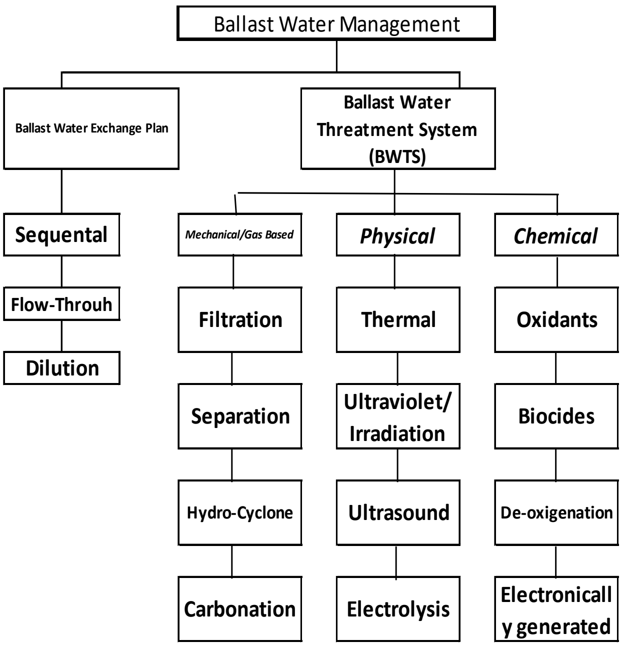

Fig. 2. Ballast Water Management System with Detailed BWM Exchanging and BWTS [7].

REGIONAL APPLICATIONS

National regulations differ significantly between countries about Ballast water management and applications. Related Convention (BWM Convention) adopted with consensus in 13th February 2004. The Convention will have entered into force 12 months after ratification by 30 States, representing 35 per cent of world merchant shipping tonnage. Currently 47 countries representing a combined tonnage of 34.56% of the world's merchant fleet have ratified the convention as of 18 January 2016.

In order for a country to manage the risk of species introductions through ballast water effectively, a supportive policy environment underpinned by scientific and technical baseline information is necessary. The National Ballast Water Management Strategy (NBWMS) is an integral part of the national regulatory framework, along with relevant policies, legislation and institutional arrangements as well as more specific programmes of work and action plans. It should translate national policies into effective and efficient ballast water management practices that are consistent with national as well as international obligations and legal requirements.

Many countries as well as local port authorities already have specific requirements regarding ballast water management for protection and maintenance of native ecosystems [4].

As Shown figure 3, while national strategies and rules are being existed, this framework has to follow.

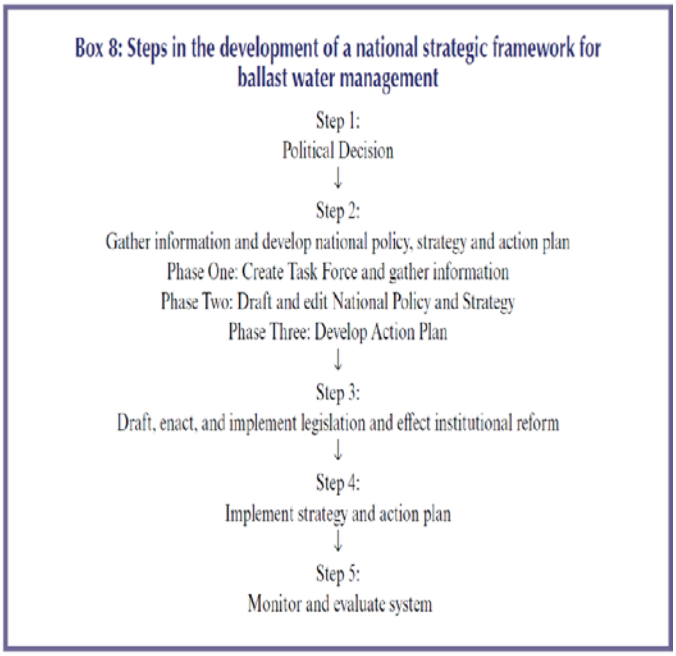

Fig. 3. Steps for National Strategies and Rules Existing [6].

Europe Maritime Safety Agency (EMSA) Maintains studies about BWM regulations and inspections. EMSA has organized workshop about it.

The Europe Countries involvement in ballast water management has been limited. The Commission has strongly recommended the ratification of the BWM Convention and has participated in the development of interim measures to reduce the risk of nonindigenous species being introduced through the discharge of ship's ballast water in Regional Seas a useful resource concerning alien species is to be found in the web-based portal for information on biological invasions in Europe Only in a few cases has it been possible to estimate the cost of the damage caused by nonindigenous species. Currently Europe Union Directives and emerging European policy have an associated impact on the treatment and discharge of Ballast Water. EMSA continue to work on completing the action points in Europe’s Ballast Water Action Programme [11].

In the U.S., two federal agencies regulate ballast water discharges: the United States Coast Guard and the Environmental Protection Agency (EPA). The National Invasive Species Act of 1996 (NISA), which amended the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, directed the Coast Guard to establish a ballast water management program for ships operating in U.S. waters. Pursuant to NISA, in 1998, the Coast Guard established a voluntary program in which ships were advised to exchange the ballast water in their ballast tanks with deep ocean water to reduce the likelihood that aquatic invasive species would be transferred from foreign ecosystems to the United States. In 2004, the Coast Guard issued regulations converting [12]. This voluntary program into a mandatory program.

The United States Coast Guard published a proposed rule to establish a federal treatment standard for ballast water discharges in 2009. Coast Guard adopted the IMO D-2 treatment standard with this rule. Several Maritime authority in the world noted that it would be impractical and unreasonable to require vessel owners and operators to install ballast water treatment systems, which are costly and complex engineering installations, in a given ship more than once. The Coast Guard published a final rule to establish a federal ballast water treatment standard for vessels operating in United States waters in March 2012. The final rule adopts as the federal ballast water discharge standard the International Convention for the Control and Management of Ships' Ballast Water and Sediments D-2 standard. Authority is working to decide to approve device for ballast water treatment system to using accordance to D-2 standard [12].

Turkey signed BWM Convention on 14th October 2014. Directorate General of Maritime and Inland Waters Regulation (DIDGM) maintains studies. Studies are being legislate, deciding procedures and inspections about BWM until BWM convention 2004 will come into force. DIDGM has been prepared national and international projects about ballast water management and inspection as follow;

- Project of Ballast Water Management (national, 2008)
- Risk Analyses of Ballast Water Software (national, 2011)
- GloBallast Project (international, continuing) [10].

CONCLUSION

Seas and oceans have been polluted from various sources. Ships are known one of the most important source. They pollute with garbage, oil, cargo waste, noxious liquid, sewage, exhaust gases. National and international authorities and organizations take measures to preventing pollution caused by vessel. However, there is a pollution at microorganism level from vessels via ballast water transfer from far water to regional water. Anybody doesn't see this pollution with the naked eye, but this pollution important for regional waters' live and habitat. IMO has published and issued various regulations and circulars about it. Last two decades, IMO has changed his attitude with developing technology.

World shipping industry is approaching new rules and obligations. They reveal additional costs, constructions on board and procedures. Appearing problems and process are needed building plans and selection of device for ballast treatment system depend on cost and productivity. .

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RISK ASSESSMENTS BEFORE COMMENCE OPERATION ON TANKER VESSELS

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ABSTRACT

Vessel are designed to transfer of cargo. Also, during the transfer of cargo, there are some operations. But, most of operations may include some dangerous situations. To eliminate and minimize of hazard situations, risk assessments are carring out. All risk assessments' goal is that minimize to dangerous and ensure a safety and security area around of working place before and during operations. There are main risk assestmenst for tanker vessels which is our subject in this topic. If we want to give example for risk assessment on tankers which are carring out; mooring/unmooring, hose connection/disconnection, pilot embarkation/disembarkation, loading/discharging, personel transfer, sts operatıons, sbm operatıons. Firstly for each operation all dangerous items is found, then numbered according to hazard degree (1 to 5.). After finding hazards, measurements is found and hazar degree was decreased. Goal in this subject is that all risk assessments on tanker operations will be explained one by one and how to be carried out these risk assessments items for safety and security.

Keywords – *Hazards, Operations, Risk Assesments, Safety, Tankers*

INTRODUCTION

Vessel are designed to transfer of cargo. Also, during the transfer of cargo, there are some operations. But, most of operations may include some dangerous situations. To eliminate and minimize of hazard situations, risk assessments are carring out. All risk assessments' goal is that minimize to dangerous and ensure a safety and security area around of working place before and during operations. There are main risk assestmenst for tanker vessels which is main subject in this topic. If a example want to be given for risk assessment on tankers which are carring out; mooring/unmooring, hose connection/disconnection, pilot embarkation/disembarkation, loading/discharging, personel transfer, sts operations, sbm operations. Firstly for each operation all dangerous items is found, then numbered according to hazard degree (1 to 5.). After finding hazards, measurements is found and hazar degree was decreased. According to research %80 of accidents was occured because of human error [1]. Examples for human error are as below:

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- -Ignore the some dangerous
- -Lack of information and ability
- -Lack of discipline
- -Negligence
- -No think for safety and security

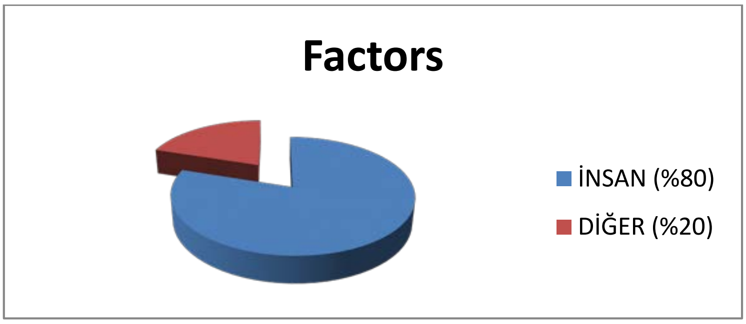

Figure 1. Factors On the Accidents in Tanker Vessels

To avoid all accidents, all risks have to been analysised before commence working. It is wanted crew to improve awareness during all operations and so all risk can be minimized and all working can be completed with safety. To minimize all risk, risk assessments are carried out. Risk assessments ensure to crew that they think dangerous things about working which will be comenced before operation. Risk assessment is a process with risk analysis and risk evaluation. Shortly, it means research about dangerous things what it will give reasons to human, business, environment, trade. So it was understood that there are make or no any prevention to do not live again same accident. Risk is occured result and possibility. (Risk= Result x Possibility [2]). Results of risks, risk assessments are carried out and all risk are minimized for safety operation.

RISK ASSESSMENT

Around of seas, there are a few kind of vessels. For example, they are dry bulk, tanker, passenger, yacht etc. Every vessel was made special operations in their vessel. In these vessel types, tankers are very dangerous vessel type. Because, tanker vessels' operations are included dangerous situations. They are carring chemical, crude oil, product. All Cargo includes some toxic, flammable gases. Besides, static electrification is other situation. During operations; explosion, fire, death, toxix gas poisoning situations have possibility percent. When the past time was researched about accident on tankers, all reasons was occured because of these subjects. But why? Whose irresponsibility? Company, human, device or technical error? Accidents was occured usually from human error. Reasons are explained. In front of accommadation on tankers writes always same sentence : 'Safety First'. But, how many are these sentences carried out. It should not be stay as sentence. these subject must be carried out always. Because life is our. If crew on tankers want to live safety and long, 'Safety First' must stay always in our mind. Therefore, risk assessment is used before all dangerous operations. What are dangerous operations? If hazardous is thought about a operation, this operation is hazardous operation. These are mooring/unmooring, crude oil washing, anchoring, pilot embarkation/disembarkation, sts operation etc. Before show tanker operation, explaining of short risk assessment stages are good think. Risk Assessment has some steps for good planning and to minimize. These are[3];

- Risk Analysis
- Risk Evaluation
- Risk Management
- Minimize the Risk

Risk Analysis

Analysis is a part of risk assessment. Here hazards are found. Then these hazards are defined and identified the likelihood. Because all hazards have different likelihood. And each hazard has different harm for places. What are these place? These are; People, Property, Environment, Business. There are classification for hazardous to four main topic. From 1 to 5. Because, a hazard can create minor dangerous for people but same hazard can create major dangerous for business. That's way classification are used. Besides, another classification for identifying likelihood from 1 to 5 are used. For example, a hazard can occur every week but another hazard can occur one ore more times in 5 year. In table.1 and table 2. which are as below these means are explained[4]:

Table 1. Hazard Categories

A. HAZARD TO PEOPLE	1. NONE
	2. NEGLİABLE (SİNGLE SLİGHT INJURY)
	3. MODERATE(SİNGLE MAJOR INJURY)
	4. MAJOR(SINGLE FATALITY)
	5. DİASTROUS(MORE THAN A FATALITY)
B. HAZARD TO PROPERTY	1. <4000 USD, NONE
	2. USD 4000<NEGLİABLE<USD 40 K
	3. USD 40 K < MODERATE< USD 400K
	4. USD 400K < MAJOR < USD 4 MİLLİON
	5. USD 4 MİLLİON < DİSASTROUS
C. HAZARD TO ENVIRONMENT	1. NONE
	2. NEGLİABLE, TİER 1 RESPONSE
	3. MODERATE TİER 2 SPİLLDECLARED
	4. MAJOR, TİER 2
	5. DİASTROUS, TİER 3
D. BUSINESS LOSS	1. NONE<4000 USD
	2. USD 4000<NEGLIABLE<USD 40 K
	3. USD 40 K < MODERATE< USD 400K
	4. USD 400K < MAJOR < USD 4 MİLLİON
	5. USD 4 MİLLİON < DİSASTROUS

Table 2. Identifying Likelihood

İDENTİFYİNG LİKELİHOOD
1. EXTREME UNLIKELY, ONE OR MORE TIMES EVERY THIRTY YEARS
2. ERY UNLIKELY, ONE OR MORE TIMES EVERY FIVE YEARS
3. POSSIBLE, ONE OR MORE TIMES A YEAR
4. REASONABLY PROBABLE, ONE OR MORE TIMES A MONTH
5. FREQUENT, ONE OR MORE TIMES A WEEK

Risk Evaluation

After numbered and identifying of hazards risk is evaluated. a risk assessment table as Ism Form. İs haven. All Classifications according to identifying is wroten. In below difference colour can be shown. These are: Green, Yellow, Red

The goal is that to catch green. Green's mean is that everthing is on safety condition. Yellow is between safety and dangerous. It means that before continue think for risk decrease. And red's meaning is that very dangerous. Crew can not start until the risk has bee reduced. In table 3. evaluation and matrix are explained.[5].

Table 3. Risk Evaluation and Matrix

RISK ANALYSIS					EVALUATION OF RISK						RISK RATING	ACTION TO BE TAKEN
SEVERİTY/ CONSEQUENCES												
PEOPLE	**PROPERTY**	**ENVIRONMENT**	**BUSINESS**	LİKELİHOOD	**CONSEQUENCE**	**LIKELIHOOD**					**1,2,3 4,5,6**	No additional controls are necessary, risk is as low as
						1	**2**	**3**	**4**	**5**	**8,9,10,12**	Efforts should be made to further reduce risk wherever possible before work start.
						2	**4**	**6**	**8**	**10**		
						3	**6**	**9**	**12**	**15**	**15,16, 20,25**	Work must be not started until the risk has been reduced.
						4	8	12	16	20		
						5	10	15	20	25		

Evaluation formul for each hazard is as below:

Evaluation= Highest Classification between People, Property, Environment, Business x Likelihood

Rısk Management

After process hazard and risk evaluation risk is found. Now, crew has to try to minimize all risks in safety condition. The best safety condition in risk assestment is green colour. To catch green crew is going to take and carry out all measurement [6]. Control measurements are found and written. Then again a classification and reduced likelihood are made. Finally crew are carry out same formul and when they reach the green, this job will has safety condition [7]. If that is explained an example, it is as below in Table 4.

Table 4. Risk Assessment Scheme

			Severity							Reduced Severity						
Activity	Hazards	Severity/ Consequences	People	Property	Environment	Business	Likelihood	Initial Risk	Control Measures	People	Property	Environment	Business	Reduced Likelihood	Final Risk Factor	Risk Acceptable Y/N?
Cow Operation	Leakage	Oil pollution might happen due to leakage on the tank washing lines	1	4	5	5	2	10	Cow line has been tested on 01.06.2016, no leakage has been observed	1	4	5	5	1	5	Y
Cow Operation	Leakage	Oil pollution might happen due to leakage on the tank washing lines	1	4	5	5	2	10	All scupper plugs will be close	1	1	2	1	1	2	Y

After all assessments, first team members, then chief officer, chief engineer and master have to sign these form.

RISK ASSESSMENTS ON TANKERS

As it was explained above, tanker vessels have hazardous operations. There are most important operations' risk assesstment details.

Moorıng/Unmoorıng

Tankers are usually use tail and wire rope. Wire rope mooring/unmooring is danger than syntetic rope operation. An example risk assessment for mooring/unmooring in Table 5. is as below:

Table 5. Risk Assessment for Mooring / Unmooring

			Severity							Reduced severity						
Activity	Hazards	Severity/ Consequences	People	Property	Environment	Business	Likelihood	Initial Risk	Control Measures	People	Property	Environment	Business	Reduced Likelihood	Final Risk Factor	Risk Acceptable Y/N?
Mooring / Unmooring	Snap-back of mooring lines	Major injury, multiple injuries, fatal injury or death	4	1	1	2	2	8	1. Mooring line snap-back zones are to be highlighted with painting. 2. Nobody is allowed to operate a windlass AND handle the rope at the same time. 3. PPE to be used as usual.	2	1	1	1	1	2	Y
Mooring / Unmooring	Bights or coils	Major injury, fatal injury or death	4	1	1	2	2	8	1. Crew members involved in mooring / unmooring operations are to be warned in safety toolbox meeting. 12. Nobody is to be allowed to operate a windlass AND handle the rope at the same time. 3. PPE to be used as usual.	2	1	1	1	1	2	Y
Mooring / Unmooring	Inexper. crew members involved in mooring & unmooring operations.	Major injury, fatal injury or death	4	1	1	2	3	12	1. Inexperienced crew members are not to be allowed to be at mooring stations.	3	1	1	1	2	6	Y
Mooring / Unmooring	Equipment / mooring line failure	Structural damage, injury / death, loss of equipment	4	3	2	3	2	8	1. All mooring equipment and lines are to be checked before operation. 2. Grease nipples are to be highligted to prevent them to be overlooked. 3. PMS schedule is to be implemented.	3	2	2	2	1	3	Y

Mooring / Unmooring	Wrong mooring practices	Structural damage, injury / death, loss of equipment	4	3	2	3	2	8	1. Following items are to be discussed in safety toolbox meeting: - The line on the windlass drum is being handled safely. The crewmember at the drum is keeping his hands clear of the turns and positioned so as not to become fouled in coils of rope; - The crewmember operating the windlass has a good line of sight of the rope and the man handling it; - Stoppers should not be left on lines after they have been secured; - Only chain stoppers will be used for wires.	3	2	2	2	1	3	Y

Hose Connectıon / Dısconnectıon

Hose connection/disconnection is the other hazardous operation on tankers. Because during these operation they can be static electrification. Besides toxic gas or leakage are other hazards. Table 6 as below is included all risks for this operation.

