III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation

18th-19th of April 2019 Selçuk, İzmir

Proceedings

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ISBN: 978-605-01-1268-9

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Online Publication Date : 31.07.2019

Editors:
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FOREWORD

On behalf of the organizing committee, we are delighted to welcome you to the 3rd Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation (GMC2019) which is to be held 18-19 April 2019 in İzmir, Turkey.

Digitalization in Maritime Community is one of the most debated topics in recent times. With the introduction of Industry 4.0 concept, many technology developing corporations have already started R&D projects to digitalize the traditional industry in order to increase the source efficiency, incorporate business partners in production process and also to improve the ability of information exchange between production tools.

Researchers in maritime field report that Maritime Sector will face even greater challenges to provide and sustain measures for safety, security, environmental concerns and efficient operation in near future. Besides energy efficient and environment friendly ships, autonomous ships will be on the top of the agenda though some issues exist to be overcome such as technological advancement status, concerns for safety and issues regarding insurance etc.

For the seafarer's point of view, the recent technological advancements will continue to create changes in their education and training strategy to include communication skills to understand and interact with the systems and machinery surrounding them. This will possibly lead to a new kind of competencies for seafarers to be proposed.

Considering this perspective, the theme of the 3rd GMC2019 conference was chosen as 'Innovation in Maritime Transportation' and 'Impact of Technological Advancements on Maritime Industry'. During the two days of the conference, we will have the opportunity to hear our esteemed key note speakers enlightening us for the state-of-art and also observe the presentations of 64 fine papers authored by distinguished delegates contributing to useful knowledge. We have no doubt that the conference will inspire the young researchers and provide food for thought to many.

We would like to express our gratitude to all academics, maritime sector representatives and our conference sponsors who made this event possible, and wish all participants a pleasant stay in the beautiful city of İzmir.

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The Proceedings *of GMC '19*

CONTENT

1. Producing Electricity Power from Ship Exhaust Gases: A Cost Analysis Application on a Ro-Ro Cargo Ship 4
2. Experimental Investigation of using Emulsified Fuel in a Diesel Engine on Performance and NOx Emissions 15
3. Investigation of the Effects of Marine Fuels in Lubrication Oil on The Friction of Piston Ring-Cylider Liner in Marine Diesel Engines 24
4. Environmental Impacts of the Exhaust Gases from Ships 37
5. Classification Analysis for Studied Fields in Maritime 45
6. Preparing Dataset for Deep Learning based Ship Detection 66
7. Determining Maritime Educational Needs for Energy Efficiency Within the Scope of MarEd Project (Erasmus+Programme) 82
8. Evaluating Efficiency Improvement Potential of an Organic Rankine Cycle for a Marine Diesel Power Plant by Applying Advanced Exergy Analysis 99
9. Evaluation of The Maritime 4.0 Using The AHP Method 123
10. An Extensive Research into Possibility of a Human-Centered Safety System for Fatigue Detection at Sea 138
11. A Survey for Analysing Factors that Affecting Marine Service and Seafarers' Job Satisfaction: Case Study for Turkey 150
12. A Compliance Analysis of Marine Engineering Cadets' Practices on Maintenance and Repair of Shipboard Machinery/Equipment Tasks & Duties Within On-Board Training Book Records 166
13. The Effect of Stress' on Seafarers' Job Performance 183
14. The Components of The Port Hinterland Performance: A Literature Review Study 192
15. Statistical Analysis of Tanker Inspection Reports 207
16. A Study on Turkish Maritime Trade Statistics 220
17. The Effect of Piracy on Maritime Transportation 235
18. Analyzing Organizational Culture for Innovation Performance in Maritime Industry 253
19. Impact Analysis for Explosion Scenario of a Sailing Gas Tanker 268
20. Are The Ships Fully Secured Against The Cyber-Attacks? 276
21. Maritime Investigation Reports Involving Man-Over-Board (MOB) Casualties: A Methodology for Evaluation Process 289

22. Investigation of Marine Accidents Under the HFACS-PV Structure 333
23. Case Study on Marine Accidents Occurred in VTS Areas 355
24. Relationship Between the Amount of Container Cargo Handled in Turkey with The Number of Turkish-Flagged Container Vessel 371
25. Maritime Security in The Framework of NATO Security Architecture 383
26. Evaluating unmanned vessel through regulatory framework 396
27. Use of Unmanned Aerial Vehicles in Maritime Search and Rescue Operations 406
28. Energy Efficiency and Environmental Aspects of Refrigerated Containers in Maritime Transport Towards Intelligent Systems 418
29. Investigation of Issues in Tank Cleaning Operations and a Proposal of an Automated System for Improvement in Tank Cleaning System 433
30. The Investigation of Improvement with Tall Oil Fatty Acid of Negative Effects Through Diesel Oil Mixed with Lubricating Oil in Marine Diesel Generators 462
31. Criteria Comparison of Companies Which Have Different Tonnage of Vessels for BWTS Selection 473
32. A Comprehensive Study On Assessment of Safety Climate Based On Theory of Planned Behaviour in Maritime Domain 488
33. A Review on Practicality of Cognitive Performance Tests in Deck Officer Selection 499
34. Investigation of Seafarer Employment in Turkey 514
35. Future of Vessel Traffic Service as A Socio Technical System and Simulation Tools 534
36. The Analysis of Endorsement and Recognition Problem for Turkish Marine Officers' Certificate of Competencies (CoC) 548
37. Investigation of Bilge System Assembly Operations of the Black Sea Type Fishing Vessels 579
38. Comparison of Damage Stability in Tankers for Different Subdivision 589
39. Interpretation of Rule-Based Ship Structural Element Sizing by Finite Element Analysis 600
40. The Prediction f Ship Shaft Bearing Gap By Artificial Neural Networks And Dry docking Maintenance Planning 617
41. Determination of Evaluation Criteria for the New Traffic Separation Schemes and Implementation for the 1915 Çanakkale Bridge 627
42. Analysis of Marine Traffic by Simulation Method in Liquid Bulk Terminals 646