Table 6. Risk Assessment for Hose Connection / Disconnection

			Severity							Reduced Severity						
Activity	Hazards	Severity/ Consequences	People	Property	Environment	Business	Likelihood	Initial Risk	Control Measures	People	Property	Environment	Business	Reduced Likelihood	Final Risk Factor	Risk Acceptable Y/N?
Hose Connection / Disconnection	Leakage	Oil Pollution, Toxic Effect, Loss of Time, Loss of Job, Mental Stress	2	4	4	4	3	12	Blanks shall be opened over the dip trays or a barrel will be used if necessary. Manifold valves will be closed securely to prevent any oil from coming to manifold.	1	2	1	2	1	2	Y
Hose Connection / Disconnection	Pressure	Major Personal Injury, Fatal Injury, Toxic Effect, Loss of Time, Loss of Job, Mental Stress	3	2	2	4	2	8	During hose conn. / disconn., all bolts and nuts will be opened/closed slowly to avoid sudden pressure escape. Hose shall be securely and tightly firmed to the manifold. Personnel connecting the hose shall wear mask, googles to avoid pressure.	2	1	1	1	2	4	Y

Hose Connection / Disconnection	H2S, HC, Toxic Effect, Flam. Gases, Inert Gas	Asyph., Minor / Major Personal Injury, Single Fatality, Corrosive Injury, Fire / Explosion, Structural Damage, Loss of Job, Loss of Time, Mental Stress	5	5	4	4	2	10	Gas contamination shall be checked by a gas measurement device. All personnel in the manifold area shall use personal gas dedector and wear a mask or breathing apparatus if necessary.	2	1	1	2	1	2	Y
Hose Connection / Disconnection	Spark	Minor / Major Personal Injury, Single Fatality, Fire / Explosion, Structural Damage, Loss of Job, Loss of Time, Mental Stress	5	5	4	4	2	10	Non-spark brass hand tools shall be used to loose and tighten the bolts and nuts. No possiblity of spark should be tolerated by using metal tools or powered equipment.	2	1	1	1	1	2	Y
Operating Hose Crane	Crane Swinging, Moving / Falling Object	Minor / Major Personal Injury, Single Fatality, Loss of Job, Loss of Time, Mental Stress	4	2	2	4	3	12	Crane shall be operated by an experienced seaman. Only on person such as a designated officer or mooring master or shore hose-team shall control the operator to avoid a confusion. A heaving line should be attached to crane block and one person control this line to prevent the crane from swinging.Personnel shall always wear helmet, gloves, and safety shoes	2	1	1	2	2	4	Y

Cargo Operatıon

These operations are another hazardous operation. Because on manifold there are leakage, vibration, stat electrification. For measurement there should be risk assessment in Table 7. as below:

Table 7. Risk Assessment for Cargo Operation

			Severity							Reduced severity						
Activity	Hazards	Severity/ Consequences	People	Property	Environment	Business	Likelihood	Initial Risk	Control Measures	People	Property	Environment	Business	Reduced Likelihood	Final Risk Factor	Risk Acceptable Y/N?
Cargo operatıon	Oil pollution due to hose conn.	Oil Pollution, Toxic Effect, Loss of Job	1	4	4	4	2	8	Safety checks/cargo operatıon procedures	1	4	4	4	1	4	Y

Cargo operatıon	Poor comm.	Loss Communication, Loss of Equipment, Secondary Structural Damage	1	1	1	2	4	8	Pre-arrival radıo checks	1	1	1	1	1	1	Y
Cargo operation	Pressure	Oil Pollution, Toxic Effect, Loss of Job, Secondary Structural Damage	1	4	5	5	2	10	%95 and %98 alarms will be in operation. One of the duty a/b will be ready at manifold side incase of any emg.	1	4	5	5	1	5	Y

Pılot Embarkatıon/Dısembarkatıon

All pilots are using gangway, pilot ladder or combination ladder. And before pilot embarkation or disembarkation, all equipments are prepared. But prepared is not enough. After that until pilot come or leave, around of vessel until come bridge all necessary safety steps should be carried out. Falling or overboard to sea is main hazard for during embarkation/disembarkation operation of pilot. To reduce hazards, all embarkation equipments should be checked as per PMS. And until pilot comes to bridge, all necessary safety measurements should be taken.

Anchorıng / Heave Up Anchor

Anchoring operations include a few hazards. These are windlass problem, brake problem, vibration, broke the land cable, dregging. To reduce hazards, windlass should be checked as per PMS. Besides, anchoring area should be checked before anchoring. Communication system should be checked before operation. When these steps are carried out, hazards ara minimized.

Sts Moorıng / Unmoorıng

Sts operations is the most dangerous mooring operation. Because two vessel are mooring during underway and they are using wire ripe. There are swelly and current situation. So this maneouvre includes hazards. In table 8. this operation is explained with risks.

Table 8. Risk Assessment for Sts Mooring / Unmooring

			Severity							Reduced Severity						
Activity	Hazards	Severity/ Consequences	People	Property	Environment	Business	Likelihood	Initial Risk	Control Measures	People	Property	Environment	Business	Reduced Likelihood	Final Risk Factor	Risk Acceptable Y/N?
STS Mooring / Unmooring	Breaking of the Lines	Major Injury, Single Fatality, Loss of control of the vessel, Collision, Loss of Time, Loss of Job, Mental Stress, Damage to Equipment, Loss of Equipment	4	3	2	4	4	16	All lines shall be heaved up carefully and easily. Mooring Masters' instructions shall always be followed unless the Captain decides that instructions lead to an unsafe operation. Lines must be heaved up or down regarding the other vessel's	1	2	1	2	2	4	Y

									position. Officers and windlass operator will look after for the other when heaving up the lines.							
STS Mooring / Unmooring	Deck Mach. and Windlass Malfunc.	Loss of control of the vessel, Collision, Loss of Time, Loss of Job, Mental Stress, Damage to Equipment, Loss of Equipment	2	3	3	3	3	9	All windlasses and other deck machinery shall be checked regulary and before operationt. Utmost attention shall be paid when using these machinery for the safe operation. If the windlasses is cooled by sea water, it will be run before start of the mooring to prevent any rapid temperature increase.	1	1	1	2	1	2	Y
STS Mooring / Unmooring	Lack of Comm.	Loss of Comm., Loss of Equipment, Secondary Structural Damage, Loss of Job, Loss of Time, Mental Stress	2	3	2	3	4	12	A satisfactory communication will be established between all gangs. All UHFs are to be fully charged before operation. Spare batteries should be carried if possible. All gangs should try to speak and report briefly and clearly.	1	1	1	2	2	4	Y
STS Mooring / Unmooring	Strong Wind	Secondary Structural Damage, Damage to Equipment, Loss of Time, Loss of Job, Mental Stress	1	3	1	3	4	12	Wind shall always be monitored. If any rapid and strong increase in the wind is observed, Chief Officer, Master and Mooring Master should be informed. And if necessary, quick response shall be taken and unmooring sequence should be considered.	1	2	1	1	1	2	Y
STS Mooring / Unmooring	Strong Current, Adverse Sea Conditions	Grounding, Collision, Loss of Time, Primary Structural Damage, Secondary Structural Damage, Loss of Job, Mental Stress	3	3	1	4	4	16	An experienced able seaman shall attend the wheel. And if necessary, tug assist shall be established before the commence of mooring.	1	1	1	1	1	1	Y
Fendering / Transfer of the STS Equipment	Breaking of the Fender Lines or Messenger Lines, Excessive Swing of the Crane	Minor/Major Injury, Single Fatality, Damage to Equipment, Loss of Time, Loss of Equipment,	4	2	1	4	2	8	Fender and messenger lines shall be slowly winded up according to the Mooring Master's inctructions. During heaving up, all crew shall be keep clear from the lines in	2	1	1	1	1	2	Y

		Loss of Job, Secondary Structural Damage							case of its breaking and snapping back. When transferring the STS equipment, hose crane shall be operated by an experienced seaman. Everybody shall keep clear of under the equipment.. In order to reduce the swinging, crane block shall be controlled with messenger lines from deck.							

Deck Seal Water Inspectıon

Tankers have Deck Seal. And it is inspected in periodic times as per PMS. And it includes some hazards in Table 9. as below:

Table 9. Risk Assessment for Deck Seal Water

			Severity							Reduced Severity						
Activity	Hazards	Severity/ Consequences	People	Property	Environment	Business	Likelihood	Initial Risk	Control Measures	People	Property	Environment	Business	Reduced Likelihood	Final Risk Factor	Risk Acceptable Y/N?
Deck seal inspection	Leak oxygen	Confined space may not include enough oxygen concentartıon	4	1	1	4	2	8	Oxygen content will be measured at an interval of 5mın.	4	1	1	4	1	4	Y
Deck seal inspection	Toxic gas	Confined space may include toxic gases	4	1	1	4	2	8	Gas content will be measured at an interval of 5min.	4	1	1	4	1	4	Y
Deck seal inspection	Injury	Enterance crew should be injured	4	1	1	4	2	8	Entrance crw will use complete ppe including self gas dedector.	2	1	1	2	2	4	Y
Deck seal inspection	Inert gas	Inert gas should return from inert gas lıne	4	1	1	4	2	8	Inert gas isolation v/v closed	4	1	1	4	1	4	Y

Entry to Enclosed Space

Enclosed space is maybe the most dangerous operation for crew and officer. Because working area is enclosed space and it may include toxic gas. So, if there are any measurement, there can be death or major situation. Do not live these situations, a good risk assessment have to prepare and use. In table 10. this operation is explained with risks.

Table 10. Risk Assessment for Entry to Enclosed Space

			Severity							Reduced Severity						
Activity	Hazards	Severity/ Consequences	People	Property	Environment	Business	Likelihood	Initial Risk	Control Measures	People	Property	Environment	Business	Reduced Likelihood	Final Risk Factor	Risk Acceptable Y/N?
Entering Enclosed Space	Lack of Vent.	Asphyxiation, Major Injury, Single or Multiple Fatality, Loss of Time, Loss of Job, Mental Stress	4	3	1	4	3	12	Enclosed space which is intended to enter shall be ventilated. In order to do that, manholes and other vents (if fitted) shall be opened at a sufficient time before entry. If necessary, portable fans shall be used to quicken time and support the ventilation.	2	1	1	1	2	4	Y
Entering Enclosed Space	Lack of Oxygen, HC, H2S, CO	Asphyxiation, Major Personal Injury, Single of Multiple Fatality, Mental Stress, Loss of Time, Loss of Job	4	3	1	4	3	12	Space atmosphere shall be checked before entry and all parameters to be logged accordingly. No entrance shall be allowed if the parameters are not as required. Entering personnel shall carry personal gas dedector with them at all time. And if any suspect decrease occurs, entrants shall evacute the space immediately.	1	1	1	1	2	2	Y
Entering Enclosed Space	Flamm. Gases	Ignition, Fire/Explosion, Major Personal Injury, Fatal Injury, Primary Structural Damage	5	5	3	5	3	15	Space atmosphere shall be checked before entry and all parameters to be logged accordingly. Ensured that gas contamination is zero.	3	2	2	2	1	3	Y
Entering Enclosed Space	Poor Illum.	Damage to Equipment, Major Personal Injury, Fatal Injury, Mental Stress, Loss of Time, Loss of Job, Mental Stress	3	2	1	3	4	12	Space entry and space itself should be well-illuminated. Fix lighting should be established and air turbo lights shall be used. Fully charged and approved type torches shall be ready at the entrance and entrants shall also carry such torches.	2	1	1	1	2	4	Y
Entering Enclosed Space	Possible Fall or Slip	Minor or Major Injury, Single Fatality, Loss of Time, Loss of Job, Mental Stress	3	1	1	3	3	9	All entrants shall don the relevant P.P.Es and all equipment shall be checked and ensured in good order. A lifeline and a safety harness should be ready and used if necessary. BA sets, resusciator, first aid kit, strecher shall be ready at the entrance in case of an injury.	2	1	1	2	2	4	Y

Entering Enclosed Space	Lack of Comm.	Minor or Major Injury, Single Fatality, Loss of Time, Loss of Job, Mental Stress, Damage to Equipment, Loss of Equipment	3	2	1	3	3	9	A responsible crewmember shall be in constant attendance outside the enclosed space, in the immediate vicinity of the entrance and in direct contact with the responsible officer. OOW shall be advised of the planned entry. Asystem of communication between the person at the entrance and those entering the space shall be agreed and tested and emergency signal agreed. All UHF radios shall be fully charged.	2	1	1	2	2	4	Y

CONCLUSION

Actually, Risk is everywhere not only vessels. For example these are at home, on Street, in a cafe. But here risks in tanker vessels were explained and shown. People can see that they are more hazardous operations on tankers and hazards during the hazardous operations. For this, these risk assessments have to be used. Because, it should not be stay on paper. All forms is being prepared to be carried out. When these measurements are carried out, it is shown that all risk is minimized and crew works on safety condition and they feels these safety. Finally, it is possible to say that ‘Safety First’ stays always in everybodys’ life and mind. And do not forget, every job can be completed in a day or in a week, somehow finally it will be completed. But, if a part of body or life are lost, it will never come or complete. That’s way, firstly is always your, secondly is operation and job. [8]

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ANALYSIS OF RISKS AT THE QUAYSIDE OPERATIONS IN PORTS

Ersoy Kacmaz[1], E. Gül Emecen Kara[2]

ABSTRACT

Ports have a significant place in the transportation system. There are different types of ports such as bulk, container and Ro-Ro as per cargo types they handled. Operations at ports are usually specialized as per cargo types but generally are divided into landside and quayside operations. Quayside operations covers the berthing and mooring operations, loading/unloading cargo to/from ships and shifting operations and cargo transport operations in there. These operations pose various risks depending on factors such as the nature of operations (cargo and handling equipment types), operation rate, job multiplicity of machines, machines and people working in the same environment. This study aims to analysis the operational risks occurring during quayside operations according to terminal types.

Keywords – Quayside Operation, Operational Risk, Safety, Terminal, Port

INTRODUCTION

Maritime shipping plays an important role in the cargo transportation process. It carries approximately 90 % of all international cargo. Ports have a significant place in the maritime shipping. Ports are defined as a functional integrity that provides cargo transportation between sea and land modes. Various handling and transport operations are carried out in Ports. These operations differ from each other according to types of handling cargo and served ship. They impose various risks depending on the characteristics of handling equipment and operations. Workers and many moving handling machines work together in the terminal area and many types operations are carried out simultaneously in this area. There is always the risk of work-related accidents in ports [1].

According to Health and Safety Execute (HSE), "*Operations at seaports take place throughout the day and night and in all types of weather and there are often pressures to load or unload a ship's cargo quickly to free up a wharf. At the same time external truck drivers want to receive or discharge of their cargo as quickly as possible and get back on the road. These factors make it a potentially high-risk industry to work in*" [2]. The operational accidents cause harm to the marine environment, life and property. An important part of the operational risks encountered in the ports happens throughout the quayside operations.

In this study, according to terminal types, the operational risks that may occur during quayside operations and their reasons are analyzed. Thus, the importance of this issue was emphasized.

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TERMINAL OPERATIONS AND HANDLING EQUIPMENT

Operations carried out at the terminals can be grouped into landside and quayside operations. These operations and used handling equipment differ from each other depending on types of handling cargo and served ship, that is, terminal types. Therefore, operational risks also vary depending on terminal types [3]. According to terminal types, handling equipment and operations at the quayside are summarized in the following.

Container Terminals

The loading, unloading and shifting operations of ships are performed by Mobil Crane (MHC) or Gantry Crane (SSC – ship to shore crane). SSC is fixed quay crane that moves on a particular rail and it is designed specifically for container handling. MHC moves on wheels and it may go to any place on the quay. It rotates about its axis. During the unloading operations, these quay cranes unload containers from the ship to a transport vehicle. Then, this vehicle delivers the inbound container to a yard crane. For the loading operation, the process is carried out in the opposite direction. Transport vehicles are used to transport containers between container yard and other locations inside of container terminal. Some of these vehicles are Trailer, Multi Trailers, Yard Trucks (YTT) and Straddle Carriers (SC) [1,4]. View of a container terminal is shown in Figure 1.

Figure 1. View of a Container Terminal [5]

Bulk Terminals

Bulk terminals are divided into two types; dry bulk terminals and liquid bulk terminals. Dry cargoes in bulk such as coal, iron ore, cereals are handled at the dry bulk terminals. The loading and discharging of these cargoes are carried out by grabs, conveyors and stacker. There are two types of grabs. These are mechanical grabs and hydraulic grabs [3]. There are three types of conveyors, namely screw conveyor, belt conveyor and pneumatic conveyor. In addition to these terminal handling equipment, there are own crane or lifting equipment with grabs of same bulk carriers [3]. A grab on discharge operation and a conveyor on loading operation are shown at bulk terminal in Figure 2.

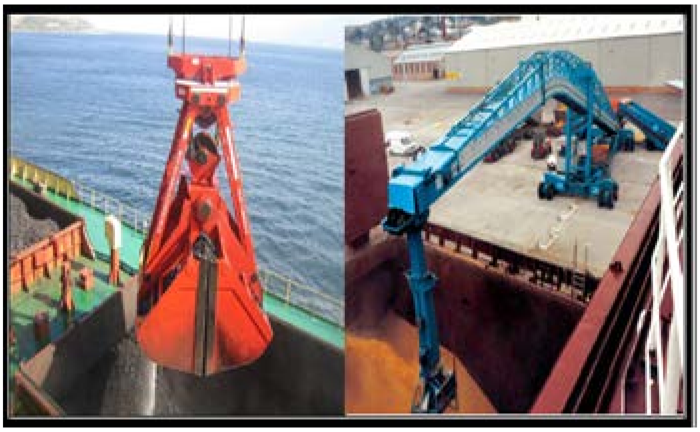

Figure 2. Grab and Conveyor on Operation at Bulk Terminal [6, 7]

Loading and discharging operations of liquid cargoes in bulk such as petroleum products, oil, and chemicals are carried out at the liquid bulk terminals. These operations are realized by cargo pipelines. Tanker ships have cargo pumps for discharging operations, however shore pumps are required for loading operations. There are different types of these pumps such as screw type with electric, hydraulic or steam power [5].

RO-RO Terminals

Ro-Ro (Roll-on/Roll-off) ships, which they carry wheeled cargo, are served at the Ro-Ro Terminal. Cars, trucks, trailers are handled at the Ro-Ro terminals. Vessel ramps and Ro-Ro bridges are used during loading and unloading operations. Cars and trucks are driven on and off the ship their wheels. However, sometimes trailers load and discharge without truck. They are loaded and discharged with terminals' trucks. These trucks are special and named tug master. Vessels' elevators are used on board at operations to connecting between her decks accordance to vessels' design. A Ro-Ro terminal is shown in Figure 3.

Figure 3. A Ro-Ro Terminal [8]

THE RISKS AT THE QUAYSIDE OPERATIONS

A lot of operations such as berthing and mooring, cargo operations, shifting and cargo transport are carried out at the quayside. The operational risks in the quayside were summarized by divided into groups of berthing and mooring operations, and loading and unloading operations according to terminal types.

Berthing and mooring operations

The Risks encountered during the berthing and mooring operations are the same with each other in the all terminals [3]. Operational risks and reasons are summarized in Table 1.

During berthing operation, ship may contact to berth or quay crane or other vessels waiting for operation. This incident arises from a failure of maneuvering generally and may cause harm to crewmen, the marine environment, berth structures, quay crane and ships.

Table 1. Operational Risks at the mooring/berthing operations.

OPERATIONAL RISKS	REASONS
• Contact • Grounding • Work Accident (on deck or on berth)	• Failure of Maneuvering • Technical problems on Ship • Ropes Problems • Extreme Weather Condition

Personal injuries and loses which may occur during these operations are defined as Work Accident. Work accident are divided into two types, namely, on deck and on berth. There is potentially work accident risk on the ship. Therefore, according to falling risk, getting on and off board the vessels must be done by using a ship boarding ladder, entry-exit to the ship must not be done from the ship railing and over the pulpits absolutely. Personnel who are boarding on the vessel must wear shoes whose soles are not slippery and must be careful against slipping and falling by considering that there may be slippery materials like ice and oil, etc. on the vessel ground. There must be sufficient illumination provided on the vessel [1].

Stretching or breaking of ship line may cause to risks of contact and Work Accident. This event is very dangerous for working personnel in this area. On the other hand, some technical problems related to line such as line entanglement of propeller cause dangers. There are recorded many injuries and losses of life due to line problems.

Loading and Unloading Operations

Operational risks encountered during the loading and unloading operations and reasons are summarized in Table 2 according to terminal types. There are the risk of Work accident on deck or on berth for all terminals.

Table 2. Operational Risks at the loading/unloading operations according to terminal types.

	OPERATIONAL RISKS	REASONS
DRY BULK TERMİNAL	• Cargo Shifts • Fire • Listing • Contact to Berth • Capsizing	• Failure of Stevedore • Failure of Technical on Ship • Failure of Loading and Unloading • Extreme Weather Condition • Rope Problems
CONTAINER TERMINAL	• Falling Container • Listing • Contact to SSC	• Failure of Handling equipment • Extreme Weather Condition • Failure of Lashing • Ropes Problems • Failure of Terminal Transport Vehicles • Failure of Stevedore
RO-RO TERMİNAL	• Falling Car to Sea • Fire • Falling of Ramp	• Failure of Ramp • Extreme Weather Condition
LIQUID BULK TERMINAL	• Fire • Exposure • Fuel Leakage	• Technical problems on Ship • Failure of Pipeline • Failure of Personnel

A failure of loading may cause to risk of cargo shift at the dry bulk terminals. A failure of handling equipment and hatches may create work accidents risk. Hence, precautions and good planning are important on dry bulk cargo operations on terminals and boards.

There are risks of explosion of hazard chemicals, fire and leakage during operations at the liquid bulk terminals.

Chemicals are hazardous for environment and human health due to chemical composition. Chemical cargoes operations must be carried out under control strictly. At the same time, because a lot of chemical cargoes have low flash point, they cause fire and explosion. If operations aren't performed under control, risks such as fire and explosion arise on boards and terminals [1].

There are risks of falling, slipping and jamming of containers or hitting to some place during loading and unloading operations due to a failure of handling equipment and stevedore at the container terminal. Failure of lashing may cause to slipping and falling of the containers to the sea. During operation, there are risk of Work Accidents on berth or deck. Quay cranes or a moving container or terminal transport vehicles may cause to dangers for workers in these area. During lashing operations, workers may fall from height. Terminal transport vehicles may crate risks such as falling to sea during operations.

Failures of Ro-Ro bridges or vessel ramps, reversing vehicles on Ro-Ro decks may cause to dangers at the RO-RO terminals. There are risks of falling car to sea and fire. Good planning is important as

all other terminals' operations. There is mobility on Ro-Ro terminals. Mobility is realized different departments as crew, staff and drivers. They have different tasks on same area.
Weather conditions effect operations and cause to dangers. Especially strong winds crate an important risk.

CONCLUSION

Ports are complex systems where different handling operations are carried out and various handling equipment and people work in the same field. The operational risks at the quayside occur depending on reasons such as the cargo type, the ship type, characteristics of the used equipment and the quay, competency of workers, lack of security and rules, environmental conditions.
The risks at the mooring and berthing operations occur depending on a failure of maneuvering and mooring rope problems in general.
The risks at the loading and unloading operations occur depending on a failure of handling at the container terminal and dry bulk terminal in general. Similarly, the risks at the loading and unloading operations of liquid bulk occur depending on failure of handling due to cargo lines and pumps. Accidents cause pollution, fire and explosions there. Hence, liquid bulk terminals have higher risks than other terminals.

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A PARAMETRIC STUDY ABOUT THE EFFECTS OF WAVES ON INTACT AND DAMAGED STABILITY

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ABSTRACT

As it is known, commercial ships can come across different sea conditions with regard to their working areas. Therefore they have to survive for all sea conditions and also one of the most important parameter is conformity of the rules which are determined by the international committees. In this study, the intact stability analyses of a commercial ship which is conceptually designed have been carried out according to IMO and also damaged stability analyses have been done. In addition, effects of waves on stability have been investigated parametrically. The parameters are the wave length, wave height and the location of the wave crest. It is aimed to determine which parameter is more important for survivability under different conditions.

Keywords – Damaged stability, stability, wave height, wave length

INTRODUCTION

Survivability is the most important feature for ships. All ship types can run into different sea conditions in their trial life. Therefore, they have to survive when they come across extraordinary circumstances. In order to guarantee their stability requirements, international committees have regulated rules for intact and damaged conditions. Every commercial ship has to satisfy these rules.

Up to now, there are many studies about intact and damaged stability of the vessels. Mantari et al [1] have studied about fishing vessels' intact stability in accordance with IS CODE [2]. They have investigated behavior of the vessels under the action of beam waves, fishing gear pull and winds. Francescutto [3] have made a study on the intact stability of ships from stone age to second generation intact stability criteria and also future developments. A study about naval ships intact and damaged stability in waves have been done by Kahramanoglu [4]. It also included comparison between different navy rules. Another study has been performed by Belenky et al [5] about second generation intact stability criteria. This work also contained effects of wave crest or through which are on the amidships. Parametric roll motion of a ship which come across a longitudinal wave has been put into practice by Taylan et al [6]. Effect of different directional waves has been investigated by Begovic et al [7]. The researchers have used different scale of models and compared the results with each other.

In this study, a parametric implementation has been performed. Intact and damaged stability analyses of a conceptual ship have been executed and also the effect of waves has been observed parametrically.

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The wave length, wave height and location of wave crest have been chosen as parameters and effect of these parameters have been examined for intact and damaged stability.

INTERNATIONAL RULES

International Maritime Organization (IMO) has proposed IS (Intact Stability) CODE [2] for various ship types. IS CODE includes some mandatory criteria which are related to GM (metacentric height), righting lever (GZ), etc. The mandatory criteria for ships are shown in Table 1.

Table 1. Intact Stability Criteria [2]

Criteria	Minimum Value
Area Under GZ curve(0˚-30˚)	3.1513 m-deg
Area Under GZ curve(0˚-40˚)	5.1566 m-deg
Area Under GZ curve(30˚-40˚)	1.7189 m-deg
Maximum GZ (at 30˚ or greater)	0.2 m
Angle of maximum GZ	25˚
GM initial	0.15 m

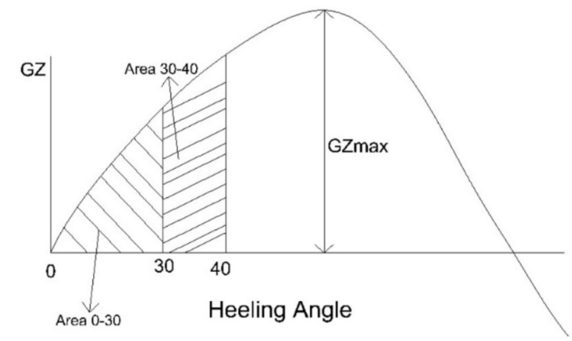

Figure 1. The areas and curves

Ships which are larger than 24 meters must meet the criteria in Table 1. Apart from these, there are extra design criteria including severe wind and liquid tanks. The criteria are mainly based on the heeling arm and righting arm which are shown in Figure 2.

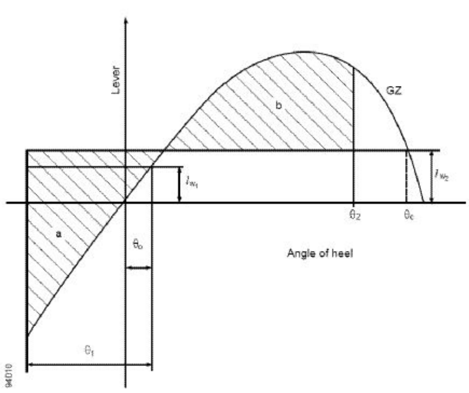

Figure 2. The areas and curves for other criteria [2]

The polynomial curve given in Figure 2 represents the righting lever (GZ) while the linear curve is the heeling lever. Figure 2 shows also the areas a and b which are related with the stability criteria mentioned above. Linear curve which is for heeling arm is dependent on ship displacement, center of gravity (CG), non-dimensional parameters which are constant and other variables related with the lateral projection area. Change in the lateral projection area related with the wave condition can be neglected for calculation of the heeling arm. For this reason, the heeling arm is considered as a constant linear curve in both intact and damaged stability cases. Therefore, this study is focused on the behavior of the righting lever (GZ) under various wave conditions.

SPECIFICATION OF THE SHIP

In this study, an LNG vessel has been used for stability observation. This vessel has been designed by Tasdemir [8] in a conceptual manner. The main particulars of the ship are shown in Table 3.

Table 2. Main particulars of the ship

LWL	111.840 m
LBP	107.679 m
BWL	19.416 m
T	6.478 m
Cb	0.684

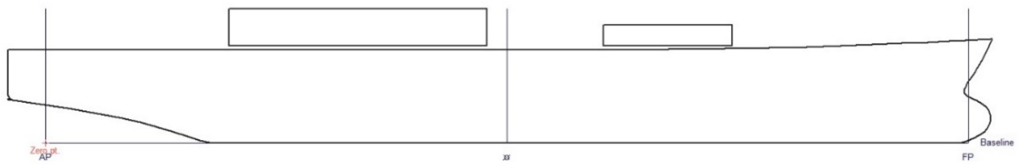

Figure 3. The profile view of the ship [8]

PARAMETRIC PROCEDURE

Intact and damaged stability analyses have been done in calm water and in waves. Since the main aim is the observation of behavior of righting lever, two damage cases have been investigated by employing the related criteria for both calm water and wave conditions.

In order to investigate the effect of wave on stability, three different parameters are chosen. While one parameter is being observed, the other two parameters are set out constant. Initially, the wave length is selected as LBP (length between perpendiculars) and location wave through is on amidships. Wave height is selected as 6.299 in accordance with formula below [9]:

$$Height_{wave} = 0.607 * Length_{wave}^{0.5} \tag{1}$$

For example, if the changing parameter is location of wave crest, the wave length and the wave height are considered as 107.6 m and 6.299 m, respectively. Wave crest location is considered as moving from fore to aft. In Figure 4, the varying wave parameters are defined.

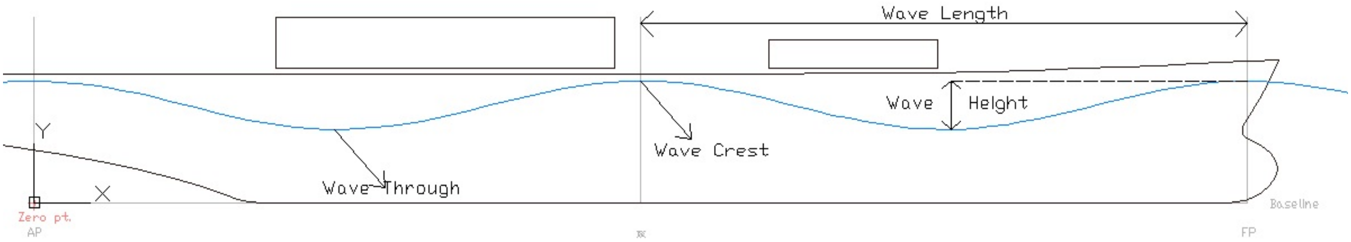

Figure 4. Varying parameters

Five different wave lengths are observed ranging between 0.5 and 1.5 times of L_{BP} while the wave heights are between 0.5 and 1.5 times of initial wave height with 0.25 interval.

RESULTS

Analyses have been carried out for both intact and damaged conditions for all three parameters. In all conditions, it is considered that the vessel is operating in head wave condition in addition to calm water.

Intact Stability Analyses

As explained before, intact stability analyses have been made for different wave crest locations, wave heights and wave lengths. Location of wave crest is moving from fore to aft and the interval of the move is selected 0.1 L. The change in GZ is given in Figure 5. The results are given for three wave crest location for simplicity.

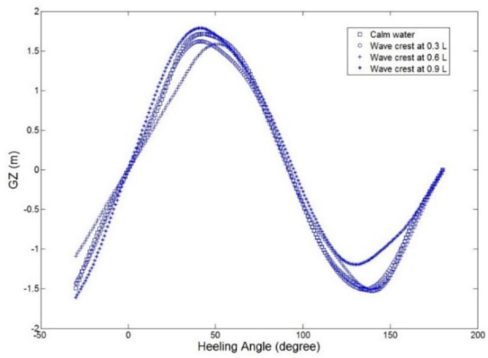

Figure 5. Effect of wave crest location on GZ curve

It is obvious that the righting lever (GZ) changes with the location of wave crest while the wave length and wave heights are selected as initial values. In Table 3, effect of the location of wave crest is demonstrated in accordance with IS CODE [2] requirements.

Table 3. Results of wave crest location for intact stability case

Location of Wave Crest	Calm Water	0 L	0.1 L	0.2 L	0.3 L	0.4 L	0.5 L	0.6 L	0.7 L	0.8 L	0.9 L	1 L	Min. Values
Area (0°-30°) m-deg	21.42	26.91	25.85	23.73	22.42	20.54	17.14	15.10	16.33	21.13	25.37	26.91	3.1513
Area (0°-40°) m-deg	38.13	44.55	43.05	40.46	38.36	34.41	28.70	25.91	29.25	37.09	43.01	44.55	5.1566
Area (30°-40°) m-deg	16.71	17.64	17.20	16.73	15.94	13.87	11.56	10.81	12.93	15.96	17.63	17.64	1.7189
Maximum GZ at > 30° (m)	1.76	1.83	1.79	1.75	1.67	1.51	1.42	1.44	1.61	1.77	1.85	1.83	0.2
Angle of maximum GZ (°)	41.8	40.9	40.9	40.9	41.8	47.3	51.8	52.7	50.9	46.4	41.8	40.9	25
GM inital (m)	2.49	3.46	3.32	2.94	2.66	2.61	2.33	1.97	1.95	2.46	3.18	3.46	0.15

Table 3 shows that the requirements are satisfied for the current load case. Also it is certain that when location of wave crest is near to the fore or aft of the ship, it has positive effect on GM initial, areas below the GZ-Φ curve and maximum GZ value. Thus, it can be stated that the wave crest on amidships is more serious. Because the righting lever, areas and metacentric height reach the minimum value.

In Figure 6, effect of wave length is shown via two phase offsets. At this point, the definition of phase offset has to be explained. The change in the wave crest location causes a delay in the starting point of the wave. This wave length-dependent delay is defined as the phase offset which differs from 0 to 1. For instance, zero phase offset means the wave crest is on the fore peak of the ship and 0.5 phase offset is that the wave crest is on the amidships while the wave length is equal to the ship length.

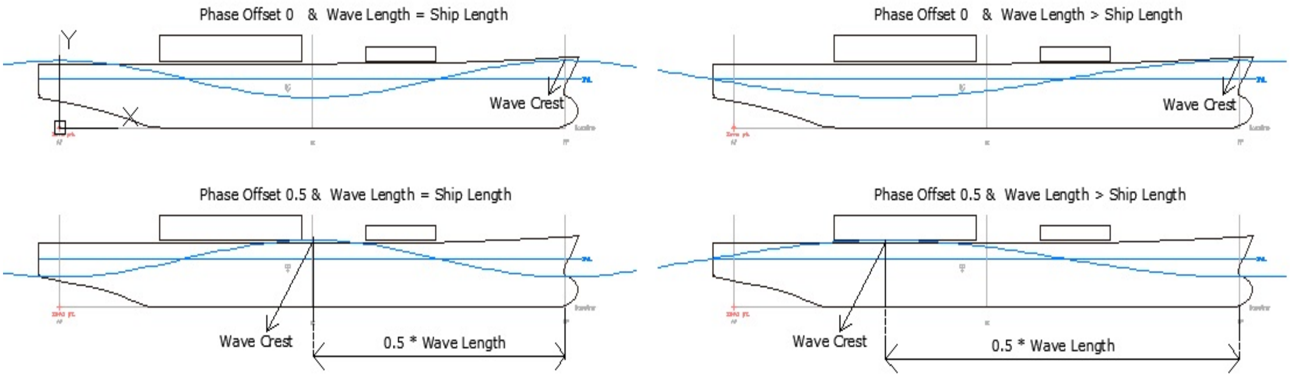

Figure 6. Phase Offset for Different Wave Lengths

In Table 4, the results depending the change in wave length are gained for two phase offsets representing the change in wave crest location. Here, the wave height is considered as the initial value. In the case of zero phase offset, area below GZ-Φ curve and initial GM gets its maximum while the wave length is equal to the ship length. When the phase offset is 0.5, if the wave length is equal to the ship length, the righting lever (GZ) reaches its minimum which makes the current case the most critical one.

Table 4. Results of wave length for intact stability case

		Phase offset 0					Phase offset 0.5				
Wave length	Calm Water	0.5 L	0.75 L	1 L	1.25 L	1.5 L	0.5 L	0.75 L	1 L	1.25 L	1.5 L
Area (0°-30°) m-deg	21.31	22.65	21.55	26.91	25.40	23.74	19.83	22.11	17.14	16.26	17.84
Area (0°-40°) m-deg	37.61	37.74	36.61	44.55	43.31	41.58	33.21	36.75	28.70	28.18	31.71
Area (30°-40°) m-deg	16.31	15.09	15.06	17.64	17.90	17.84	13.39	14.63	11.56	11.91	13.87
Maximum GZ at > 30° (m)	1.71	1.64	1.71	1.83	1.86	1.85	1.51	1.53	1.42	1.51	1.63
Angle of maximum GZ (°)	42.7	45.5	48.2	40.9	40	40	48.2	41.8	51.8	52.7	50
GM inital (m)	2.46	2.947	2.708	3.461	3.08	2.722	2.609	2.85	2.333	1.954	2.085

In Table 5, effect of wave height on intact stability is demonstrated. In this case, wave length is considered as initial value of 107.6 m. If wave height increases, stability behavior (area, GZ, GM) get worse regardless of wave crest location or phase offset.

Table 5. Results of wave height for intact stability case

		Phase offset 0					Phase offset 0.5				
Wave Height	Calm Water	0.5 h	0.75 h	1 h	1.25 h	1.5 h	0.5 h	0.75 h	1 h	1.25 h	1.5 h
Area (0°-30°) m-deg	21.31	24.55	26.00	26.91	26.87	25.99	19.21	18.22	17.14	15.90	14.49
Area (0°-40°) m-deg	37.61	42.71	44.12	44.55	43.70	41.83	33.20	30.92	28.70	26.45	24.15
Area (30°-40°) m-deg	16.31	18.17	18.12	17.64	16.83	15.84	13.99	12.70	11.56	10.55	9.65
Maximum GZ at > 30° (m)	1.71	1.88	1.88	1.83	1.75	1.66	1.60	1.51	1.42	1.30	1.17
Angle of maximum GZ (°)	42.7	40	40	40.9	42.7	43.6	50	50.9	51.8	51.8	51.8
GM inital (m)	2.46	2.804	3.088	3.461	3.742	3.735	2.469	2.449	2.333	2.23	2.27

Damaged Stability Analyses

Damaged stability analyses have been carried out for two damage cases. Although there are so many damage scenarios, two of them are selected within the scope of this work. Lost buoyancy method is employed to calculate stability values in both scenarios.

Figure 7. Damage case 1

Longitudinal extents of damage zones are 10.2 m for damage case 1 (Figure 7) and 18.5 m for damage case 2 (Figure 8). The vertical extents of damage zones are limited by main deck while transverse extents by center line. In damage case 1, vessel is damaged at fore of the body and in the second case, the damage is almost on amidships as shown in Figure 7 and 8.

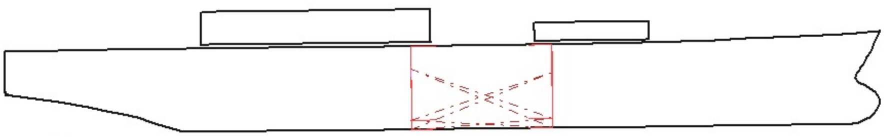

Figure 8. Damage case 2

Table 6. Results of wave crest location for damaged stability cases 1-2

	Damage Case 1							Damage Case 2						
Location of Wave Crest	CW	0 L	0.2 L	0.4 L	0.6 L	0.8 L	1 L	-	0 L	0.2 L	0.4 L	0.6 L	0.8 L	1 L
Area (0°-30°) m-deg	22.07	26.08	24.31	21.45	16.02	20.45	26.08	19.74	33.06	23.40	12.91	7.78	22.60	33.06
Area (0°-40°) m-deg	39.31	43.76	41.61	36.13	27.53	36.35	43.76	36.09	52.78	40.18	25.12	17.00	39.23	52.78
Area (30°-40°) m-deg	17.24	17.68	17.30	14.68	11.51	15.90	17.68	16.35	19.73	16.77	12.21	9.22	16.63	19.73
Maximum GZ at > 30° (m)	1.81	1.84	1.82	1.60	1.51	1.77	1.84	1.79	2.02	1.77	1.46	1.46	1.88	2.02
Angle of maximum GZ (°)	41.8	40.9	41.8	47.3	52.7	47.3	40.9	49.1	40.0	41.8	51.8	54.5	50.0	40.0
GM inital (m)	2.58	3.51	3.03	2.67	2.10	2.50	3.51	2.51	3.42	3.00	2.64	1.98	2.44	3.42

In Table 6, effect of wave crest location is shown. Wave height and wave length are chosen as initial values. When the damage is at fore of the ship (case 1), the change in righting lever is smaller than case 2. For case 1, wave crest of location on amidships is the worst condition. The areas, righting lever (GZ) and GM decrease when location of wave crest is on amidships in case 1. For case 2, similar results are gathered. The wave crest on amidships is again the most serious circumstance.

In Table 7, effect of wave length is pointed out for both damage cases. For damage case 1, when wave length increases, the areas, righting lever and GM values are getting higher in phase offset 0. However when the phase offset is 0.5, almost all parameters get minimum when length of wave is equal to L_{BP}. For damage case 2, for phase offset is zero, righting lever, areas and initial GM reach their maximum when wave length is equal to the ship length. Phase offset of 0.5 makes the same parameters minimum, except initial GM.