43. A Review of Agent-Based Simulation in Maritime Transport 661

44. An Application of Agent-Based Modeling for the Maritime Transportation 681

45. A Review of International Standards of Environmental Noise and Its Adverse Effects on Port Workers 694

46. Technological Advancements and Innovation in Logistics Industry: Perspectives of Maritime Faculty Students 706

47. Overview of the Newly Opened Arctic Routes in Terms of World Maritime Shipping…….. 719

48. A Brief Comparison of International and National Regulations on Preparedness Response and Co-Operation to Pollution Incidents by Oil, Hazardous and Noxious Substances (HNS): Status of Pollution Response Organization 736

49. Analysis of Marine Traffic Density Using AIS Data: An Application in the Iskenderun Bay 747

50. Shipmaster Evaluation System for the Safety of Navigation and Fleet Management ..... ……764

51. Examination of Ships Arrested by Years in Port State Controls 778

52. Training and Assessing Software in MET 798

53. Industry 4.0, Industrial Internet of Things and Shipping 4.0 epoch: Tasks, Challenges and Problems 808

54. Towards Introducing Knowledge Management Concept to Maritime Education & Training 818

55. Optimal Use Of Port Cranes To Maintain The Environment Of Port Cities 839

56. Updating Issue in Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) 851

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The Proceedings *of GMC '19*

Producing Electricity Power from Ship Exhaust Gases: A Cost Analysis Application on a Ro-Ro Cargo Ship

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ABSTRACT

Fuel cost, in the framework of ship total operation costs, play importance on maritime transportation. On the other hand, greenhouse gases (GHG), emerging from ship fuels is another challenge that ship owners and ship operators have to face. This paper's main contribution is presenting the availability of producing electricity power from ship main engine's exhaust gases. Hot exhaust gases reveal from ship main engines during sailing periods. After using waste exhaust gases at turbocharger and exhaust gas boiler, respectively, those gases discard through funnel to atmosphere in spite of still consisting of respectable energy. Therefore, recycling waste exhaust gases in order to produce electricity power have important benefits in both aspects: economic and environmental. Making use of waste exhaust gases for electricity power provides less fuel consumption and as a matter of course less GHGs to atmosphere. Producing electricity power works on the principle of Organic Rankine Cycle (ORC). In this paper, this electricity generator system application on a model Ro-Ro cargo ship cost analysis was carried out by using Net Present Value (NPV) method. Underlying parameters including initial cost and operation cost of system, reduction amount of fuel consumption, ship sailing time were used to determine whether this system is profitable or not.

Keywords: Exhaust Gases, Organic Rankine Cycle, Fuel Consumption, Cost Analysis

1. Introduction

In many ways, shipping is unrivaled transportation mode in the world. Especially cargos, which have very big weight and volume, have not a chance of transporting by other transportation modes such as airways and railways transporting. According to data of worldwide transportation, announced on January 2016, maritime transportation provides around 80 per cent of the volume of international trade in goods [1].

In spite of having many advantages of maritime transportation, ship fuels are still an important item in both economic and environmental ways for shipping companies to face. Fuel cost, consisting of ship's total lubricating oil and fuel consumption both at sea and port period, is the main item of voyage costs contributing between 47% and 53% of total cost [2], [3]. On the other hand, ship fuels have also negative effects on maritime transportation. By the year 2014, the total fuel oil consumption of the global merchant ship reaches around 330 million tons of fuel annually and 80-85% of that amount is residual fuel oil having high sulfur content. The rest of that amount is distillate fuels which are appropriate for International Maritime Organization (IMO) regulations, which put into action for restricting greenhouse gases (GHG) (especially NO_x, SO_x and particulate matter-PM) onboard [4]. However, CO_2 is also dangerous for environment. In 2012 total CO_2 emissions arising from shipping fuels reached to 602 million tones contributing of 1,90% of the total CO2 emissions from fuel combustion [5].

In order to eliminate both economic and environmental disadvantages of ship fuels, shipping companies is today facing challenges on fuel consumption and energy efficiency. Fuel costs are the combination of fuel prices and fuel consumption. Shipping companies cannot control the fuel prices but they can control fuel consumption. For environmental purposes less fuel consumption means less GHG emissions. That's why many methods are applied onboard for lowering fuel consumption. Using ship waste heat coming from main engine exhaust gases with Organic Rankine Cycle (ORC) is one of the popular methods for energy efficiency onboard.

2. Organic Rankine Cycle

Because of increasing fuel prices and stricter upcoming regulations by IMO, energy efficiency became vital reality of the shipping. Hence, nowadays technologies about converting low grade heat into power are being studied. One of the most hopeful technologies is the ORC, which is convenient for various heat sources and provides simple power cycle [6].

Organic rankine cycle has similarities with steam rankine cycle. Steam rankine cycle comprises from four basic components; pump, boiler, turbine and condenser. Boiler is a big heat exchanger in this cycle. Saturated water is pumped to cycle and then converts into superheated steam by boiler heat transfer. After that superheated steam expands on turbine and turns the shaft attached to the generator for electricity production. After the turbine, saturated water-steam mixture goes to the condenser and converts into saturated water. Thus, water comes to again to the pump and cycle is completed. Besides, ORC cycle uses organic fluids instead of water which vaporize at lower temperatures and reaches at higher pressures [7].

Using those organic fluids in cycle instead of water brings out some advantages to ORC;

- Less heat requirement for evaporation process
- Due to the expansion process ends in the vapor form, superheating is not required. So there is no the risk of blades erosion.
- The evaporation process occurs at lower pressure and temperature.

The temperature difference between evaporation and condensation processes is smaller. Therefore, pressure drop/ratio is smaller and simple single stage turbines can be used in ORC systems [8].

Geothermal energy, solar energy, ocean thermal energy, solar ORC reverse osmosis (RO), binary geothermal power plants, ORC biomass power plants, Duplex-rankine cooling system and ORCs in waste heat recovery system (WHRS) are the main applications of ORC

[8]. However, ORC in WHRS one of the promising applications on ships for lowering fuel consumption.

2.1 ORC in Waste Heat Recovery System Application on Ships

In general, marine diesel engines' maximum 55% of the fuel energy is converted into useful power output and the rest, mainly exhaust gas, is lost [9]. In typical marine diesel engines, after exhaust gas stroke waste exhaust gases go through turbocharger and exhaust gas boiler, respectively. Then they are discarded from funnel to atmosphere. However, those hot gases still consist of respectable energy. Both in economic and environmental ways it is very important to profit from waste exhaust gases onboard.

Fig. 1 shows a diagram of ORC in waste heat recovery system.

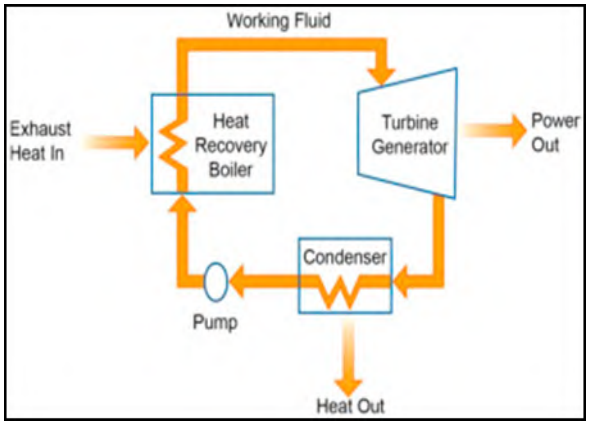

Figure 1. ORC in WHRS [10].

According to Fig.1 heat energy, that provides vaporizing working fluid in ORC system, is coming from exhaust gases. In marine application, the source of heat energy is provided by waste exhaust gases after following up exhaust gas boiler.

The literature review reveals fair interest on this topic especially after IMO regulations about restricting GHG emissions from ships. Baldi and Gabrielii [11] used ORC in waste heat recovery system (both exhaust gases and cooling waters from diesel engine) in their work and found out that 5% and 8% fuel savings could be achieved in marine applications.

Song et al. [9] also studied on ORC in WHRS on ships and revealed an efficiency increase of 10.2% for the marine diesel engine. Singh and Pedersen [12] examined all WHRSs (including ORC) for maritime applications and stated that WHRSs onboard can lower the cost and mitigate maritime emissions. Bellalio et al. [13] discussed ORC in WHRS for ships. In that work they analyzed fuel savings and emission reduction by using ORC in WHRS and found out that up to 6% fuel savings and remarkable GHG emissions reduction can be achieved.

3. Description of the Investigated Case Study

ORC in WHRS application on model ship was investigated. Model Ro-Ro ship average main engine exhaust temperatures at sailing period are shown on Fig.2.

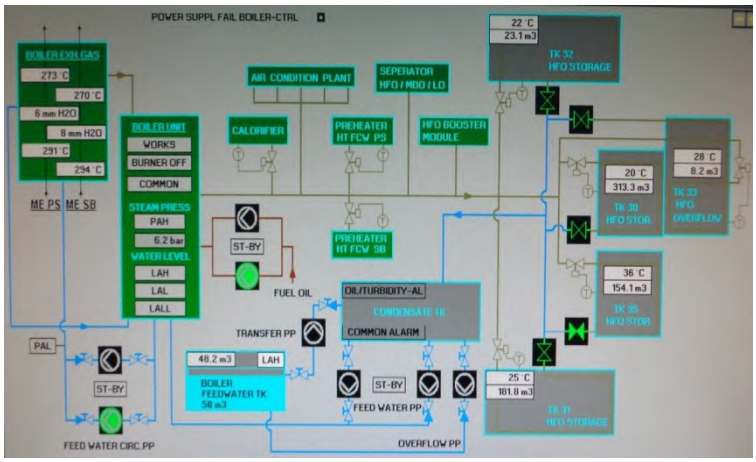

Figure 2. Model ship main engines' exhaust gas temperatures

Model ship is equipped with two four-stroke main engines with total power output of 16200 KW. As seen Fig.2, after stopping by turbocharger exhaust gases go through exhaust gas boiler at 291ºC and 294 ºC. Following exhaust gas boiler, exhaust gas temperatures drop to 273 ºC and 270 ºC. According to previous works on ORC in WHRS

applications [8], [12], those temperature values are fair enough to use ORC in WHRS application on model ship.

Model ship is frequently on service Pendik-Trieste-Pendik route where total sailing time is 128 hours per week. Energy study report, made for model ship's company, shows that ORC in WHRS with 200 KW power capacity is convenient for model ship. However, after the usual loses net power will be around 170 KW. Price of that ORC system is around €800.000. Previous study about ORC in WHRS system application on ships shows that operation and maintenance (O&M) cost is around £0,0079 KW/h [14] which is equal to €0,0089 KW/h (European Central Bank exchange rate on 12 February 2018).

Using model ship's total sailing hours for a year (52 weeks), O&M cost (KW/h) and ORC system power output, operation and maintenance cost will be around €11.847.

$$O\&M\text{cost} = \text{ORCpower} \times 0{,}0089 \times \text{Sailing time} \times 52 = €11.847 \quad (1)$$

Talking about revenues; 170 KW net electricity power production for one-year total sailing time will be around 1.131.520 KW/year.

$$\text{Power} = \text{ORCnet} \times \text{Sailing time} \times 52 = 1.131.520 \text{ KW/h} \quad (2)$$

The cost of 1 KW electricity by fuel oil is €0,0676 [15] in this way total electricity power revenue by ORC system will be around €76.490 per year.

$$\text{Power revenue} = 1.131.520 \times 0{,}0676 = €76.490 \quad (3)$$

4. Methodology

In this paper, net present value (NPV) and internal rate of return (IRR) methods were used to determine whether ORC system application on model ship investable or not. The NPV, determined by calculated interest rate, presents that how amount of wealth growth have been gathered by the investment during its period, but it does not tell the real profitability of capital investment. Besides, the investment's IRR informs the decision maker that how works the real profit of long capital investment [16]. The formulas of NPV and IRR are shown below.

$$NPV=\sum_{t=1}^{T}\frac{Ct}{(1+r)^t}-Co \quad (4)$$

$$IRR=\sum_{t=1}^{T}\frac{Ct}{(1+r)^t}=Co \quad (5)$$

NPV: Net present value

Ct: Cash flow

Co: Initial investment

r: Discount rate (Libor Rate + 1,40%)

t: Time

T: Expected life of investment

It was assumed that both incomes and expenses would be raised 5% per year. In addition, discount rate (r) assumed as European Libor plus 1,40% (1,15%) annually. Because of this ORC in WHRS system application is planned onboard, economic life of ORC in WHRS system assumed as 20 years.