Table 7. Results of wave length for damaged stability cases 1-2

	Damage Case 1										
	Calm	Phase offset 0					Phase offset 0.5				
Wave length	Water	0.5 L	0.75 L	1 L	1.25 L	1.5 L	0.5 L	0.75 L	1 L	1.25 L	1.5 L
Area (0°-30°) m-deg	22.07	22.16	20.66	26.08	25.44	24.22	20.71	22.85	18.29	17.17	18.62
Area (0°-40°) m-deg	39.31	37.23	35.63	43.76	43.50	42.46	34.76	38.16	30.70	29.79	33.10
Area (30°-40°) m-deg	17.24	15.07	14.97	17.68	18.06	18.24	14.05	15.31	12.41	12.62	14.49
Maximum GZ at > 30° (m)	1.81	1.64	1.72	1.84	1.88	1.89	1.60	1.61	1.51	1.59	1.68
Angle of maximum GZ (°)	41.8	46.4	49.1	40.9	40	40	48.2	42.7	51.8	52.7	50
GM inital (m)	2.58	3.01	2.75	3.51	3.16	2.81	2.72	2.93	2.49	2.13	2.20

	Damage Case 2										
	Calm	Phase offset 0					Phase offset 0.5				
Wave length	Water	0.5 L	0.75 L	1 L	1.25 L	1.5 L	0.5 L	0.75 L	1 L	1.25 L	1.5 L
Area (0°-30°) m-deg	19.74	14.86	25.87	33.06	28.15	24.04	25.13	14.65	8.63	10.11	14.05
Area (0°-40°) m-deg	36.09	28.88	42.53	52.78	47.09	42.15	40.22	27.76	18.37	20.52	27.04
Area (30°-40°) m-deg	16.35	14.02	16.66	19.73	18.93	18.11	15.09	13.11	9.73	10.41	12.99
Maximum GZ at > 30° (m)	1.79	1.62	1.89	2.02	1.96	1.88	1.67	1.42	1.39	1.54	1.70
Angle of maximum GZ (°)	49.1	48.2	49.1	40.0	40	40.9	47.3	44.5	53.6	53.6	53.6
GM inital (m)	2.51	3.03	2.63	3.42	3.10	2.75	2.52	2.90	2.37	2.02	2.06

In Table 8, effect of wave height is demonstrated for both damage cases. According to Table 8, if damage is at fore of the ship and the wave crest is at the same location (phase offset 0), righting lever decreases when the wave height is higher. Similarly for damage case 1, if the wave crest is on amidships (phase offset 0.5), righting lever decreases with the increase in wave height. Also this comment is valid for areas and GM. However, for damage case 2 when wave crest is at the fore, righting lever gets maximum when wave height equals to initial value. For same damage case, if wave crest is on amidships, the righting lever, areas and GM decrease when wave height increases.

Table 8. Results of wave height for damaged stability cases 1-2

	Damage Case 1										
	Calm	Phase offset 0					Phase offset 0.5				
Wave Height	Water	0.5 h	0.75 h	1 h	1.25 h	1.5 h	0.5 h	0.75 h	1 h	1.25 h	1.5 h
Area (0°-30°) m-deg	22.07	24.65	25.63	26.08	25.77	24.91	20.10	19.24	18.29	17.16	15.83
Area (0°-40°) m-deg	39.31	42.97	43.81	43.76	42.63	40.79	34.83	32.74	30.70	28.56	26.35
Area (30°-40°) m-deg	17.24	18.32	18.18	17.68	16.87	15.88	14.73	13.49	12.41	11.41	10.52
Maximum GZ at > 30° (m)	1.81	1.90	1.88	1.84	1.76	1.67	1.68	1.60	1.51	1.40	1.28
Angle of maximum GZ (°)	41.8	40	40	40.9	42.7	44.5	49.1	50.9	51.8	51.8	51.8
GM inital (m)	2.58	2.89	3.16	3.51	3.74	3.73	2.57	2.63	2.49	2.42	2.38

	Damage Case 2										
	Calm	Phase offset 0					Phase offset 0.5				
Wave Height	Water	0.5 h	0.75 h	1 h	1.25 h	1.5 h	0.5 h	0.75 h	1 h	1.25 h	1.5 h
Area (0°-30°) m-deg	19.74	26.76	30.15	33.06	35.04	35.85	13.86	11.19	8.63	6.08	3.63
Area (0°-40°) m-deg	36.09	45.82	49.79	52.78	54.47	54.69	26.57	22.28	18.36	14.63	11.12
Area (30°-40°) m-deg	16.35	19.06	19.63	19.73	19.42	18.84	12.71	11.09	9.73	8.54	7.49
Maximum GZ at > 30° (m)	1.79	1.96	2.01	2.02	1.99	1.93	1.63	1.52	1.39	1.25	1.09
Angle of maximum GZ (°)	49.1	40	40	40	40.9	40.9	52.7	53.6	53.6	54.5	55.5
GM inital (m)	2.51	2.81	3.07	3.42	3.84	3.92	2.50	2.56	2.37	2.31	2.27

IS Code [2] is to regulate the intact stability. Damage scenarios are investigated similar to intact cases, in order to compare the results within the same code. From a different viewpoint, in addition to the effect of wave length, height and wave crest location; damage case effect can be observed.

CONCLUSION

In this study, basic intact and damaged stability analyses of a ship have been investigated. In addition to this, wave effect is taken into account. In both intact and damaged stability analyses, wave length, height and location of wave crest are the chosen parameters. In the analyses, one load case is considered in order to make a reliable comparison. Some commentary notes are given below for intact and damaged cases.

For intact stability analyses, phase offset 0.5 is the most critical case when the wave length is equal to the ship length. This effect can be erased by shifting the phase offset to zero. As expected, the increase of wave height has a negative effect on the righting lever and areas.

For damage stability analyses, when the wave crest is on amidships, it is the most critical case without considering the damage location. When the wave crest is in the fore and the damage is on amidships, the wave length can be equal to the ship length for ship stability.

For all intact and damaged cases, increasing wave height has a negative effect on stability. Locating the wave crest on amidships is the most critical case for all analyses, except for damaging on amidships. As a future work, wave encounter type can be varied.

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INVESTIGATION OF FLOWING AIR CHARACTERISTICS AROUND A MARINE RADAR ANTENNA WITH CFD

Mehmet Zeki SENER[1], Erhan AKSU[2], Ercan KOSE[3]

ABSTRACT

In this study, the flowing air characteristics around a marine radar antenna is determined for Beaufort scale numbers 2,3,4,5,6 and 7 using realizable k-ε turbulence model. Three different meshes that has different number of cells are created for the computitional domain to obtain mesh independent solutions. The resaults are compared with each other to obtain the appropriate solutions.

Keywords –cfd analysis, flow field image, marine radar antenna, static pressure

INTRODUCTION

Nowadays, because of the increasing ship number at seas and near the shores, marine radars has become more important components for ship's safety and maneuverability. Marine radars has antennas that sends out a signal and receive the signals that are reflected from solid targets. With the received signals they can detect and determine the exact distance of the ships that surrounds them by using a mathematical calculation.

S. Muggiasca et al. [1] are studied aerodynamic behaviour of a standard radar scanner used for maritime applications. Baris Gumusel and Cengiz Camci [2] are investigated viscous flow details and vortex shedding characteristics around an ASDE-X antenna. Cengiz Camci and Baris Gumusel [3] are studied vortex shedding into the wake using numerical simulation in a time accurate mode. G. Lombardi [4] is investigated a model antenna rotating in a cross flow with wind tunnel tests. G. Lombardi [5] is investigated a model antenna with different fin configurations. Baris Gumusel and Cengiz Camci [6] investigated aerodynamic drag characteris-tics and shape design of a radar antenna used for airport ground traffic control.

In this study, the flowing air characteristics around a marine radar antenna is determined for 2.5 m/s, 4.4 m/s, 6.7 m/s, 9.4 m/s, 12.3 m/s, and 15.5 m/s wind speeds using realizable k-ε turbulence model. Three different meshes that has different number of cells are created for the computitional domain to

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optain mesh independent solutions. Simulation is performed using Fluent 16. The static pressure distributions and flow field images are compared with each other.

NUMERICAL METHOD

In general the continuity is given by

$$\frac{\partial \rho}{\partial t} + \frac{\partial}{\partial x_i}(\rho u_i) = 0 \tag{1}$$

In general the momentum equation is given by

$$\frac{\partial(\rho u_i)}{\partial t} + \frac{\partial}{\partial x_j}\left(\rho u_i u_j\right) = -\frac{\partial \rho}{\partial x_i} + \frac{\partial \rho}{\partial x_j}\left[\mu\left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i} - \frac{2}{3}\delta_{ij}\frac{\partial u_j}{\partial x_i}\right)\right] + \frac{\partial}{\partial x_j}\left(-\rho\overline{u'_\imath u'_\jmath}\right) \tag{2}$$

Transport equation for turbulent kinetic energy k is given by

$$\frac{\partial(\rho k)}{\partial t} + \frac{\partial}{\partial x_j}\left(\rho k u_j\right) = \frac{\partial}{\partial x_j}\left[\left(\mu + \frac{\mu_t}{\sigma_k}\right)\frac{\partial k}{\partial x_j}\right] + G_k + G_b - \rho\varepsilon - Y_M + S_K \tag{3}$$

Transport equation for turbulent dissipation ε is given by

$$\frac{\partial(\rho\varepsilon)}{\partial t} + \frac{\partial}{\partial x_j}\left(\rho\varepsilon u_j\right) = \frac{\partial}{\partial x_j}\left[\left(\mu + \frac{\mu_t}{\sigma_\varepsilon}\right)\frac{\partial \varepsilon}{\partial x_j}\right] + \rho C_1 S_E - \rho C_2\frac{\varepsilon^2}{k+\sqrt{v\varepsilon}} + C_{1\varepsilon}\frac{\varepsilon}{k}C_{3\varepsilon}G_b + S_E \tag{4}$$

In these transport equations, due to the mean velocity gradients and the buoyancy, the generation of turbulence kinetic energy considered as G_k and G_b , respectively. G_k, G_b and Y_M defined as

$$G_k = -\rho\overline{u'_\imath u'_\jmath}\frac{\partial u_j}{\partial x_i} \tag{5}$$

$$G_b = \beta g_i\frac{\mu_t}{Pr_t}\frac{\partial T}{\partial x_i} \tag{6}$$

$$Y_M = 2\rho\varepsilon M_t^2 \tag{7}$$

σ_k and σ_ε are the turbulent Prandtl numbers for turbulent kinetic energy and turbulent dissipation, respectively. C2 and $C_{1\varepsilon}$ are constants. SK and SE user-defined source terms. $\sigma_{k=1}$, $\sigma_\varepsilon = 1.2$, C2=1.9 and $C_{1\varepsilon} = 1.44$ are closure coefficients in fluent for the realizable k-ε turbulence model.

Numerical domain of the marine radar antenna and the meshes that is created for computitional domain can be seen in Figure 1 and Figure 2, respectively. The Diameter of the marine radar antenna is L=520mm. Meshes are created using tetrahedral and prism elements. Boundary layer around the marine radar antenna meshed
with using only prism elements and height of the first cell is created considering y+<1 for the boundary layer.

Numerical solution is obtained from solving continuity equation, momentum equation and the transport equations for turbulent kinetic energy k and turbulent dissipation ε that are in realizable k-ε turbulence model. These four equations are solved using Fluent 16. The converge absolute criteria is set to 1x10-5 for the residuals. Pressure-Velocity Coupling scheme is set to SIMPLE algorithm. Green-Gauss Cell Based method is used for the gradient and second order method is used for pressure, momentum, turbulent kinetic energy, turbulent dissipation rate to optain more accurate solutions.

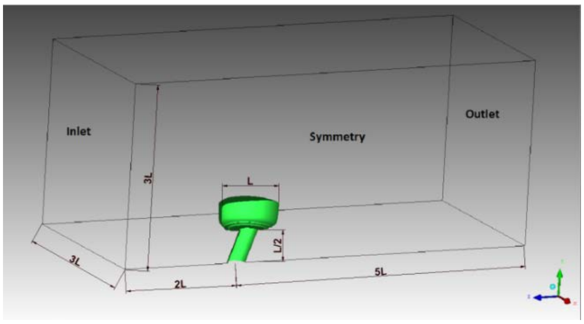
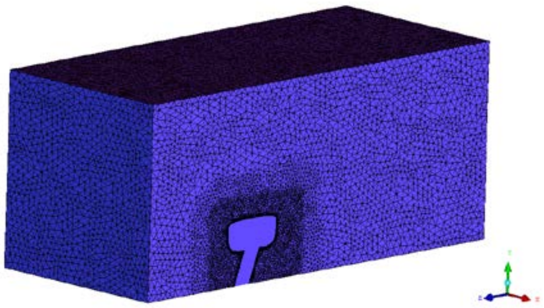
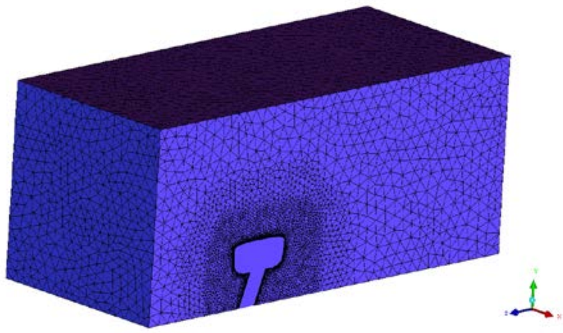


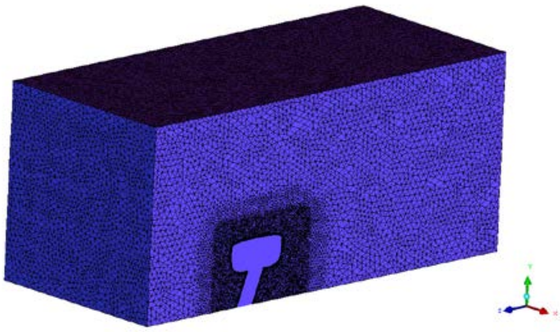
Figure 1. Numerical domain of the marine radar antenna



(a) Computitional domain that has approximately 2m cells



(b) Computitional domain that has approximately 3m cells

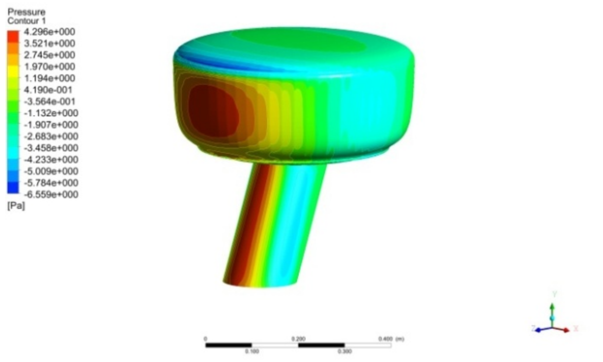


(c) Computitional domain that has approximately 4m cells

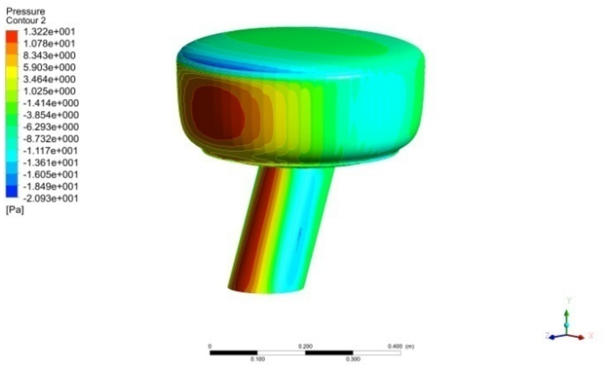
Figure 2. Meshes for the computitional domain.

SIMULATIONS AND RESAULTS

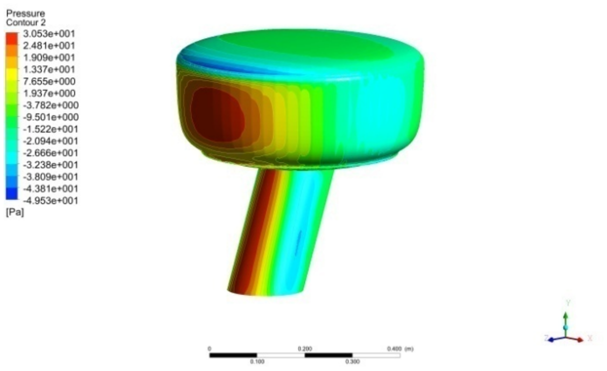
The resaults are given for the computitional domain that has approximately 4m cells. Static pressure distributions and flow field images of the marine radar antenna can be seen in the Figure 3 and Figure 4, respectively. Static pressure distributions in Figure 3 and flow field images in figure 4 show us that the flow seperation on the upper edge of the marine radar antenna causes to negative preassure field on the edge and reverse flow behind the marine radar antenna. Possitive pressure areas occur on the front part that has exposed to the wind directly and pressure progressively decrease toward the sides due to the cylindrical form of marine radar antenna. With the increasing wind speed, possitive pressure on the front part increases and the negative preassure area on the edge decreases.



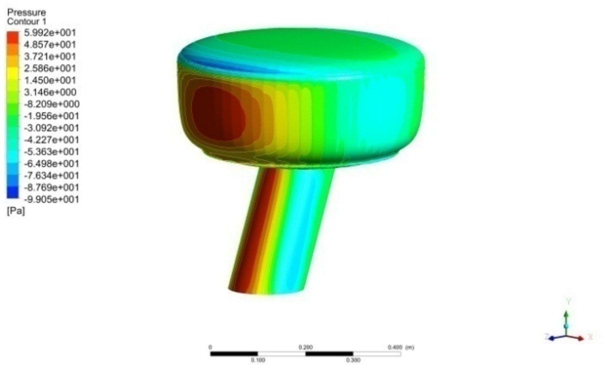
(a) Static pressure distributions for 2.5 m/s wind speed



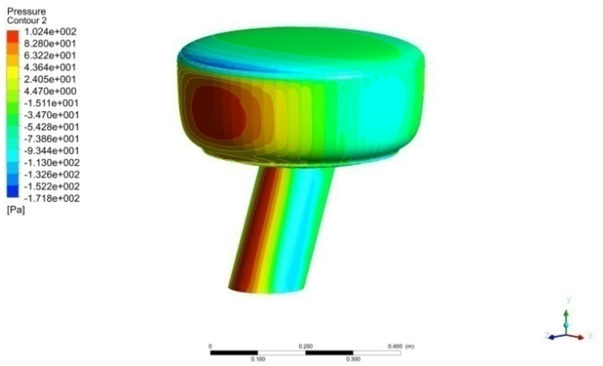
(b) Static pressure distributions for 4.4 m/s wind speed



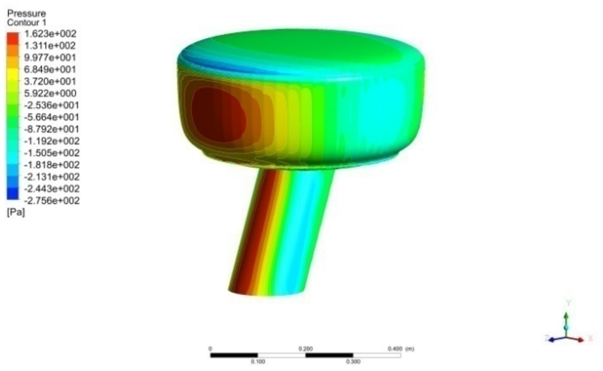
(c) Static pressure distributions for 6.7 m/s wind speed



(d) Static pressure distributions for 9.4 m/s wind speed

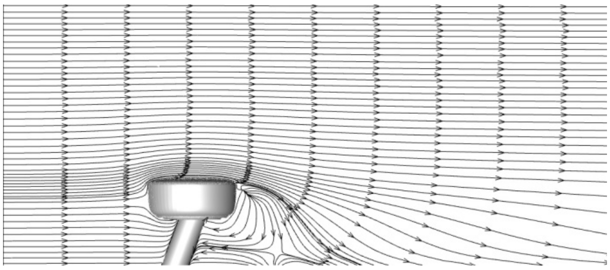


(e) Static pressure distributions for 12.3 m/s wind speed

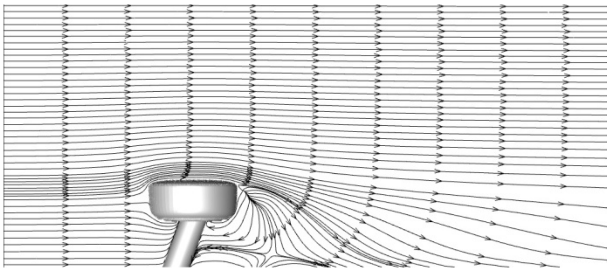


(f) Static pressure distributions for 15.5 m/s wind speed

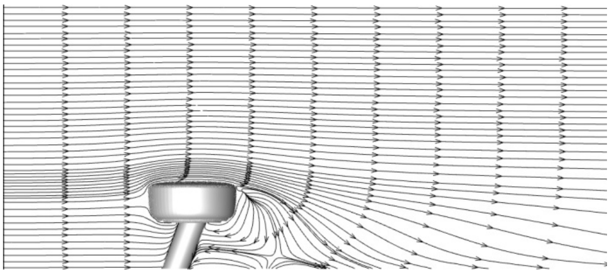
Figure 3. Static pressure distributions of the marine radar antenna



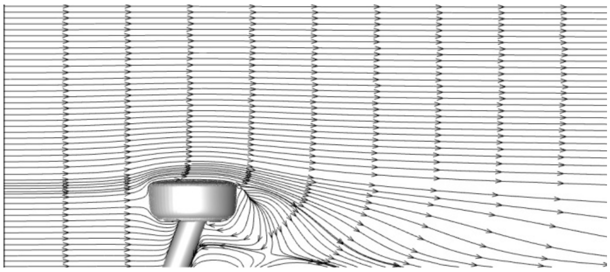
(a) Flow field image for 2.5 m/s wind speed



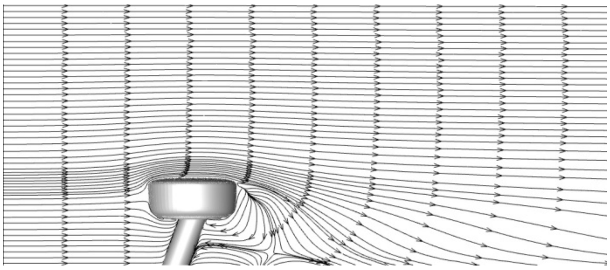
(a) Flow field image for 9.4 m/s wind speed



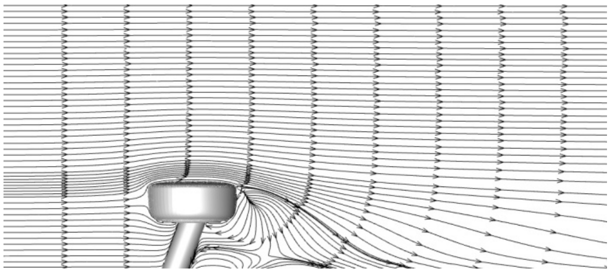
(b) Flow field image for 4.4 m/s wind speed



(b) Flow field image for 12.3 m/s wind speed



c) Flow field image for 6.7 m/s wind speed



c) Flow field image for 15.5 m/s wind speed

Figure 4. Flow field images of the marine radar antenna

CONCLUSIONS

In this study flowing air characteristics around a marine radar antenna is studied numerically. The flow seperation on the upper edge of the marine radar antenna causes to negative preassure area on the edge and reverse flow behind the marine radar antenna. Possitive pressure area occur on the front part that has exposed to the wind directly and pressure progressively decrease toward the sides due to the cylindrical form of marine radar antenna. With increasing wind speed, possitive pressure on the front part increases and the negative preassure area on the edge.