Table 1. shows the financial cash flow of ORC in WHRS project application on model ship. O&M cost (1) and cumulative amount provided by power revenue (3) were used to generate 20-year cash flow of project.

Table 1. Financial cash flow table

Year	O&M Cost (€)	Cumulative Amount (€)	Net Cash Entry (€)	Amount of Investment (€)
0	-	-	-	800.000
1	11.847	76.490	64.643	-
2	12.439	80.315	67.875	-
3	13.061	84.330	71.269	-
4	13.714	88.547	74.832	-

5	14.400	92.974	78.574	-
6	15.120	97.623	82.503	-
7	18.876	102.524	86.628	-
8	16.670	107.629	90.959	-
9	17.503	113.011	95.507	-
10	18.379	118.611	100.283	-
11	19.298	124.594	105.297	-
12	20.262	130.824	110.561	-
13	21.276	137.365	116.090	-
14	22.339	144.233	121.894	-
15	23.456	151.445	127.989	-
16	24.629	159.017	134.388	-
17	25.861	166.968	141.108	-
18	27.154	175.316	148.163	-
19	28.511	184.082	155.571	-
20	29.937	193.286	163.350	-

According to data given in Table 1, NPV and IRR values were calculated by using Microsoft Excel. Plus, another financial indicator, profitability index (6), was calculated. Following equations were analyzed to determine profitability of the project.

NPV= €1.088.462 ≥ 0 Accept

IRR= 9,98% ≥ 0,015 (r) Accept

$$\text{Profitability index (PI)} = \frac{\text{NPV}}{\text{Initial investment}} = \frac{1.088.462}{800.000} = 1,36 \geq 0,015 \text{ (r)} \quad (6)$$

PI=1,36 ≥ 0,015 (r) Accept

On account of above equations, project of ORC in WHRS on model ship is acceptable. Moreover, investment return period is around 9 years and 9 months.

5. Conclusion

The aim of this paper is to give perception into ORC in WHRS system application on a Ro-Ro ship from an economic point of view. Fuel oil plays vital role in shipping companies both economic and environmental ways. Fuel cost is the main item of voyage costs contributing between 47% and 53% of total cost. On the other hand, less fuel consumption onboard provides less GHG emissions. Furthermore, reducing fuel consumption has become challenge among shipping companies. One of the main systems about reducing fuel consumption onboard is ORC in WHRS systems. Especially waste exhaust gases after exhaust gas boiler has to be recycled to produce electricity onboard.

As a matter of this case study, it was proved that ORC in WHRS (using waste exhaust gases) on model Ro-Ro ship is remarkable option for fuel saving. Also, investment indicators (NPV, IRR, PI and investment return period) show profitability of this project. This study could be expanded by taking all fleet of model ship's company into account. Furthermore, this study could be improved by adding some parameters to future study such as alternative waste heat sources onboard (cooling water, diesel generator exhaust gases), alternative fuels (LNG) and fuel prices.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Experimental Investigation of using Emulsified Fuel in a Diesel Engine on Performance and NOx Emissions

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ABSTRACT

Diesel water emulsion is an alternative fuel for diesel engines which can be used in a main engine of excursion boats and fishing vessels to reduce NOx emissions without any additional engine adaptation in the existing engine installation. In this study, implementation of emulsified fuel to diesel engine has been experimentally investigated on the engine performance and NOx emission in a single cylinder, four stroke diesel engine. The obtained results have been compared with standard diesel engine performance and emissions. Emulsified diesel fuels of 5%, 10% and 15% water in diesel fractions by mass have been studied at various engine speeds. The results show a NOx significant decrease in NOx emissions with the increase in the amount of water in the fuel, moreover the brake power decreases and the specific fuel consumption increases.

Keywords: Diesel engine, Emulsified fuel, NOx emission, Performance.

1. Introduction

Nowadays, diesel engines are still one of the highest efficient internal combustion engines [1]. For this reason, it is used on ships quite a lot with releasing harmful gases to the nature as other internal combustion engines. Most of these gases are CO_2, CO, NOx, SOx, HC and particulate matter (PM). Especially, PM and NOx are problematic issues for diesel engines. MARPOL (International convention for the prevention of pollution from ships) has introduced a number of restrictions to prevent ship-induced environmental pollution. NOx emissions are explained in Annex VI, Regulation 13 of MARPOL Convention for reducing emissions from ships. Emissions from ships over 130 kW of machine power built after 1 January 2000 have been limited [2]. Due to these restrictions, the engine manufacturers had to take some measures.

In the literature, various methods have been applied to reduce NOx emissions in diesel engines. These methods can be exemplified as Selective Catalytic Reduction (SCR)[3–5], Exhaust Gas Recirculation (EGR)[6–8], fumigation[9–11] and use of emulsified fuels [12–15]. Among these methods, the use of emulsified fuel is the most suitable method for the applicability of the existing systems.

In this application, water is homogeneously mixed into the fuel for mixture stability. The resulting emulsified fuel is injected into the cylinder from the present injector. Thus, NOx emissions are reduced by avoiding high temperatures in the cylinder.

In this study, emulsified fuel mixture, in fractions of 5%, 10% and 15% water in diesel, were prepared and has been experimentally investigated in a single cylinder, water cooled diesel engine. The obtained performance and NOx emission data have been presented.

2. Experimental Set-up

A single cylinder, four stroke, water-cooled, direct injection diesel engine was used in the experiments. The specifications of the engine are shown in Table 1.