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A REVIEW ON MODELS PROPOSED FOR MARITIME COLLISION AVOIDANCE ROUTE OPTIMIZATION PROBLEM

Remzi Fışkın[1], Hakkı Kişi[2], Efendi Nasiboğlu[3]

ABSTRACT

The development of Soft Computing Techniques in recent years has encouraged researchers to study on Intelligent Decision Support Systems (DSS) on maritime collision avoidance route problem. These techniques are also widely used in the marine industry for solving such problem like all other industries. Inadequacy of ship movement, collision avoidance timing, collision risk assessment and strategies to avoid collision at sea and technology-oriented new solutions are being widely studied by researchers. Many models, methods and techniques have been proposed for the solution of such problems and preventing their occurrence in order to contribute to strengthening maritime safety. In this study, a review on the techniques, models, methods and technologies proposed for solving maritime collision avoidance route planning and optimization problem has been carried out so as to discuss related literature. The results of the review survey have pointedly showed that researchers who are interested in this topic used various models and methods especially artificial intelligence methods

Keywords: Maritime, Collision Avoidance, Optimization, Decision Support System (DSS), Artificial Intelligence,

INTRODUCTION

Over the years, ship navigation has conventionally been carried out thoroughly by human endeavor [1], and it brings some human based errors [2]-[3]. Nowadays, but, developing technology has contributed to ship crew for minimizing these errors. These technologies will create some intelligent navigation systems in a close future. These type of systems that will contribute to operator in planning optimum collision avoidance route [1]. Limiting human subjective elements in sea navigation and changing them with an intelligent decision making system can reduce marine collision [4].

Technological development has led to increase ship traffic that caused navigation to become more difficult for marine officers. Performing navigation is a complex process, due to the fact that it requires analyzing of huge amount of data continually. Making assessment of navigational situations improperly can cause to collision situations. In this respect, it is necessary to support marine officers in collision avoidance decision making process [5].

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Collision avoidance process is multi-criteria, non-linear programming problem and there has also to be equilibrium between navigational safety and economy simultaneously [6]. In other expression, the collision avoidance process must not only keep on the danger assessment and action to avoid collision but also take into consideration optimizing the amount of yaw from the original trajectory [3]. The study aims to look over the proposed methods in the literature for solving ship collision avoidance route optimization problem.

THE MODELS PROPOSED FOR MARITIME COLLISION AVOIDANCE ROUTE OPTIMIZATION PROBLEM

In relevant literature, there has been many methods, techniques and models proposed for solving maritime collision avoidance. These approaches can be divided into three main categories as deterministic approaches, artificial intelligent approaches and hybrid systems.

Deterministic approaches refer to the certain mathematical definition of navigation environment. This type of approaches utilizes a precise description for solving collision avoidance problem. These algorithms are important in terms of providing exact solutions compared to heuristic algorithms, but the solution time may take a long time.

Artificial intelligent approaches comprise primarily of fuzzy logic [7], heuristic approaches, neural networks and etc. These type of algorithms can make easier complicated problem by means of its high computational competence and learning capacities.

Hybrid systems propose a combination of all mentioned above.

The only recent and selected approaches proposed after 2012 are only included in the scope of the study and they are shared below in detailed.

Deterministic Approaches

Tam and Bucknall (2013) [8] described the development of a deterministic path planning algorithm. The proposed algorithm computed a practical and COLREG compliant navigation trajectory for ships are on a collision course. The approach was evaluated with a set of test cases and simulating several navigation scenarios. There have been several assumptions to manage complexity of the algorithm in the study. These assumptions are as follows: A vessel that is in direct control is referred as “own ship” (OS), any other vessels apart from OS are referred as “target ship” (TS) or “obstacle”. The safety domain sets as 5 Nm around OS. The availability of data according to traffic in the vicinity and also hydrodynamic data of each vessel involved are assumed to be available. The algorithm in the study is categorized into two main sequences; the first one is to determine the risk of collision of each vessel or obstacle in the vicinity. The second one is to compute the evasive maneuver to clear the risk of collision. The risk of collision is defined by the proxy metric instead the traditional definition of risk in System Engineering. If there is a collision risk between vessels the algorithm that have avoidance_maneuver subroutine is activated to calculate proper maneuver to propose solution for potential conflict. Figure 1 shows the template used to construct the avoidance maneuver.

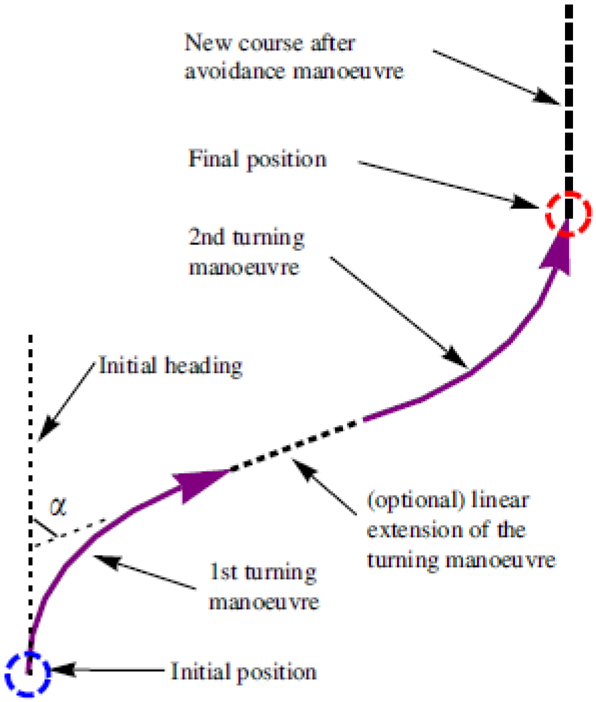

Figure 1. Template for the collision avoidance maneuver. The blue and red circles represent the initial and final position of the vessel for the avoidance maneuver. The turning angle (a) is the magnitude of rotation with respect to the initial heading (For interpretation of the references to color in this figure caption, the reader is referred to the web version of this article).
Source: Tam and Bucknall (2013) [8]

The findings from the computational shows that the algorithm is practical and consistent with COLREG. The algorithm is based on deterministic structure, so it generates the exact solution.

Perera et al. (2012) [9] proposed a model that focuses on the formulation of collision avoidance action application that gives opportunity collision avoidance characteristics in open sea navigation systems while considering COLREGs. The decision process included in a fuzzy based parallel decision making (PDM) module whose decisions were formulated into consecutive actions via Bayesian network based module. Two multi ship collision cases were simulated in the study. Case I where three target ships were equaled to three collision situations and case II where three target ships are equaled to two collision situations is taken into consideration. In the study, various parameters were introduced as constant collision risk function (CRF) and collision avoidance action function (CAAF). The parameters were relevant to the navigation features of the own vessel as well as the navigation sensor ability such as radar system. the result of the study showed that collision avoidance system (CAS) achieved collision avoidance comprising multi ship in open sea navigation while considering COLREGs.

Artificial Intelligent Approaches

Lazarowska (2015a) [10] presented an application of the Ant Colony Optimization (ACO) technique in a safe ship control system. The proposed model introduced to solve the problem of collision avoidance and trajectory planning of a vessel in the restricted water and also open sea. The state of the safe ship control process was determined with the use of actual navigational situation information as follows:

- the course and speed of the own ship (OS),
- the course and speed of j-th the target ship (TS),
- the bearing of the j-th target ship,
- the distance of the j-th target ship from the own ship,
- data from static obstacle (shoals, lands, buoys)

In the proposed method the following assumptions were conducted:

- static and dynamic limitations
- specified endpoint to determine a safe ship path
- a kinematic model of ship motion
- consider the dynamics of OS
- navigational data of TS from AIS and ARPA
- compliance with COLREGs,
- the form of hexagon domain around the TS for safety domain
- sixty second for computational time limit
- reproducible results
- not consider the strategies of TS

The proposed algorithm was tested various navigational situation. The test results showed that every solution generated a safe ship path and fulfilled COLREGs, and it was the same for each trial for the same situation. During the calculation, computational time not exceeding time limit. The test results showed that the algorithm was suitable for solving related problem in heavy traffic areas and also provided reproducible solution despite the application of a stochastic approach method.

Nguyen et al. (2012) [2] proposed an Adaptive-BFOA (Bacteria Foraging Optimization) based model and applied for collision avoidance trajectory problem. The purpose of the study was to provide optimal route for collision avoidance that pass all target ships and other obstacles safely and efficiently considering with COLREGs. The structure of the proposed model is as illustrated in Figure 2.

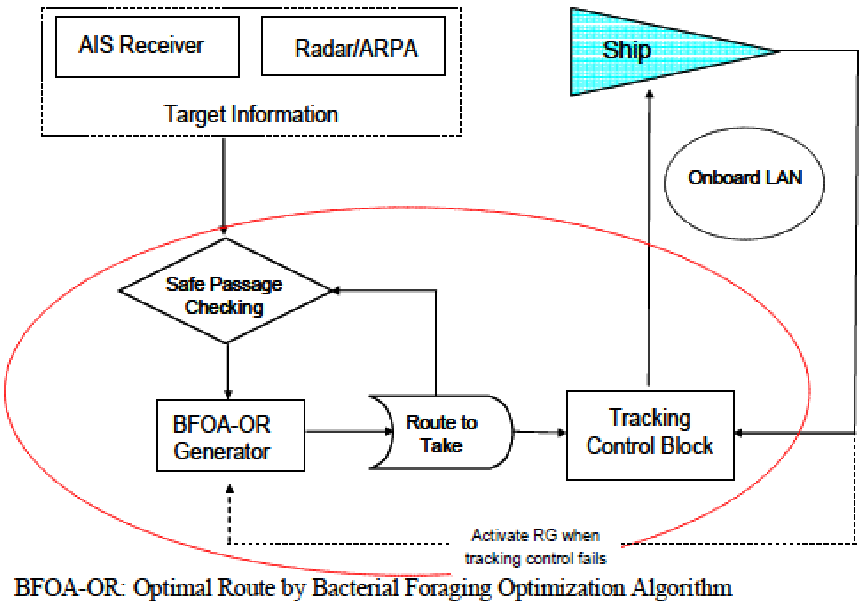

Figure 2. Structure of the model

Source: Nguyen et al. (2012) [2]

A suitable risk assessing criteria should be applied for verifying collision risk exist. For this purpose, Bumper Model for encounters in congested waters and Ship Domain for encounters at open sea. The former one is being used by Tokyo marine traffic. If the bumpers of two ships overlap each other, it has to be considered to be high risk of collision. The later one is hexagon domain suggested by Smierzchalski et al. (2002) [11]. Similar to Bumper concept, domains of own ship and target ship shouldn't overlap each other.

The various scenario that include heavy traffic and open sea was applied to evaluate performance of the proposed model. The Adaptive-BFOA based model was efficient, robust and reliable for producing collision avoidance route according to case scenario and the solution time was within the acceptable time limit.

Hybrid Systems

Ahn et al. (2012) [12] suggested a collision avoidance system using the following: a simply structured fuzzy inference system is combined with an expert system. The expert system was stored the navigator's knowledge in a database. The DCPA and TCPA were used to calculate the degree of collision risk in this approach. The fuzzy inference system that used for assessing the degree of collision risk was arranged to create a rule base. ANFIS (Adaptive Network -based Fuzzy Inference System), a general neuro-fuzzy system, was used for organizing the membership functions and rules. As a consequence, neural network based multilayer perceptron (MLP) system and fuzzy logic based inference system (ANFIS) was designed and trained. At final step, collision avoidance maneuvers were performed on several scenarios to verify and benchmark the collision avoidance system based on MLP and ANFIS. The collision avoidance flow chart that adopted of the study is shown in Figure 3.

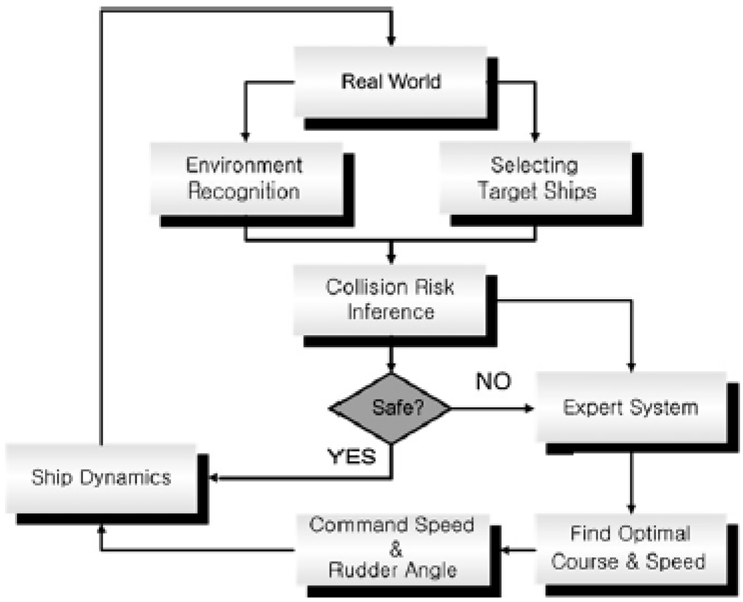

Figure 3. Collision Avoidance Flow Chart

Source: Ahn et al. (2012) [12]

The proposed system was presented various conclusions as a result of simulation experiments such as MLP ship underestimated the collision risk than fuzzy ship within the same condition so, this caused to less rudder changing.

Zhuo and Hasegawa (2014) [13] proposed an intelligent collision avoidance control model. A fuzzy set explicating is developed to obtain the collision avoidance information capability and to handle indefinite data. The optimization process of the is based on the Particle Swarm Optimization (PSO) that frequently used in the literature. The experimental was based on three-stage calculation to simplify intelligent collision avoidance utilizing fuzzy set and expert experience. In the process, fuzzy logic was implemented for dealing with whether the ship ought to take action to avoid collision. During the experimental calculation, multiple target vessel end obstacles was considered. The result of the study showed that the proposed model performed favorable to apply the optimizing control of ship collision avoidance.

Collision avoidance route planning and optimization studies that proposed for solving related problem can be seen in detailed in Table 1.

Table 1. Collision Avoidance Route Planning and Optimization Studies

Author(s)	**Year**	**Country**	**Journal/ Conference**	**Method**	**Publication Type**	**Main Topic**
Grinyak and Devyatisil'nyi [14]	2016	Russia	Journal of Computer and Systems Sciences International	Fuzzy Logic	Article	A fuzzy based decision-making system
Zhang et al. [15]	2015	Portugal, China, Norway	Ocean Engineering	Linear Extension Algorithm	Article	A distributed anti-collision decision supporting formulation in multi-ship encounter situations
Wei et al. [16]	2015	China	International Conference on Computational Science and Engineering	Cat Swarm Biological Algorithm	Conference Paper	Heuristic algorithm based collision avoidance action
Vettor and Soares [17]	2015	Portugal	Information, Communication and Environment: Marine Navigation and Safety of Sea Transportation	Genetic Algorithm	Book Chapter	Multi-objective route optimization for onboard decision support system
Perera et al. [18]	2015	Portugal Finland Netherlands	IEEE Journal of Oceanic Engineering	Artificial Neural Network, Fuzzy Logic	Article	Collision avoidance of ship maneuvers by intelligent guidance
Lee et al. [19]	2015	Korea	Intelligent Automation and Soft Computing	Bandler and Kohout's Fuzzy Relational Products	Article	Heuristic search technique for collision avoidance
Lazarowska [20]	2015b	Poland	Cybernetics International Conference	Ant Colony Algorithm	Conference Paper	Heuristic algorithm based safe ship trajectory planning
Lazarowska [10]	2015a	Poland	Polish Maritime Research	Ant Colony Algorithm	Article	Heuristic algorithm based safe ship control system
Hongdan et al. [21]	2015	China	International Journal of Simulation: Systems, Science and Technology	Wolf Colony Search Algorithm	Article	Heuristic algorithm based ship collision avoidance

Zhuo and Hasegawa [13]	2014	China, Japan	Information Science, Electronics and Electrical Engineering	Fuzzy Logic	Conference Paper	Intelligent collision avoidance control approach for large ships
Xu [22]	2014	China	Computers and Industrial Engineering	Danger Immune Algorithm	Article	Intelligent optimization algorithm based collision avoidance strategy
Simsir et al. [23]	2014	Turkey	Applied Soft Computing	Artificial Neural Network	Article	Decision support guidance for strait passing vessels
Tam and Bucknall [8]	2013	UK	Ocean Engineering	Deterministic Algorithm	Article	Cooperative path planning algorithm
Perera et al. [9]	2012	Portugal	Ocean Engineering	Fuzzy-Bayesian	Article	Collision avoidance decision action model
Nguyen et al. [2]	2012	Vietnam Japan	International Conference on Control, Automation and Information Sciences	Bacteria Foraging Algorithm	Conference Paper	Tool for optimal collision avoidance strategy
Su et al. [3]	2012	China	Journal of Marine Science and Technology	Fuzzy Logic	Article	A fuzzy based decision-making system
Lisowski [24]	2012	Poland	Polish Maritime Research	Game Control	Article	Game control method in ship collision avoidance
Lazarowska [5]	2012	Poland	Polish Maritime Research	Ant Colony Algorithm	Article	Heuristic algorithm based safe ship trajectory planning
Ahn et al. [12]	2012	Korea	Applied Ocean Research	Neural Network, Fuzzy Logic	Article	Expert system for path collision avoidance
Escario et al. [25]	2012	Spain	Expert Systems and Applications	Ant Colony Algorithm	Article	Swarm algorithm based path planning
Campbell et al. [26]	2012	UK	Annual Reviews in Control	Search Algorithm	Article	Intelligent collision avoidance manoeuvers

CONCLUSION

Maritime collision avoidance planning and optimization problem stands as a complicated topic and related literature shows us that many methods and models have been proposed to solve this problem. Especially, fuzzy logic, heuristic and artificial intelligent optimization methods are being used very often to create a model for related problem. Deterministic approaches and hybrid systems are also being used but not as much as previously mentioned ones. It is revealed that the majority of the models took into account COLREG rules while forming algorithm structure but some others ignored. On the other hand, the majority of the models used the terminology to define the ship that is operated by us and the ship to be avoided as own ship (OS) and target ship (TS), respectively. It is also revealed that researchers from China, Portugal and Poland are most interested in related field.

In conclusion, intelligent collision avoidance systems will undoubtedly be beneficial for safe navigation and they will have an important task in unmanned and autonomous ship.

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THE NAME OF ENIGMA - ECDIS

Murat YILDIZ[1], Fatih AKKUS[2]

ABSTRACT

ECDIS that breathe a new life into traditional navigation activities and plannings,is one of the most important innovation developments of maritime industry. It started the revolution of irreversible navigation activities and became the basics of paperless navigation with international rules and implementations since 2012. It would create a great contribution to safety of navigation and minimize the sea accidents according to various people. Then why ECDIS originated sea accidents come into being and keep going? Who is guilty, ECDIS, operators or rule makers? In this study, ECDIS was investigated both technical and operational, and ECDIS originated sea accidents were evaluated for the development of the system creating a much more safety navigation. This study will encourage the manufacturers, operators, rule maker associations and flag states to enhance and emend the weak points of ECDIS operations, specifications.

Keywords −Ecdis, maritime navigation, electronical navigation, sea accidents,

INTRODUCTION

Is it a miracle of technological age or a monster that may drift maritime staff to vital mistakes? In order to clarify this mystery, it would be better to start with its history.