Table 1. Engine Specification.

Engine	Antor
Model	3LD510
Displacement (cm_3)	510
Bore (mm)	85
Stroke (mm)	90
Compression Ratio	17.5:1
Injection Pressure (bar)	160
Maximum Speed (rpm)	3000

In order to measure the torque, s type load cell produced by Esit company was used with dynamometer produced by Kemsan company. MRU Vario Plus emission analyzer was used for the analysis of the exhaust gases. The temperature of the exhaust gases was monitored with K type thermocouple which can measure up to 1000 ◦C. Before performing measurements, attention is paid for the engine to be in the proper operating conditions. For this purpose, engine coolant inlet and outlet temperatures were monitored with the help of K type thermocouples. And, the fuel flow into the engine was measured by the Krohne brand mass flow meter.

The experiments were performed at intervals of 200 rpm between 1500 rpm and 3000 rpm. First, performance and emissions data for pure diesel were obtained for each engine speed. Then, mixtures of 5%, 10% and 15% water were tested for the same engine speeds.

2.1 Fuel Preparation

Fuel mixtures were prepared in 1 kg. 2% surfactant was used in each mixture[12]. The surfactants used were Span 60TM and Tween 80TM. The HLB values of the surfactants used were adjusted to be 10 [16]. A mixer was used at a speed of 4000 rpm to prepare the mixtures. In order to prepare the mixture, first, the required amount of diesel was measured on a precision scale. Then the Span 60TM was dissolved in the fuel in the mixer.

And then, Tween 80TM was added into the mixture. Finally, water was added into the mixture at a rate of 6 ml/s rather slowly. Stirring was continued until the mixture stays in a stable state.

3. Results and Discussion

In this study, the experimental results obtained from a diesel engine at different emulsion ratios has been investigated for engine performance and emissions.

3.1 Performance Parameters

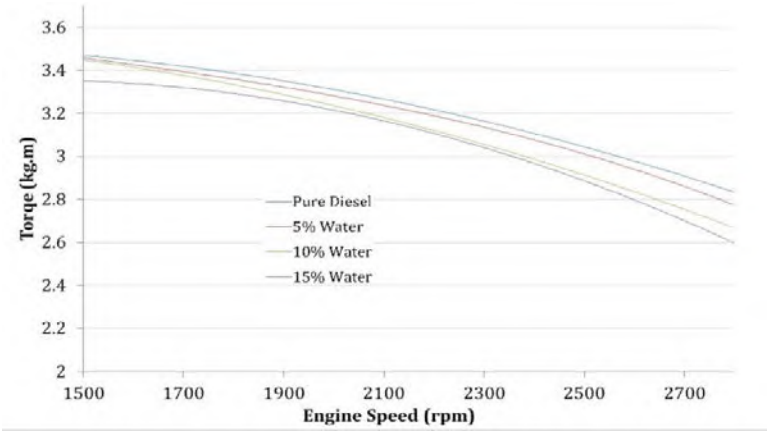

Figure 1. Engine Torque at different engine speeds.

Figure 1 shows the experimental results of engine torque versus speed with three water ratios (5%, 10%, 15%) and pure diesel in comparison. The results reveal that, as the water ratio increases, a decrease in engine torque is observed. The maximum torque was calculated as 3.45 kgm for water fraction of 5%, 3.425 for water ratio of 10% at 1500 rpm and 3.375 for water ratio of 15% at 1800 rpm. The average reduction in engine torque was calculated 1.6% for 5%, 5.6% for 10% and 6.4% for 15% in comparison to neat diesel fuel.

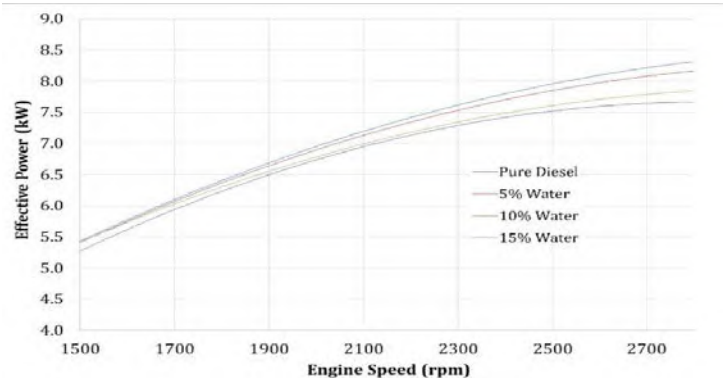

Figure 2. Brake power values at different rpm.

Figure 2 shows the experimental results of effective power for three different water ratios. According to experimental results, power reduces with increase of water ratios. When neat diesel is used, the maximum power is available as 8.24 kW at 2800 rpm. Similarly, the maximum power is obtained at 2800 rpm, when the emulsified fuel is used. When the test results were examined, the maximum power for fuels of 5%, 10% and 15% water was obtained as 8.14 kW, 7.84 kW, 7.77 kW, respectively. The loss of engine power remains at an average of 5.4% for the 5% and 10% water fraction, while for the 15% water fraction, it is reduced by approximately 9%, which differs from other fuels.

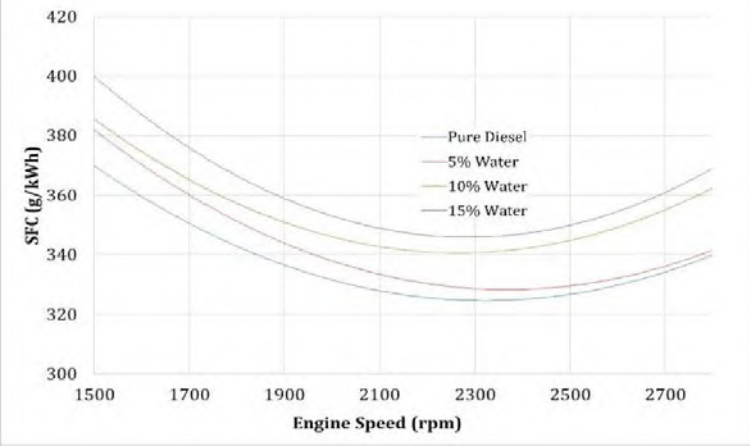

Figure 3. Specific fuel consumption values at different rpm.

Figure 3 shows specific fuel consumption (SFC) data. SFC increases with the increase in water fraction. The minimum fuel consumption is seen at 2300 rpm and in neat diesel fuel. The largest increase in fuel consumption is obtained for water fraction of 15%. This increase is approximately 9.34%.

3.2 NOx Emissions

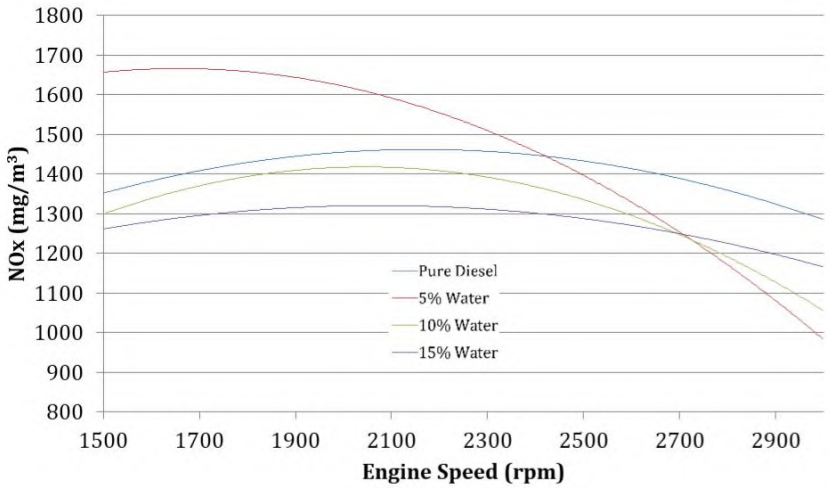

Figure 4. NOx emission values at different rpm.

Figure 4 shows the formation of NOx emission for neat Diesel and 5%, 10% and 15% water in diesel fuel under full load and at variable engine speeds. As shown in the figure, there is a remarkable reduction of NOx in all types of water in diesel emulsions of 10% and 15% compared to neat diesel. However, an increase by water addition is observed in high engine speeds. As shown in Figure 4, the amount of emitted NOx increase at low percentage of water addition[17–19]. But, as the percentage of water in the emulsified fuel increases, NOx emissions reduce due to the decrease in the local adiabatic flame temperature.

4. Conclusion

Emulsified diesel fuels containing 5%, 10% and 15% water contents were prepared using surfactants, Span 60™ and Tween 80™. The effects of emulsified fuels prepared were investigated experimentally on a single cylinder diesel engine. The results showed that, the engine performance was slightly decreased with the amount of water added into the diesel fuel. Nevertheless, emulsion fuels presented are environmentally friendly, due to the lowering of NOx emissions at high water ratios in low and medium speed range. The numerical results for using emulsified fuels in comparison to neat diesel fuel can be summarized as follows;

- Reductions in the engine torque are observed as the water fraction is increased. The maximum torque is reduced as the engine speed falls, as in pure diesel.
- The addition of water in water diesel emulsions causes a slight reduction in engine power.
- Specific fuel consumption increases with water addition. In addition, the minimum specific fuel consumption is recorded at lower engine speeds.
- NOx emissions decreased significantly at high water ratios.

5. Acknowledgement

This study has been supported by Yildiz Technical University (YTU) Scientific Research Project Coor. (BAPK) (Project no FBA-2018-3215). Thanks to YTU BAPK for the financial support.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Investigation of the Effects of Marine Fuels in Lubrication Oil on The Friction of Piston Ring-Cylider Liner in Marine Diesel Engines

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ABSTRACT

In the combustion engine, the ring-cylinder liner friction constitutes a large part of the total friction losses. Therefore, the friction between the piston-cylinder will affect the overall engine efficiency and therefore the exhaust gas emissions. In this study, piston ring-cylinder liner friction in two different temperature points on a piston ring-cylinder liner test setup which is working at different speeds is investigated. In the experiments, the effects of different amounts of lubricating oil-fuel mixtures on the friction were investigated. As a result of the study, it was seen that the lubricant lubrication varied under different conditions.

Keywords: Friction, Marine Diesel Engines, Lubrication, Marine Fuels

Gemi Dizel Makinelerinde Yağlama Yağı İçerisine Karışan Deniz Yakıtlarının Segman-Gömlek Çifti Sürtünmelerine Etkilerinin Araştırılması

ÖZET

İçten yanmalı motorlarda segman-silindir gömleği sürtünmesi toplam sürtünme kayıpların büyük bir bölümün oluşturmaktadır. Bu nedenle segman-silindir gömleği arasındaki sürtünme, genel motor verimliliğini ve buna bağlı olarak da egzoz gazı

emisyonlarını etkileyecektir. Bu çalışmada, farklı devirlerde çalışan bir piston-silindir deney düzeneği üzerinde, iki farklı sıcaklık noktasında segman- silindir gömleği sürtünmeleri incelenmiştir. Yapılan deneylerde farklı miktarlardaki yağlama yağı-yakıt karışımlarının sürtünme üzerindeki etkileri incelenmiştir. Çalışmanın sonucunda yağlama yağının farklı koşullar altında segman-silindir gömleği sürtünmesinin değişiklik gösterdiği görülmüştür.

Anahtar Kelimeler: Sürtünme, Gemi Dizel Makineleri, Yağlama, Deniz Yakıtları

1. Giriş

Günümüzde artan gemi işletme maliyetleri ve yürürlüğe giren uluslararası kurallar çerçevesinde, gemilerinin işletme maliyetlerini azaltıcı çalışmalar yapılmaktadır. Gemi işletme maliyetlerinin en büyük bölümünü oluşturan yakıt giderlerini azaltmak için ise geminin ana ve yardımcı makineleri ve sistemleri için çeşitli çalışmalar yapılmaktadır.