ECDIS (Electronic Chart Display and Information System), one of the most important results of research and development department, first got type approval certificate in 1999 and took a great place in the center of maritime navigation. Especially paperless system has become a revolutionary innovation at maritime industry. In summary this praxis on ship includes one ECDIS device and one back-up unit, or one more ECDIS device and vector chart (ENC) were also recommended. By this way, all navigational activities should be planned on vector chart rather than on a paper chart.

The majesty of paper maps for years, greatly weakened by setting ECDIS device on ship and create a different point of view from technologic aspect. In spite of the books, articles and lots of investigations on manner of working of ECDIS that has become the milestone of maritime navigation, questions and hesitations are still encountered both at ship and office sides.

Although today’s young marine staff are pleased to use ECDIS, middle aged and older ones still call it a trouble maker and this situation affects the efficiency from different aspects.

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In spite of ECDIS, sea accidents and accident possibilities still occur on ships and fleet that use paperless navigation model. Most of the companies that prefer paperless system expect the decrease on costs and time, increase the safety of navigation, ease of application for responsible staff and time saving unexpected accidents had been encountered. These criteria come out on evaluation of ECDIS facilities, appliance and sectoral effects [1]:

- ECDIS manufacturer companies' point of view on the area and future strategies
- Equipment specifications and standardization
- IHO and praxis of chart provider companies
- Navigational safety
    - at planning of voyage stage
    - during voyage progress
- Expenses
- Time saving
- Education praxis and efficiency [2].

ECDIS TRAINING APPLICATIONS AND EFFICIENCY

Education praxis and efficiency come out to detect the state of the operators' actively usage of system and profitability.

ECDIS can be determined as a simple electronic navigation aid, but from operational aspect according to the device's effectively usage, the results have ranged from minor accidents to disasters.

Despite the technical suitability of the device is determined by international rules, the capability of bridge staff that use this device is evaluated by personal educations and measurements. This side still is kept as a gray area.

If operator is familiar with operational details of ECDIS device's brand and model, then it would promote the vessel navigation safety beyond the expectations.

ECDIS Training is divided into Generic ECDIS Training (IMO Model course 1.27) and Type Specific Training.

Type Specific Training is specified according to brand and models and carried as classroom training, online training and CBT (Computer Base Training) all over the world.

The operator takes the first step in ECDIS world with one of the compulsory training IMO model course 1.27. By taking this course navigator will learn about ECDIS philosophy, get technical knowledge at operator level and maps and applications. However, this does not mean the staff that completed this training has the capability of operating all ECDIS brands and models. In addition to this, the operator should take the Type Specific Training according to the available model and brand of ECDIS on ship that navigator will participate. Otherwise it is impossible to use the device properties appropriately. There are 3 different kinds of training models on Type trainings all over the world.

Classroom Training – Under classroom facilities, accompanied by a trainer

Online Training - Operator carries out own training provided by training provider company or manufacturer on a virtual machine with ECDIS software by internet connection.

CBT (computer base training)- operator downloads the software provided by ECDIS manufacturer or training company on his personal computer and run with password.

Among this training models, classroom training is the best of all, not only reliability of the system but also to measure the capability of operators to use this machine. Furthermore, it affords the trainee to ask all questions to make everything clear. Obviously, classroom training should be served at high standards. Nowadays, it is really just a dream to say that all training providers serve the same quality. CBT and online training are the most preferred types by operators and companies due to their low expenses. Despite the development of this training models focus on operators ECDIS usage, lack of basic facilities, problems with the consultant center of training provider, operators certificate desire rather than training and lack of suitable training conditions may resullt in inadequate training quality.

These questions arise for training systems out of classroom training

- Online and CBT test were performed by the navigator himself or somebody else?
- Whom will navigator ask questions about unclear points?
- After navigator completed CBT and online training, how would be his assurance and self-sufficiency to perform a safe navigation using ECDIS?

  The companies, flag states and operators should use ability to prevent from accidents caused by operator performance faults and to create the awareness about training is beyond to have a simple piece of paper [3].

EXEMPLARY OF ACCIDENT

Ecdis-assisted grounding MARS Report 200930

Official report: Abridged from MAIB Report 21/2008

Loaded dry cargo ship ran aground on Haisborough Sand off the east coast of England. The vessel quickly refloated without assistance and continued on passage to Grimsby, River Humber, where she arrived the following morning. There were no injuries or damage to the vessel, and there was no pollution.

The ship grounded 29 minutes after the OOW had adjusted course to follow an amended passage plan shown on the vessel's Ecdis. The route was hastily revised to ensure arrival at high water. This route took the vessel across Haisborough Sand, where the charted depth of water was considerably less than the vessel's draught.

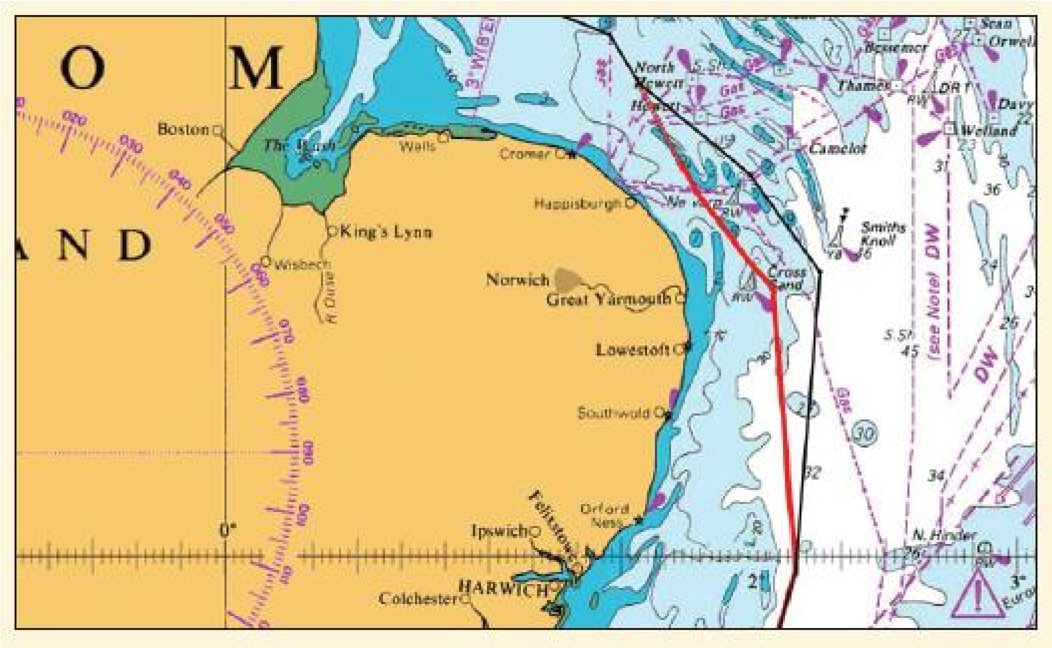

Figure 1 : Accident Area Haisborough Sand off the east coast of England

Root cause/contributory factors:

1. The deck officers had not been trained in the use of Ecdis and no procedures on the system's use were included in the vessel's SMS. They were, therefore, ignorant of many of the system requirements and features, operating the system in a very basic and inherently dangerous manner.2. The route across Haisborough Sand was not adequately checked for navigational hazards, either when planned or when being monitored.3. In-built safeguards in the Ecdis which are intended to prevent accidents of this nature were not utilized and system warnings were not acted upon.4. The safety contour alarm did not sound as the vessel approached the shallow because a watch vector had not been set.5. It is also highly likely that the configuration of the display was not optimized to clearly show the shallows over Haisborough Sand. At a scale of 1:100000 and with a safety contour of 30 m selected, the shallows over the bank were not readily apparent.6. The OOW placed undue reliance on the Ecdis: it is possible that the grounding could have been avoided had he remained vigilant and continuously monitored the vessel's position in relation to navigational hazards.

Some of the pertinent deficiencies recorded by Port State Control at the destination port were:1. The planned route took the vessel with a draught of 5.9 m across Haisborough Sand where the charted depth was less than 2 m.2. The ship's navigating officers were not properly trained in the use of Ecdis.3. The incident was not reported to the vessel's DPA for 23 hours.4. The chart support certificate had expired.

Similar recent grounding accidents recorded by MAIB:

A cross-Channel ferry grounded after the helm was put the wrong way as the vessel approached a port entrance. This mistake was not noticed by the bridge team and, although an Ecdis was in use, no warning was given to indicate that the vessel was approaching shallow water because the watch vector, or predicted movement warning area, had not been correctly enabled.
A ro-ro ferry ran aground after the safety contour in her Ecdis was set at 30 m. This caused the chart

display to be shaded blue, which severely impeded the bridge team's ability to see that the vessel was outside the navigable channel. A Ro-Ro passenger ferry hit a submerged wreck near Dover and severely damaged her propellers. Although the vessel's primary means of navigation was paper charts, her deck officers relied on the vessel's ECS, despite not having been trained in its use. The wreck was not shown on the ECS display due to the settings applied to the system at the time. Contributory factors to the grounding of a container ship in UK waters included lack of training in the use of the vessel's electronic chart system. This resulted in the use of inappropriate settings with regard to depth contours, and chart and depth alarms. Foreseeing that Ecdis will replace paper charts as the primary planning and monitoring media on board most vessels over the next 10 years. MAIB has included the following in its recommendations:

1. A review of the content of the IMO model course syllabus for Ecdis. 2. As there can be significant differences between Ecdis models in terms of menus, terminology and equipment interface, ship-owners must ensure that all bridge watchkeeping officers are familiar with navigation systems in use and they should use both generic and model specific training to meet this obligation.3. Ships' crews are reminded of the need to ensure that all recorded information including VDR and ECDIS and other electronic data is preserved following an accident or incident [4].

CONCLUSION

The most important question, is the ECDIS necessary for safe navigation or not?

Our personal idea, ECDIS is necessary and very supportive navigational aid at the same time maritime industry is affected continuously at the high level of technological developments. We see the deep effects of this situation in all areas of Maritime industry. ECDIS also has begun to play the leading role in this as a reflection of the development of navigational safety and other related Operations. Unfortunately, we are living same cases of being caught unprepared and unawares of the risky gray areas that constituted the different industries.

In order to clarify this gray area of ECDIS implementations the rule makers and related parties should be ignored to determine about calendar, responsibility of parties, methods of improvement and other related topics.

The Maritime industry have his own strong volition to create optimal solutions and applications but the necessary steps must be put as soon as possible by rule makers of industry to create a significant change to avoid of possible losses.

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POSTER PRESENTATIONS

POSTER PRESENTATION

IMPORTANCE OF INERT GASES FOR CHEMICAL TRANSPORTATION

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ABSTRACT

The world's trade volume has increased with globalized world. Maritime transport increased in parallel with the world trade. It reached 9.84 billion tons in 2014 [1]. Liquid bulk made up approximately 30.3 % of the total maritime tonnage of cargo handled in the world [2]. The chemicals transport represents an important place in liquid bulk goods. Tankers carry crude oil, crude oil derivatives and other hazardous chemical loads. Unless tankers are considered ingredients of the atmosphere above the cargo and the system, risk situations may occur. Hydrocarbon vapors which are explosive, may explode a risk by energy sources in sufficient amounts, in such a tank with atmosphere. In particular, during cargo handling the potential risk that would be faced is greater. During this process, it consists of explosive gas mixtures with a mixture of steam by oxygen in the air. To avoid danger of explosion is necessary to control the atmosphere in the tank. It can be achieved that inert gas is keeping the oxygen content of the atmosphere below the threshold of combustion in the tank. This dangerous situation is eliminated by the addition of very effective inert gas generator on the cargo tanks and also prevents environmental pollution. In the study has emphasized the importance and the conditions of the inert gas used in the transport of flammable chemicals.

Keywords – Chemical Transportation, Inert Gases, Tankers

INTRODUCTION

The volume of maritime transport has risen steadily as result of the growth in world trade. Especially, liquid bulk cargo was above average trade of other shipping sectors. Parallel to the increase in liquid bulk cargo, chemical tanker fleet has caused to grow in the world. Crude oil and petroleum products, organic chemicals and non-organic chemicals, liquefied natural gas (LNG), liquefied petroleum gas (LPG) and vegetable oil are carried by liquid bulk cargo or tanker. The most important difference between a chemical tanker from other ships are built differently due to the handed dangerous cargo and its properties. Chemical cargo for safety transportation, many precautions must be also taken. Because, a part of chemical substances has the highly flammable and explosive properties. Therefore, when handling chemicals may occur various hazards such as fire, explosion and toxic release [3]. Also the transport of chemicals may threat to human life and marine pollution. So the tanker loading, unloading and during cleaning may contain risks [4]. Having

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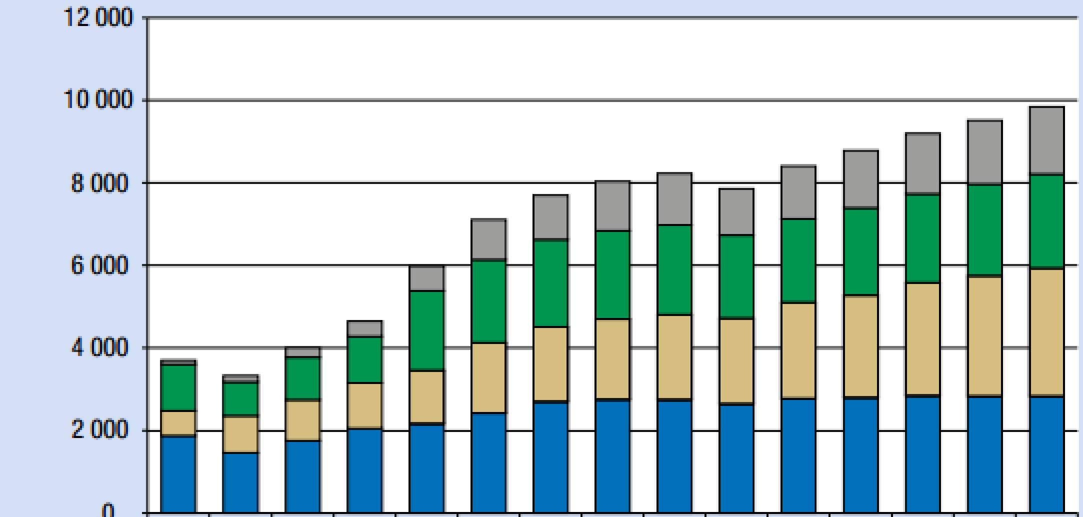
flammability property loads, to prevent spontaneous combustion and explosion in the tank, that creates the fire should be avoided the air, fuel and of heat a combination of a trio. If handling material is flammable, the other two of the trio must be intervened. Thus it is retained from damage. To avoid fire, it can be applied the process to cut air with flammable materials. The inert gas is used to cut contact with air of flammable materials. Nitrogen is specifically preferred from other the inert gases because of its high natural abundance and low comparatively cost. Nitrogen which is heavier than air stays on top of the load combination allowing the air on the cavity of the tank. In this study, firstly liquid bulk transportation has been mentioned in the world and Turkey. Afterwards, the concept of inert gas that is extremely important in the chemicals maritime transport is described. In addition, this study focuses on the advantages and disadvantages of inert gas systems used on ships.

Liquid Cargo Transportation

The globalization of the world has caused to increase volume of trade between countries. World maritime trade reached 9.84 billion tons in total through the 300 million tons with growth of 3.4% in 2014. This constitutes about 80% of total world trade [1]. When we examine as the cargo groups, amount of handling cargo in 2014 is 10.25 billion tons, which made up 30.3% of the liquid bulk, 29% of the iron ore, coal, grain shipments and 15.9% of container. World seaborne trade between 1990-2014 is as shown in Figure 1.



	1980	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Container	102	152	234	371	598	969	1 076	1 193	1 249	1 127	1 280	1 393	1 464	1 544	1631
Other dry cargo	1 123	819	1 031	1 125	1 928	2 009	2 112	2 141	2 173	2 004	2 022	2 112	2 150	2 218	2272
Five major bulks	608	900	988	1 105	1 295	1 709	1 814	1 953	2 065	2 085	2 335	2 486	2 742	2 923	3112
Oil and gas	1 871	1 459	1 755	2 050	2 163	2 422	2 698	2 747	2 742	2 642	2 772	2 794	2 841	2 829	2 826

Figure 1. International seaborne trade between 1990 – 2014 years [1]

As maritime transport increased in the world, it soared similarly in the Turkey. Figure 2 shows the export and import values to the Turkey in 2014. In foreign trade transport, a maximum cargo of ranking in transit-export load; was realized as liquid cargoes in bulk with 37.3%, container by 33.2%, general cargo with 15.6%, bulk cargo 10.8% and vehicle floor 3.1% [2]. Turkey has reached 116.934.088 tons with an increase of 61.9% in the years from 2004 to 2014 [5].

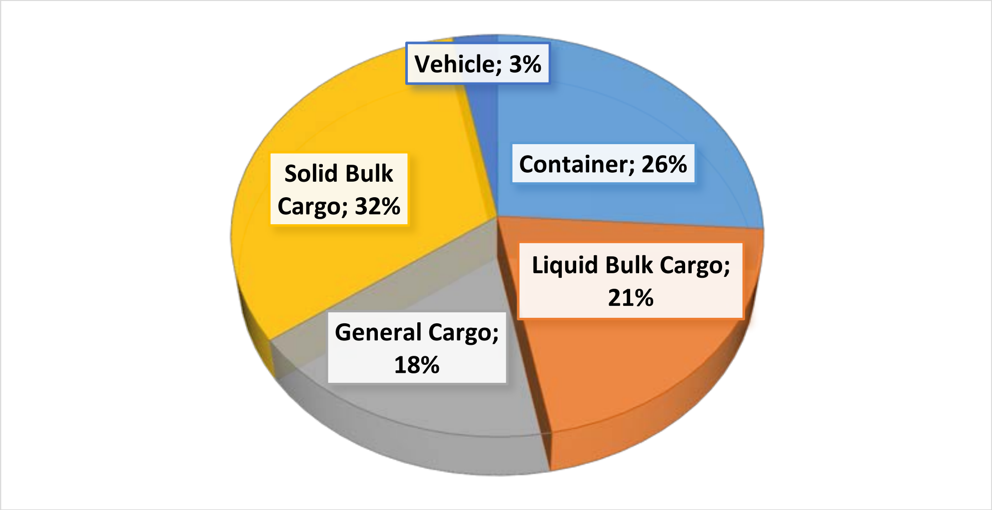


Figure 2. Structure of Turkey Seaborne Trade, 2014 [2]

Inert Gas

In storage tanks of chemical tankers has flammable and volatile gas. These gases may cause fire and explosion at the appropriate temperature and in contact with atmospheric oxygen. This combination is called the fire triangle as shown figure 3.

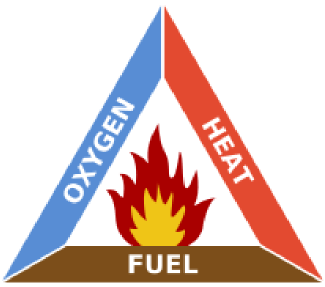


Figure 3. The Fire Triangle [6]

The simplest and easiest way to eliminate this danger, is to remove oxygen from the environment. This is the working principle of the inert gas system. Inert gas is a gas that does not chemically react under certain conditions [7], [8]. Inert gas is typically used to prevent unwanted chemical reactions of the affected cargo. These undesirable chemical reactions are oxidation and hydrolysis reactions that formed generally oxygen and moisture in the air. In the nature abundantly available (? air, 78% N_2) and low cost due nitrogen gas, is most commonly used as an inert gas. Especially inert gas prevents the formation of explosive or combustible mixture, keeping under control the atmosphere in the tank. For preventing the occurrence of combustion in the tank should not exceed 11% by volume of oxygen. Oxygen within the tank in IMO the regulation is permitted to be situated at the level of 5% [9] The oxygen limit for inert gas provided to cargo tanks has been modified from 8% to 5% in 2015 [10].

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The Effect of Flammable of Inert Gas

The first risk of the handling of chemicals is the flammability. This is always present danger. An inert gas when added to a hydrocarbon gas/air mixture, the hydrocarbon concentration of Lower Explosion Limit (LEL) is increased and Upper Explosion Limit (UEL) is reduced. These effects are shown in Figure 4.

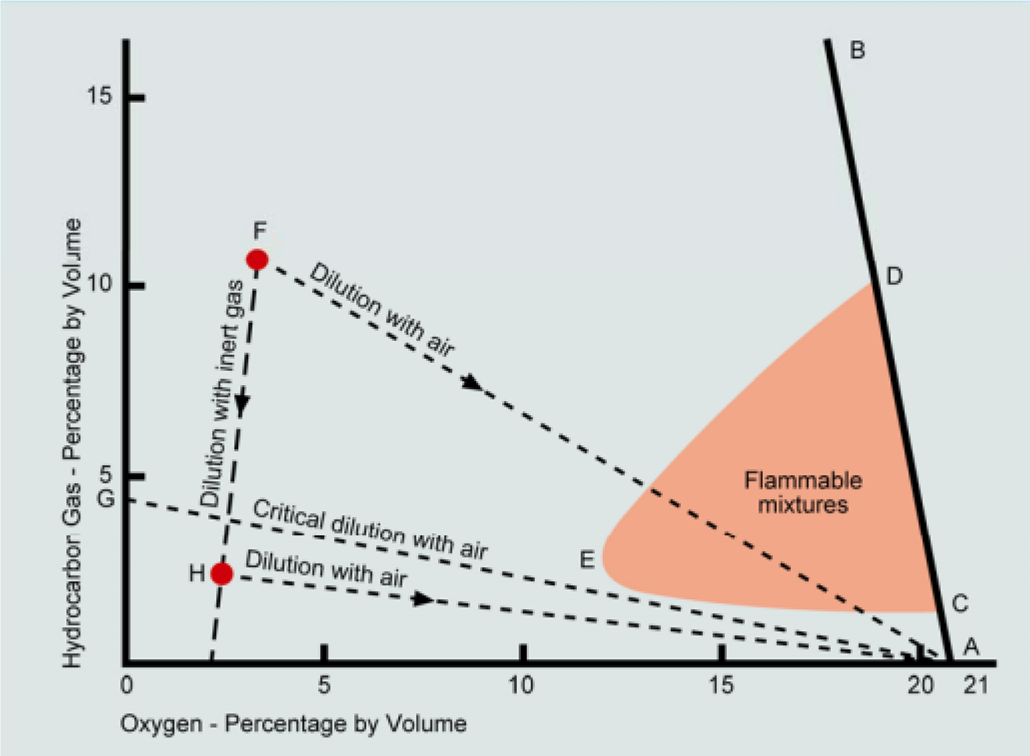

Figure 4. Flammability composition diagram [11]

When oxygen level drops to 11% by volume is decreasing combustion width as shown in the graph. As the safety is maintained below 8%. It is used to accelerate the discharge process by pressurized over the cargo in the tank. It prevents the loss of load by prevent evaporation of the load.

Chemical tanker is accepted that inert gas should be applied just before the start of unloading [12]. This is necessary to reduce the load handling time. However, nitrogen is considered just inert gas atmosphere. Cargo tanks, flashpoint not exceeding 60ºC carrying cargo or cargo residues including the slop tanks, means the cargo tanks. Inert gas systems, inert gas systems using flue gas, inert gas generators and nitrogen generators containing inert gas plant and with means to prevent the backflow of cargo gas to the machine area of the inert gas distribution means stationary and portable measurement devices and control devices. Gas-free is a condition in a tank, hydrocarbons or other flammable vapor content of the lower flammable limit (LFL) of less than 1%, oxygen content in case there is a minimum of 21% and no poisonous gas.

Inert Gas Systems

In the context of chemical tanker processes and chemical cargoes, an inert gas system might have three several uses: avoiding a fire and a chemical reaction or protecting cargo quality. Inert gas systems in tankers; nitrogen generators using membrane separation, exhaust of the boiler vessel, an

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inert gas generator, nitrogen generators using pressure swing adsorption (PSA), stored compressed nitrogen and may be a gas turbine plant equipped with an afterburner.

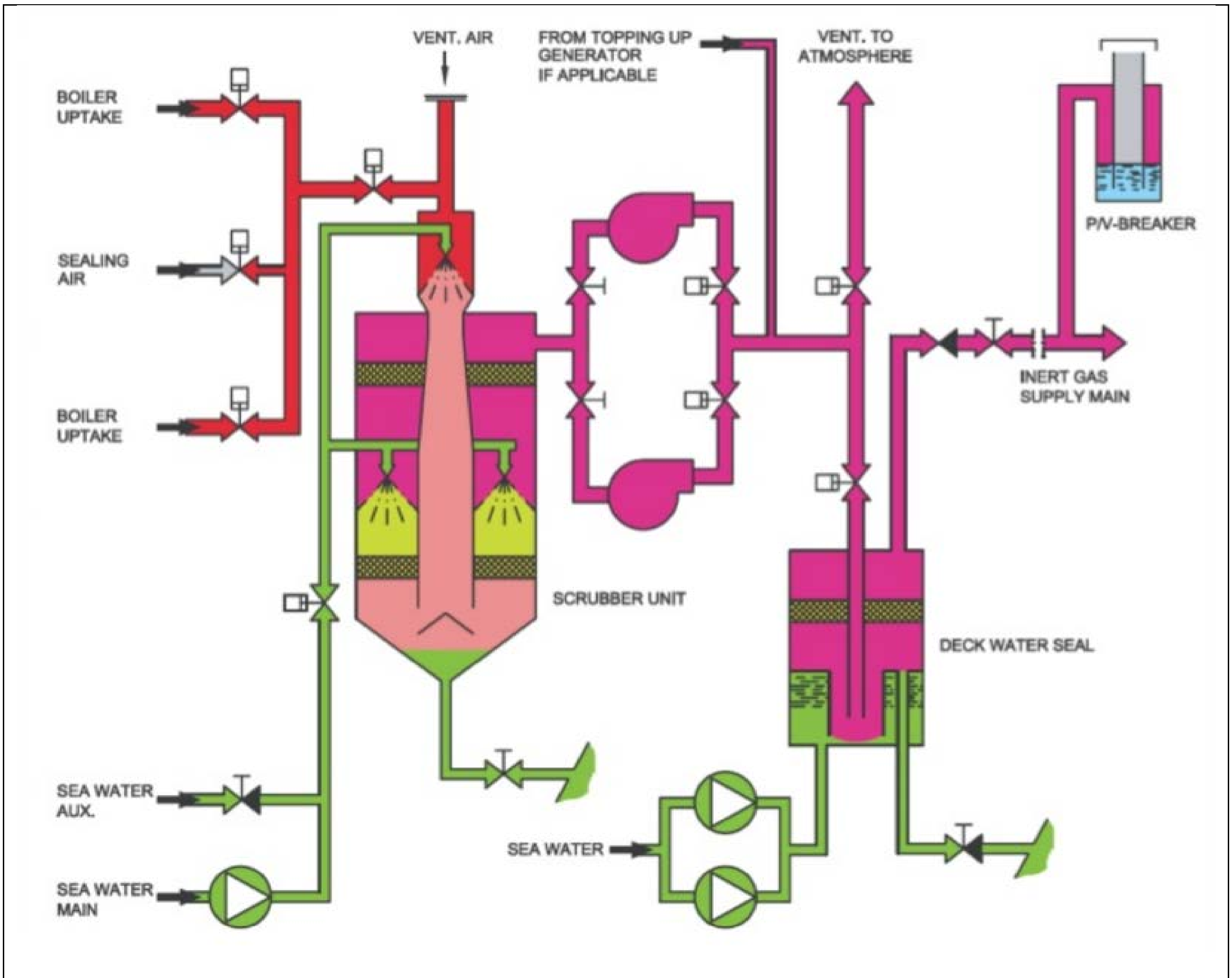

Figure 5. Flue Gas System[13]

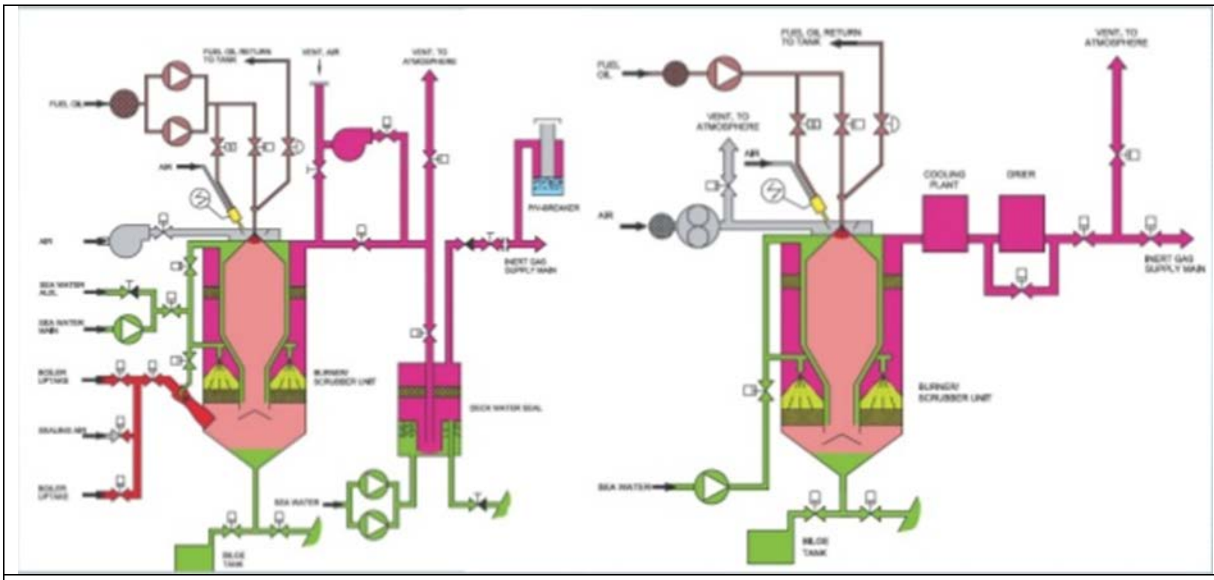

Figure 6. Inert Gas Generators for Oil/Chemical/Products and LPG/LNG [13]

CONCULUSION

Nitrogen used as inert gas on chemical tankers is not only used for protection reasons but also used for cargo standard control. Shippers frequently have their own private requirements to provide cargo quality. It can require inert gas of high purity, and may define that nitrogen for first inerting of cargo systems previous to loading a cargo will be provided from the loading terminal [14].

When using an oil fired inert gas generator, an oxygen level of less than 5% can usually be acquired, depending on the quality of burning control and the load on the boiler. The gas should be cooled and scrubbed with water to remove smut and Sulphur acids before being provided to the cargo tanks. But chemically reactive cargoes are delicate to oxygen concentrations as low as 2.0% by volume [15].

Some cargoes react with carbon dioxide in flue gases. Other cargoes are highly sensitive to moisture. For these reasons oil fired flue gas systems are infrequently used on chemical transporter when carrying chemical cargoes [16]. Therefore, inert gas systems are determined by the carrying substance in the chemical tanker.

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POSTER PRESENTATION

ASSESMENT OF TREATMENT METHODS FOR SHIP ORIGINATED WASTEWATERS

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Esra Billur Balcıoğlu[4], Neşe Tüfekci[5]

ABSTRACT

Seas and oceans are related to all water resources directly or indirectly. Waters reach seas and oceans being receiving waters following their natural cycles. Marine pollution consists of land based sources as 80%, ship originated as 12% and other sources as 8%. Ship originated pollution is classified as pollution from pollution from accidents, shipping activities and pollution from submerging of ships. 60% of world marine transportation is petroleum transportation. Oil-bearing vessels do not drain their load completely and an amount of oil stays at the bottom of the tank. It causes marine pollution that vessels release their wastes randomly without abiding by the international rules. Moreover, due to the accidents oil spills in seas and oceans have been reported many times. Ship originated pollution is grouped as bilge, ballast and domestic wastewaters. It is permitted that vessels can discharge their wastewater only having some criterions. The rest of the waters are processed (burn, separation etc) and discharged according to MARPOL 73/78. Wastewaters which are not permitted to discharge into the marine environment must be sent to waste acceptance facilities. Therefore it is needed to establish liquid and solid waste acceptance facilities that stores and treats the wastewater and sludge. The most efficient way to minimize the ship originated pollution is to treat the waste and wastewaters in vessels and waste acceptance facilities. Thus, treatment ways for ship originated wastewaters will be assessed and the most efficient treatment method will be determined in this paper.

Keywords - Bilge water, environment, marine pollution, wastewater treatment.

INTRODUCTION

The pollution by shipping activities is one of the most main reasons for marine pollution and it should be kept in mind that it has a huge impact on the marine environment and that devastating consequences are linked with it. Every year 1.800 million tons of crude oil end up in the sea and destroy the wide variety of marine animals and plants [1].

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Up to the early 1970s the international law regarding the marine pollution by ships was unfocused and fundamentally unregulated. In those days there were only national regulations. For protection the sea and to ensure safety and prevention of pollution from ships worldwide, the best way was to establish international regulations. Today a wide legislative framework attempting to prevent and reduce pollution from shipping activities and to mitigate the degradation of the marine environment exists [1].

The International Convention for the Prevention of Pollution of the Sea by Oil was the first international convention which objective was to preserve the marine environment against pollution by oil tankers established in 1954. It came into force in 1958 and set up criteria to ensure the protection of the sea. According to OILPOL, tankers were totally prohibited to discharge oil or any oil mixtures containing more than 100 parts of oil per million, within specified zones. A forbidden zone covers an area 50 miles from the nearest land. Although OILPOL did not focus on oil spill accidents caused by oil tankers, mainly on the discharge of oil mixtures in the sea and the pollution resulting from routine operations. Due to various amendments and the increase in oil trade and transportation, it was clear that OILPOL 54 did not work sufficiently, stricter and new guidelines were required in order to make it more compatible with present tanker practices [1].

The International Convention for the Prevention of Pollution by Ships, commonly known as MARPOL 73/78, made the OILPOL 54 Convention obsolete. MARPOL was adopted in 1973 and modified by the Protocol of 1978. Since the 1973 Protocol had not entered into force, the Protocol absorbed the Convention and as a combined instrument it entered into force on 2 October 1983. Through the years MARPOL 73/78 has been extended, modified and updated by various amendments and protocols. Now there are six Annexes, each dealing with a different type of ship-sourced marine pollution. Thus, it does not only deal with oil, which is regulated in Annex I but with all forms of marine pollution from shipping activities. The Convention includes regulations for control and prevention of pollution by hazardous and noxious liquid substances in bulk (Annex II), harmful substances carried by the sea in packaged form (Annex III), sewage pollution from ships (Annex IV), garbage pollution from ships (Annex V), as well as air pollution from ships (Annex VI). The first two of the annexes need to be accepted by the parties to the Convention, but the other annexes are voluntary [1].

Nowadays nearly 98% of the world’s merchant tonnage is registered to, have accepted and become parties to the MARPOL Convention. All vessels flagged under countries that signed the Convention are subject to its requirements, irrespective of where they sail or operate, and member states are responsible for ships registered under their respective nationalities. After a state signed the Convention, it is that state’s responsibility to create and enact national legislation which will implement the regulations set out in the convention [1].

MARPOL is not always effective, on the ground that there are some Member States which do not make this convention part of their domestic law due to the lack of experience, resources and know-how [1].

In this study treatment types for ship originated wastewaters will be discussed and the most efficient way will be determined.

CLASSIFICATION OF SHIP ORIGINATED WASTES

Domestic, bilge, sludge and dirty ballast waters being discharged uncontrolled from vessels into the marine environment cause a serious threat.

Transportation in recent years via vessels and larger tankers make ship originated pollution a current issue. For Istanbul which is a significant transit pass, commerce, industry and world ship transportation adds a serious dimension to ship originated pollution. Wastes from ship are classified [2]:

Dirty ballast: Ballast waters causes an oily appearance on the surface water, a colour change in water coloumn or on surface water and accumulation of suspended solid/emulsion.

Domestic wastewater: Waters from toilets and urinals, streams and wastewaters mixing from sink and bathtubs from hospitals, dispensaries and infirmaries.

Bilge: Bilge is the lowest part of a ship´s interior containing oily wastewaters.

Bilge waters: Waters accumulating in bilge tank.

Sludge: a sludge forming from residue or/and oil precipitations in engine room, petroleum and fuel tanks.

Slope: Oily wastewaters accumulating in slope tanks and washing waters of cargo tanks in vessels.

Poisonous liquid waste; describes a liquid contaminated from washing tanks following unloading of ship [2].

CHARACTERIZATION AND TREATMENT SYSTEM OF BİLGE WATER

Characterization of Bilge Water

Wastewaters consisting of fuels used in engine rooms in vessels, various lubrication oils and cooling water are collected in the lowest part of a ship´s interior which is known as bilge [3].

Oils, fuel and liquid forming waste from cargo hold wash water and engine room are known as the most significant wastes which occupies a place. These waters are not separated according to their properties, thus they are collected in the bilge as a mixture. Collected wastes in the bilge must be removed and discharged from vessel at regular intervals within the framework directives. If bilge waters are not drained as needed, it causes various problems such as load corruption due to humid conditions in cargo hold, rustiness in the hull, deteriorate in ship insulation and increase in fuel consumption.

Water, wash oils, cleaning liquids and compounds, fabric and string, metals, dye and dye derivations are generally found in bilge water. Moreover it contains fast oxidizing materials, volatile and semi-volatile organic compounds and organic salts.

These materials leaks from main and auxiliary machines of vessels, boiler and separators, connectors, junction of pipes and reach bilge. Various liquids are used due to the structural and operational properties of vessels. These liquids leaks from systems due to a few reasons such as neglect, aging etc. and form pollutant sources. Therefore this water must be discharged at regular intervals in terms of the balance of vessel and loading operation.

Generally 2 methods are used for disposing of bilge waters.

a- They are collected in a collection tank and discharged into the collection plant when the vessel makes land.
b- They are discharged into marine after decomposition using Oily Water Separator (OSW) while cruising.

In the second method, if the content of oil in the bilge water is lower than 15 ppm, it will be discharged into the marine. Otherwise oils which cannot be discharged are collected to be burnt or sent to waste accepted facility [4].

Characterization and amount of bilge water and discharge limits according to vessel size are shown in Table I and II.

Table 1. Amount of Bilge Water in Vessels [5]

Vessel Size (DWT)	Number of Staff (person)	Amount of Bilge (m^3)
15000-30000	30	25.0
30000-170000	50	27.5

Table 2. Character and Discharge Limits of Bilge Waters [5]

Parameter	Unit	Amount	MARPOL 73/78 Discharge Limit
Oil and grease	ppm	130000	15
TSS	mg/I	420-175	-
pH	-	5.8-7.8	-
Cupper	mg/I	27-190	-

TREATMENT SYSTEMS FOR BILGE WATERS

Absorption and Adsorption

Adsorption and absorption are both physicochemical sorption processes that can be used to separate oil from bilge water. Absorption is the incorporation of a substance from one physical state into another physical state (e.g., a liquid absorbed by a solid). Adsorption is the physical adherence or bonding of molecules onto the surface of another phase (e.g., reagents adsorbed from water only a solid surface). For both processes, bilge water is pumped through the sorption media in a reactor vessel or contactor, and the oil is removed from the media. Once the capacity of the sorption media is exhausted, the reactor or contactor is removed from service, and the media is replaced. For all sorption processes, the spent media is an oily solid waste residual. Certain spent media can be regenerated aboard ship while others may be regenerated or disposed of on shore.

Oil can be absorbed from bilge water using granular substrates and absorbents or cartridge filters with surfaces modified to have a high affinity for emulsified droplets [6].

Adsorption is used by bilge water treatment systems. Granular activated carbon (GAC) is the most popular adsorption media and dissolved oil and hydrophobic organic chemicals can be effectively removed from water. Initial capital costs for GAC adsorbers are relatively low. However, based on personal communication with a manufacturer, activated carbon has a low capacity for emulsified oil and becomes saturated once it adsorbs 10-20% oil by weight. GAC is vulnerable to high suspended solids and oil loading; these can foul or bind the adsorber and require frequent backwashing or media replacement.

Based on personal contact with a manufacturer, sorption processes are well suited for smaller (<400 GT) vessels on the grounds that they are relatively compact, have relatively low capital cost and cost of operation for treating modest volumes of bilge water, and require relatively low maintenance other than media replacement. Replacement is straight forward if the sorbent media is configured as modular cartridges, similar to under-sink water treatment devices.

In this case, the capacity of the activated carbon is significantly reduced, requiring frequent replacement of the sorbent media at greatly increased cost and liability of solid waste generation.

Biological Treatment

Microorganisms are widely used in biological treatment employs to convert the substrate (oil and other organic compounds) to carbon dioxide, cell components, and products typical of the usual catabolic pathways. The microorganisms are grown as a film attached to a synthetic support media in a bioreactor. Oil and related contaminants are degraded in this bio-layer by means of oxidations of hydrocarbons by bacteria. Aerators, located beneath the media, provide the oxygen required to support bacterial growth and oxidation of the target organic contaminants. Nutrient addition and pH adjustment of bilge water are also usually needed. Biological treatment of oily bilge water typically consists of the bioreactor and a final clarifier, which removes microorganisms (biomass).

Biological treatment can degrade organic pollutants (i.e., bilge oil) to low concentrations, even in the presence of detergents and other bilge contaminants. Emulsified oil being difficult to treat by physical/chemical treatment processes is readily degraded by microorganisms in biological treatment since small oil droplets are processed quickly [7]. Moreover, biological treatment is effective at removing other organic pollutants that may be of concern such as glycols, detergents, solvents, jet fuel, phosphates, nitrogen and surfactants. Biological treatment produces essentially no waste oil, which can be a significant advantage of this technology. Biological treatment is also mechanically simple and functions well under conditions of moderate throughout with controlled loading. Loading spikes can overwhelm and upset biological units, and the microorganisms upon which they rely are sensitive to temperature, pH and nutrient concentrations [6]. Capital costs are relatively high, even though operating costs are low. The degree of operator skill necessary for the proper function of biological treatment may be higher than that required for other polishing processes.