Bu açıdan bakıldığında gemilerde sevk ve elektrik üretim sistemlerinde kullanılan dizel motorlarda toplam sürtünme kayıplarının önemli bir kısmını segman-silindir gömleği sürtünmesi oluşturmaktadır. Bundan dolayı segman-silindir gömleği sürtünmesinin yakıt harcamı ve egzoz emisyonları açısından makineye etkisi oldukça fazladır. Piston segmanlarının tribolojik davranışları, içten yanmalı motorların güç, yakıt tüketimi, yağ tüketimi ve egzoz emisyonları açısından önemli bir etkiye sahiptir [1]. Nakada motor teknolojilerindeki trendler ve tribolojiden bahsettiği çalışmasında, motor sürtünme kaybının etkisinin, diğer kayıplardan daha büyük olduğunu ve toplam kayıp enerjinin yaklaşık %40'ı motor sürtünmesinin oluşturduğunu belirtmiştir [2].

Sürtünme kayıplarındaki değişiminin en önemli nedenlerinden biri de yağlayıcı içerisinde bulunan kirleticilerdir. Motorun çalışması sırasında yağlama yağının sahip olduğu yağlayıcı özellikler hem harici hem de iç kirleticilerden dolayı düşeceğinden yağ, gerçek koşullarda optimum yağlayıcı özelliklerini çok uzun süre koruyamaz [3].

İçten yanmalı motorlarda sürtünmeyi azaltıcı çeşitli çalışmalar yapılmıştır. Grabon, Weislaw ve diğerleri yaptıkları çalışmada, silindir gömlekleri iç yüzeylerinde yağ cepleri bulunan ve bulunmayan deney düzeneklerinde tribolojik incelemede bulunmuşlar ve bu iki farklı yüzey geometrisine sahip silindir gömleklerini karşılaştırmışlardır. Yağ ceplerinin varlığının yüksek devirlerde %15'e kadar kazanç sağladığı sonucuna ulaşmışlardır [4].

Aydın ve diğerleri yapmış oldukları çalışmalarında farklı türde dizel yakıtı silindir yağlama yağı ile karıştırmışlardır. RMG 380 ve MDO kullandıkları çalışmalarında farklı miktarlarda yakıt içeren yağlama yağı karışımları ile yalnızca yağlama yağı kullandıkları durumları birbiri ile karşılaştırmışlardır. Farklı devir hızları, yük ve sıcaklık durumları

için yaptıkları ölçümlerde yağlayıcı tipi, yük, hız ve sıcaklık, sürtünme katsayısına sırasıyla %33, %32, %30 ve %14'lük katkı paylarına sahip olduğunu görmüşlerdir [5].

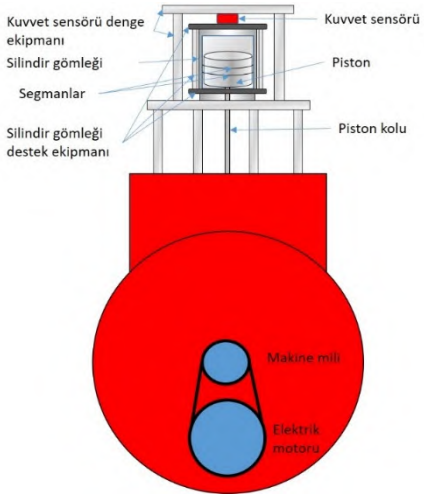
Bu çalışmada, gemi dizel makinelerinde kullanılan iki farklı yakıtın yağa %10, %20 ve %30 karışmalarında durumunda, farklı devir ve sıcaklıklar için segman-gömlek çiftinde sürtünme deneyleri yapılmıştır.

2. Deney düzeneği

Deney düzeneği içten yanmalı bir motorun çalışma şartlarına uygun bir şekilde hazırlanmıştır. Pistonun hareketini aldığı elektrik motoru 0.75 kW güce sahiptir. Hazırlanan deney düzeneğinde tek silindirli bir dizel motor modifiye edilerek elektrik motoruyla çalışan piston-silindir gömleği sistemi oluşturulmuştur. Hazırlanan bu düzeneğe deney yapmak üzere iki segmanlı bir piston ile bu pistona özel imal edilmiş bir silindir gömleği kullanılmıştır.

Deney düzeneğinde kullanılan silindir gömleği piston kolu ve pistona göre hizalandırılmıştır. Böylece pistonun deney sırasında oluşabilecek yanal kuvvetlerin ve piston-silindir gömleği hızlandırılmasındaki yanlışlıklardan doğacak sürtünme artışlarının önüne geçilmiştir. Bunun dışında silindir gömleğinin herhangi bir yere bağlantısı bulunmamaktadır. Bu şekilde piston-silindir gömleği arasındaki sürtünme kuvvetleri haricinde herhangi bir kuvvetin ölçüme etki edilmesinin önüne geçilmiştir.

Deney düzeneğinde kullanılan kuvvet sensörü Kistler marka 9027C üç eksenli ölçüm yapabilen modelidir. Sekil 1'de görüldüğü gibi sensör silindir gömleği ile denge ekipmanlarının arasında yer almaktadır. Bu sayede kuvvet sensörü yalnızca segman ile silindir gömleği arasındaki sürtünme kuvvetini ölçmektedir. Şekilden de anlaşılabileceği gibi silindir gömleği üzerinde yalnızca denge ekipmanları bulunmakta bunun dışında herhangi bir yere bağlı değildir.



Şekil 1. Deney düzeneği ve bileşenleri.

Belirlenen deney ölçümleri için silindir gömleğinin sıcaklığını ayarlamak üzere ısıtıcı fişekler kullanılmıştır. Isıtıcı fişekler ile silindir gömleğinin tüm yüzeyi ısıtılmış ve ölçümler istenen sıcaklık noktaları elde edildiğinde yapılmıştır. Sıcaklık kontrolleri farklı konumlara monte edilmiş ısıl çiftler (termokupl) yardımı ile kontrol edilmiştir.