Coagulation and Flocculation

Coagulation and flocculation are associated processes which are used to aggregate particles too small for gravitational settling into larger, more readily settable aggregates. In the case of oil (particularly emulsified oil), the separation of the aggregated particles may also be accomplished by flotation. Coagulation and flocculation are often referred to as "emulsion breaking" in oily bilge water treatment. Following the separation of free oil in an OWS, the remaining emulsified bilge water is directed to a circulation tank where a flocculent chemical and, in the case of flotation, air are added to the water. Tank mixing is provided by a mechanical stirrers or circulation pump. The aggregation of colloidal particles involves two steps [8], particle transport to effect interparticle contact and particle destabilization to permit attachment when contact occurs. The aggregated flocks forming with the oil are skimmed off, and the remaining water undergoes through a number of filtering steps. Flocculation is also be used in conjunction with high performance gravity separation devices (generally a centrifuge).

Coagulation and flocculation are effective methods if they are properly applied, although they can suffer from several shortcomings [9]. These are:

- High susceptibility in change of influent quality,
- Optimization aboard each vessel to determine the type and quantity of required chemicals,
- Skilled operators and careful control (or sophisticated automation) to optimize performance.

Chemical addition is a daily or hourly process and a significant operating cost. Coagulation and flocculation can generate considerable quantities of sludge requiring disposal. According to manufacturers, as much as 5 to 25% of the volume of oily water treated by flocculation chemicals can become residual waste for onshore disposal [10].

Flotation

Air or gas flotation is used to enhance gravity separation. Flotation uses the differential density between the air or gas bubbles to which the oil droplets and small solid particles become attached and the water to effect separation. Since the agglomerates have a lower density than the medium in which they are immersed, they rise to the surface where they can be removed by skimming.

Flotation has been used to treat oil-bearing effluents from a wide variety of sources, including bilge and ballast waste aboard vessels [11]. There are different types of flotation systems classified based on their method of bubble formation. Dissolved air flotation (DAF), for instance, relies upon gas released from a supersaturated solution as a result of pressure reduction. As mentioned above, the flotation step is often augmented by the addition of flocculating agent and may be followed by additional gravity separation as a safety precaution [12].

Membrane Technologies (Ultrafiltration)

Membrane technologies, in essence molecular sieves, have been used for production of purified water in numerous industrial and municipal applications. Membrane processes have been developed to be an effective method for the treatment of oily effluents due to high efficiency in hydrocarbon removal, relatively low energy requirements, no chemical addition and relatively low space requirement [9]. Membrane operations typically are classified as three categories: nanofiltration (NF), ultrafiltration (UF) and reverse osmosis (RO) with the following particle size and molecular weight (MW) ranges shown in Table 1.

Table 1. Reverse Osmosis Particle Size and Molecular Weight Ranges [9]

Membrane technology	Particle size cutoff	Molecular weight (mw) ranges	Components retained
Ultrafiltration	0.01 to 0.1 µm	1,000 – 100,000	most organics over 1000 MW
Nanofiltration	0.001 to 0.008 µm (10 to 80 angstroms)	200 – 10,000	95% divalent ions, 40% monovalent ions, organics greater than 150-300 MW
Reverse Osmosis	0.0005 to 0.0015 µm (5 to 15 angstroms)	100 – 300	99% of most ions, most organics over 150 MW

Membrane processes have gained wide acceptance because they consistently produce effluents of acceptable discharge quality, and they are perceived to be a simple process from an operational viewpoint [9]. Membranes act as positive barriers to rejected components, so the quality of the treated water tends to be uniform regardless of influent variations. These variations may decrease the permeate flux, but generally do not affect quality of its output. Ultrafiltration (UF) has been the primary membrane technology used for bilge water polishing. UF devices separate high molecular weight constituents and solids from fluids by forcing the fluid through the very small pores of a polymeric or inorganic membrane. UF membranes allow the passage of water, ions, or small molecules, but prohibit the passage of oil and other larger molecules. UF operates at relatively low pressure (0.7–7 bar) because the osmotic pressure exerted by the high molecular weight solutes is negligible, and the membranes are designed to separate such solutes [13]. Membrane systems produce two output streams: permeate, which is the treated water, and the concentrate, which may contain up to 50% oil. The concentrate is typically recycled back to the bilge water holding tank.

As the oil recovered with the concentrate is usually de-emulsified, it can be readily separated by the OWS upon its subsequent pass through the treatment system. Based on personal communication with a manufacturer, experience has shown that bilge separators incorporating UF generate waste oil at a rate of less than 15% of the treated bilge water flow rate. The treatment of bilge water by UF has been demonstrated to substantially reduce the content of oil to less than 5 ppm [14]. Ceramic module UF systems have been tested and used on U.S. The systems are able to reduce oil concentrations from approximately 232 ppm to less than 5 ppm at flows of about 1 m^3/hr.

OPERATION PRINCIPLES AND UNITS OF WASTE ACCEPTANCE FACILITIES

The establishment of adequate waste acceptance facilities (WRFs) is a necessary step to reduce and eliminate ship originated pollution. WRFs should be designed by taking into account the ship types that may be anticipated to use them. Consideration should be given to the requirements for ballast tank cleaning that may take place and of repair facilities in the area(s) the acceptance facility serves. The capabilities and any capacity limitations of acceptance process (facilities and equipment’s) should be made available to ships wishing to use the facility. The details made available to ships should include but not be limited to: 1) maximum capacity (volume or weight) of sediment, 2) maximum volume or weight that can be handled at any time, 3) packaging and labeling requirements, 4) hours of operation, 5) details of ship-to-shore transfer, 6) ports, berths, areas where access to the facility is available, 7) if ship or shore crew are required for the transfer, 8) contact details for the facility, 9) how to request use of the facility including any notice period and what information is required from the ship, 10) all applicable fees, and 11) other relevant information.

A port WRF needs to be introduced to seaport and terminals entertaining ships with sludge tank, in addition to all ports.

- which have ships generating oily bilge water and other residues that cannot be discharged into the sea,
- which are loading crude oil,
- loading and discharging bulk cargo in respect to oil residue from combination carriers,
- in which 1000 tons/day oil other than crude oil is loaded,

having ship repair yards and providing tank-cleaning facility [15].

CONCLUSION AND ASSESMENT

An important reason of ship originated marine pollution is discharge of vessel solid and liquid wastes (wastewaters) as well as oil spills, ship dyes and ballast waters. Vessels must store the residues of wastes which are permitted to be discharged into the sea according to International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). Ships discharge the wastes which are allowed to be drained into the sea, and give wastes to waste acceptance facilities in ports following process wastes such as burn, separation etc. which are not allowed to be drained. Therefore, waste acceptance facilities are needed in ports for storage of wastes and residues without any delay. The most efficient way to minimize the ship originated pollution is to treat the wastes and wastewaters using suitable treatment systems on board during the cruise or discharge to waste acceptance facilities at ports. Two kinds of wastes are formed in waste acceptance facilities as petroleum contaminated waters and petroleum originated wastes.

Generally, wastewaters are discharged into marine following treatment using conventional methods and petroleum originated waters are sent to disposal plant or recovery plants. Ship originated wastewaters have a structure making emission. In other words, water, oil and particles are bound to each other in the waste. It is needed that some auxiliary equipments and materials must be used for particles to release their water in this type of wastewater and this case complicates the treatment.

Ship originated wastewaters have changeable character so various treatment technologies must be used together. Therefore, many combinations can be developed containing adsorption, absorption, coagulation- flocculation, biological treatment, floatation and membrane technologies.

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POSTER PRESENTATION

EVALUATION AND PREVENTION OF MARINE POLLUTION IN TURKEY

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ABSTRACT

Approximately 70 % of the Earth is covered by oceans and seas. For Turkey being surrounded by seas on three sides, the prevention of marine pollution is particularly important. Marine flora and fauna should be considered as well as living, recreation and tourism. However, industry, marine transportation, urbanization, direct discharge of waste and major accidents in the oceans and seas damage marine flora and fauna, and also lead to rapid contamination. Marine pollution is a significant part of environmental pollution. Yet the disadvantage of the marine is being receiving water for all type of pollutants originating various environments such as land, rivers and the atmosphere. Some of them are pesticides with chloride, artificial radioactive substances and the tributyl stannum and these contaminants are totally extraneous matter to the seas. Other contaminants such as lead are found naturally in sea, but high concentrations disturb the natural balance of the sea. In this study, national and international agreements which had been made for preservation marine pollution and literature studies are evaluated. And the importance of seas of Turkey is underlined.

Keywords −Contaminant, environmental pollution, marine accident, marine pollution

INTRODUCTION

Marine pollution can be described as; discharging matters and energy into the sea directly or indirectly, by human activity. These matters and energy have some negative effects on marine ecosystems, threat for human health, prevention for fishing and other legal uses of marine resources, deterioration in the quality of sea water. The most important reason for the consequences of marine pollution is reducing the amount of oxygen in seawater. Depleted oxygen level creates anaerobic environment which causes oxygen dependent sea creatures to extinct. By the extinction of the sea creatures marine ecosystem, food chain and as a result sea water quality is deteriorated.

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Marine pollution could be classified such as oil (petroleum), heavy metal, detergent, microplastics, pesticides and marine litter pollution.

Turkey, having a coastline of approximately 8,000 km, is situated to the southeast of Europe and northeast of the Mediterranean Sea where the European and Asian continents meet via the Turkish Straits System. Due to this geographical location, Turkey is in the middle of the Middle East, North Africa and Caspian Region oil reserves which account for two thirds of the global oil reserves. It is also a transit country between oil producing and oil consuming countries. Furthermore, important amounts of Iraqi and Caspian Azerbaijani oil have been carried using pipelines to the Ceyhan oil terminal on the Turkish Mediterranean coast and distributed from there to the users world-wide (REMPEC) Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea [1].

Oil pollution is one of the most important pollution types in marine environment. Oil enters the seas due to spectacular oil tanker or marine accidents, and particularly from diffuse sources, such as leaks during oil extraction, illegitimate tank-cleaning operations or transportation. Oil inputs also include volatile oil components being relased into the atmosphere during various types of burning processes and then enter the water. Since oil (petroleum) pollution is one of the serious problems, it has been extensively investigated in many scientific publications. Detailed studies on petroleum hydrocarbons are examined in Marmara Sea [2-6], in Aegean Sea [7- 11], in Black Sea [12, 13].

Detergent contamination poses a special problem in the pollution of seas is a toxic compound for marine life and its film covers surface water and prevents penetration of oxygen to water from air. In the research on *Oncorhynchus mykiss* in aquarium, the lethal dose is 12,5 mg/L for single dose and 35 mg/L for progressive dose [14] and also affects on plasma parameters [15]. LAS (detergent) pollution was investigated in various parts of the Turkish Seas such as Marmara Sea [16 – 20], Aegean Sea [21; 22], Black Sea [23].

Microplastics are tiny pieces of plastic, smaller than 5 mm that pollute the world’s oceans. They were first researched in 2004 when a team of scientists showed that ‘microplastic‘particles had accumulated in the oceans since the 1960s and are now present worldwide. Microplastics originate in two main ways, firstly from products such as exfoliating beauty products including microbeads. Secondly, they are also formed from the disintegration of larger plastic matters being broken down by sunlight. They may act as carriers of contaminants and can enter the food web and as direct and indirect (i.e. toxic chemicals carrier) risks for marine biota (including large filter feeders) [24]. Marine litter and microplastics are investigated by various studies extensively in different marine environments such as [25] in Marmara Sea, [26- 28] in Black Sea, [29 - 31] in Mediterranean Sea and [32; 33] in Aegean Sea.

Heavy metals are defined as metallic elements that have a relatively high density compared to water. They are tolerated at low concentrations, but may become toxic at higher levels. In marine environments however, three metals are of primary concern: lead, mercury and cadmium [34]. Heavy metals are a natural part of the earth's crust. Heavy metals enter the sea usually through river, atmospheric deposition and anthropogenic activities. Heavy metals are stable and accumulated in the environment. They are mostly concentrated in coastal areas, near densely populated and industrialized regions in marine ecosystem. these metals are combined to particles and these particles are often tiny so they can stay in solution for a long time. Nevertheless they end up in the sediments having 10 to 100 times higher levels than those in solution [35]. There are various and comprehensive studies on metal pollution in Turkish Seas such as Marmara Sea [36 - 39], Aegean Sea [10, 11, 22, 40 - 47], Black Sea [41, 48 - 51].

Microbiological pollution is one of the most serious pollution types. The bacteria belonging to *Enterobacteriaceae* family which enter the marine environment via domestic, industrial waste and maritime transport are considered to be the indicator of bacteriological contamination. Due to uneconomical way is to determine pathogenic bacteria individually in the sea water, indicator bacteria analysis have become a common approach to determine the level of bacteriological pollutioin and potential existence of pathogenic bacteria [52]. Microbial contamination in coastal waters may change seasonally due to temperature, rainfall and other influences [53]. The pathogenic bacteria inputs are undesirable situations with respect to public health, ecology and the environment. Bacterial pollution has been investigated various studied in Turkish Seas [54 - 57].

THE REASONS OF MARINE POLLUTION

Land run off: Land run off is a source of pollution in the ocean. This occurs when water infiltrates the soil from rain, flooding or melting flows over the land and into the ocean. Mostly, this water contains antropogenic harmful contaminants polluting the ocean.

Pollution from wastewater discharges of industrial plants: Many chemicals are released into the marine environment due to the discharging of wastewater without treatment. These chemicals harm the marine ecosystem significantly and accumulate in human and animals via marine organisms.

Ship accidents: Particularly, as a result of oil spills due to the oil carrying tanker accidents, oil layer on the sea surface prevents sunlight access and causes the death of many marine organisms [58].

Discharge of the ballast and bilge waters from the ships: Ballast water being loaded from a ocean randomly is used for keeping the ships in balance during the cruise. Yet the ships discharge ballast water into the other seas or oceans unconsciously that deteriorates the marine ecosystem. This case harms local species seriously [58].

Petroleum platforms and pipelines located on the seas and oceans: Location of pipelines in seas causes non-recovery harms to the marine environment during and after construction, transportation and also accidents on the platforms.

THE EFFECTS OF MARINE POLLUTION

Toxic Effects of Wastes on Marine Organisms: When oil enters into the ocean it could get on to the gills of marine animals so they cennot move or fly easily and they suffer the long term effect such as cancer, changes in behaviour and death.

Decrease of Oxygen in Water: Debrises in the ocean are not decomposed, remain for years and use the oxygen during degradetion. Consequently oxygen level decreases seriously.

Effect on Food Chain: Industrial and agricultural chemicals contaminate rivers and reach to the oceans. These chemicals sink at the bottom and bentic life is affected.

*Failure in the Reproductive System of Sea Animals***:** Accumulation of poisonous chemicals being found in industrial wastes, causes a failure in reproductive systems of animals.

Effects on Human Health: Consumption of impacted animals by human may cause cancer, birth defects and long term health issues.

CONVENTIONS AND LEGAL REGULATIONS ABOUT MARINE POLLUTION IN TURKEY

There are some conventions and legal regulations about marine pollution in Turkey. These international conventions in which Turkey is a party and not a party are given in Table 1. As seen from the table Turkey supports almost all of the conventions and legal regulations. So it can be said that Turkey attach importance to marine pollution and preventation.

Table 1. Conventions on marine pollution

Conventions	**Turkey's situation and content information**
International Convention for the Prevention of Pollution from Ships (MARPOL) Annex I: Prevention of pollution resulting from offshore Oil and Derivatives 2 October 1983	24 June 1990 International Oil Pollution Prevention Certificate-Annex-I The Convention "oil causing pollution ' crude oil, fuel oil, refined petroleum products is intended. Petrochemistry products are not in scope.
(MARPOL) Annex II: Control of pollution by noxious liquid substances in bulk 6 April 1987	24 June 1990 Certificate of Fitness It details the discharge criteria for the elimination of pollution by noxious liquid substances carried in large quantities.
(MARPOL) Annex IV: Prevention of Pollution by harmful substances carried by sea in packaced form Ships resulting from sink waste 7 July 1992	Turkey is not a party to Annex III It contains general requirements for the standards on packing, marking, labeling, documentation, stowage, quantity limitations, exceptions and notifications for preventing pollution by noxious substances. International Maritime Dangerous Goods (IMDG) Code There is no certificate.
(MARPOL) Annex IV: Prevention of Pollution from Ships resulting from sink waste 22 September 2003	It introduces requirements to control pollution of the sea by sewage from ships There is a certificate
(MARPOL) Annex V: Prevention of Pollution from Ships resulting from solid waste 31 December 1988	Turkey is a party to Annex V It specifies the distances from land in which materials may be disposed of and subdivides different types of garbage and marine debris There is no certificate.
(MARPOL) Annex VI: Prevention of Air Pollution from Ships 19 May 2005	It introduces requirements to regulate the air pollution being emitted by ships, including the emission of ozone-depleting substances, Nitrogen Oxides (NOx), Sulphur Oxides (SOx), Volatile Organic Compounds (VOCs) and shipboard incineration. It also establishes requirements for reception facilities for wastes from exhaust gas cleaning systems, incinerators, fuel oil quality, for off-shore platforms and drilling rigs and for the establishment of SOx Emission Control Areas (SECAs)
International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990 (OPRC - 1990) [59]	18.09.2003 This convention introduces; Preparedness, Response, Co-operation, training and technical support between the parties on Oil pollution.
International Convention of Rescue, 1989	27.9.1990

(SALVAGE - 1989) 14 July 1996 [59]	This contract specifies the encouragement of the studies about preventing the pollution.
International Convention on Civil Liability for Oil Pollution Damage, 1992 (CLC - 92) [59]	It is applied for the damages caused by continious oil pollution from the petrol tankers.
International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1992 (FUND - 1992) [59]	18.08. 2001 1992 Fund Convention is an annex to 1992 Civil Liability Convention. If Civil Liability Convention is not enough, then compensation for the damages will be applied according to the Fund Convention.

MARINE POLLUTION IN SEAS OF TURKEY

Marmara Sea and Turkish Straits System: Turkish Straits, connecting Black Sea and Mediterranean Sea and this system has one of the busiest marine traffic in the world.

The increasing traffic in Turkish Straits System bring out the accident risks causing massive environmental destruction and damage such as past examples and turkey had to take some security measures in 1994 and revised in 1998. Besides traffic separation schemes (TSS) were introducedin 1994 in the Straits with the domination of the International Regulations for Prevention of Collision at Sea (COLREG). These schemes were validated by the International Maritime Organization (IMO) in November 1995. The IMO Rules and recommendations have been saved the purposed and there hase been a significant decline in the number of accidents.

Marine Pollution in Black Sea: The environmental situation of Black Sea has been suffered major problems such as pollution, coastal deterioration and decrement in biodiversity. One of the pollution type is oil pollution originating operational and accidental discharges from vessels. Other toxic substances such as pesticides come from rivers due to agricultural activities and heavy metals coming from industry.

Another significant issue is the discharge of untreated sewage waters causing bacterial contamination and poses a threat to public health. Radioactivity has been introduced to the Black Sea in more significant amounts after the nuclear power plant disaster in Chernobyl in 1986.

Against pollution The Convention on the Protection of the Black Sea (Bucharest Convention) was signed by Turkey, Romania, Ukraine, Bulgaria, Georgia and the Russian Federation in Bucharest on 21 April 1992, entered into force on 15 January 1994.

Marine Pollution in Mediterranean Sea: The Mediterranean Sea has played a central role in the development of civilization. Most pollution originates in one of five sectors: energy, agriculture, industry, transport, or households.

The Mediterranean Action Plan (MAP) was approved in 1975, followed in 1976 by the Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona Convention). These general frameworks were more specifically detailed in 1980 by the Protocol of the Mediterranean Sea against Pollution from Land-based Sources (LBS Protocol).

The main objectives of The Barcelona Convention are:

- To control marine pollution and protect natural and cultural heritage;
- To hedge sustainable management of marine nature and coastal resources;

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- To protect the marine environment and coastal zones;
- to strengthen solidarity among Mediterranean coastal states; and to improve the quality of life.

CONCLUSION

For sustainable sea water quality there are some important issues have to be done. The conclusions of this study were specified on marine pollution as the following: Sea water quality is the very important for the sea life. Coastal administration is an important mechanism for avoiding marine pollution. Receiving resources should be protected from untreated waste of pesticide, herbicide and chemicals. Prevention is an important way to inhibit coastal pollution, but will need radical changes in all levels of society. Since marine pollution can be prevented by legal regulations, governments and law competent authorities must be determined to apply the rules for protection the marine environment against the pollution.

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