Deneylerde kullanılan yağ; ağır devirli, gemi dizel motorlarda kullanılmak üzere geliştirilmiş bir yağlama yağıdır. Kullanılan yağın ilgili özellikleri Tablo 1'de belirtilmiştir.

Tablo 1. Yağ özellikleri.

Parametre	**Değer**
Viskozite (cSt)	12.5-16.3
TBN (mgKOH/g)	29-31
Parlama Noktası (°C)	Min. 246
Akma Noktası (°C)	Max -18

Ölçümler sırasında farklı yakıt türlerinin sürtünme kuvveti üzerindeki etkisi incelenmiştir. Bunun için deniz tipi dizel motorlarda kullanılan yağ ile iki farklı yakıt

türünün çeşitli oranlarda karıştırılmasıyla elde edilen yeni karışım yağlar kullanılmıştır. Karışımları oluştururken Marine Diesel Oil (MDO) ile Heavy Fuel Oil (HFO) kullanılmıştır. Her iki tür yakıt da gemilerde yaygın olarak kullanılan yakıt türleridir [6]. Yağlama yağına farklı oranlarda yakıtlar mekanik karıştırıcı yardımı ile oluşturulan karışım tek faz haline gelene kadar karıştırılmıştır. Karıştırma işlemi bittikten sonra karışımlar, bir süre bekletilip deneyde kullanılmaya hazır hale getirilmiştir. Deney sırasında kullanılan tüm yakıt numuneleri sepere edilmiştir.

Tablo 2. MDO özellikleri [7].

Parametre	**Değer**
Yoğunluk (@15 °C)(kg/m^3)	Max. 890
Viskozite (cSt)	2-6
Asit Sayısı (mgKOH/g)	0.5
Parlama Noktası (°C)	Min. 60
Kükürt (%)	Max. 0.1

Tablo 3. HFO özellikleri [8].

Parametre	**Değer**
Yoğunluk (15 °C'ta)(kg/m^3)	Max. 991
Viskozite (cSt)	13-17
Asit Sayısı (mgKOH/g)	2.5
Parlama Noktası (°C)	Min. 60
Kükürt (%)	1.0-3.5

Sürtünmeyi incelemek amacıyla oluşturulan karışımlar için RMG 380 ve DMA isimli deniz tipi dizel yakıt kullanılmıştır [7-8].

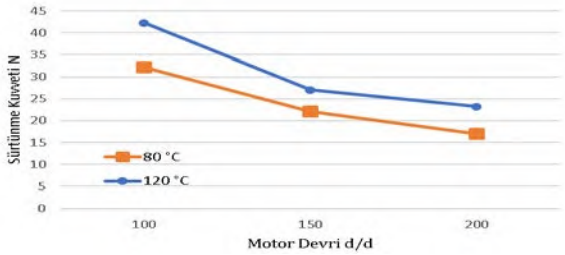
3. Tartışma ve Bulgular

Yapılan deneyde segman-silindir gömleği arasındaki sürtünme kuvvetleri farklı koşullar altında ölçülmüştür. Yapılan tüm ölçümlerin sonunda silindir gömleği yüzeyi, piston segmanı, pistonun diğer yüzeyleri temizlenmiş yeni ölçümlere bu işlemden sonra başlanılmıştır. Ayrıca yağ örnekleri piston yüzeyi üzerine gravite yöntemine uygun olarak kılcal borular yardımı ile eklenmiştir.

Devir sayısının, sıcaklığın ve yağa yakıt karışmasının sürtünme kuvveti üzerindeki etkisini gözlemlemek için ölçümler yapılmıştır.

a. Yağ içeriğinde MDO olma durumu

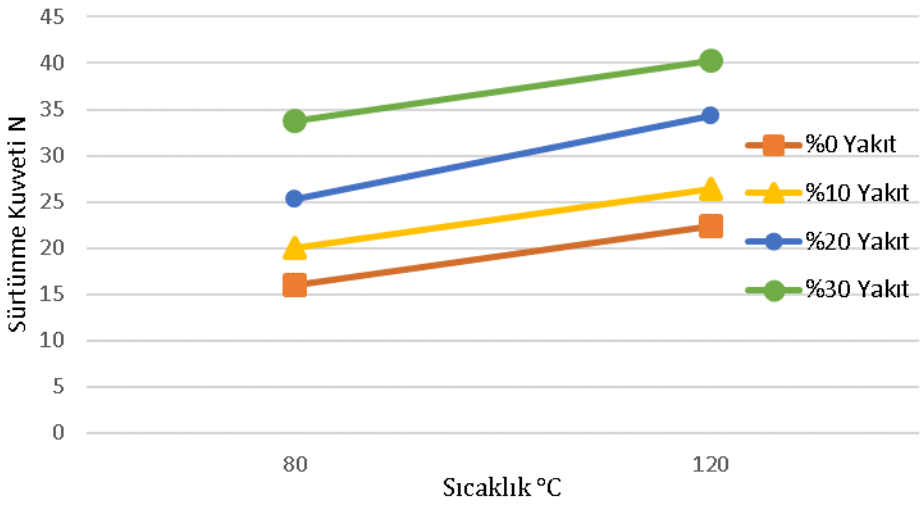
i. Devir Etkisi



Şekil 2. Farklı devir ve sıcaklıklar için sürtünme grafiği (MDO)

Şekil 2' de yağ içeriğine farklı oranlarda MDO karışması durumlarında devir ve sıcaklık parametrelerinin etkilerini gözlemlenmektedir. Farklı oranlardaki trendlerin aynı olmasından dolayı tek bir ortalama grafiğinde gösterilmiştir. Devrin arttıkça sürtünme kuvvetinin azaldığı görülmüştür. Şekilden de anlaşılabileceği gibi sürtünme kuvvetleri 120 °C' de 100 devir için maksimumken 80 °C' de 200 devirde minimum değerlerde ölçülmüştür. Buradan devir arttıkça sürtünme miktarının azalması ile yüksek devirlerde daha iyi yağ filmi yüzeyi oluştuğu sonucu çıkmaktadır.

ii. Sıcaklık etkisi



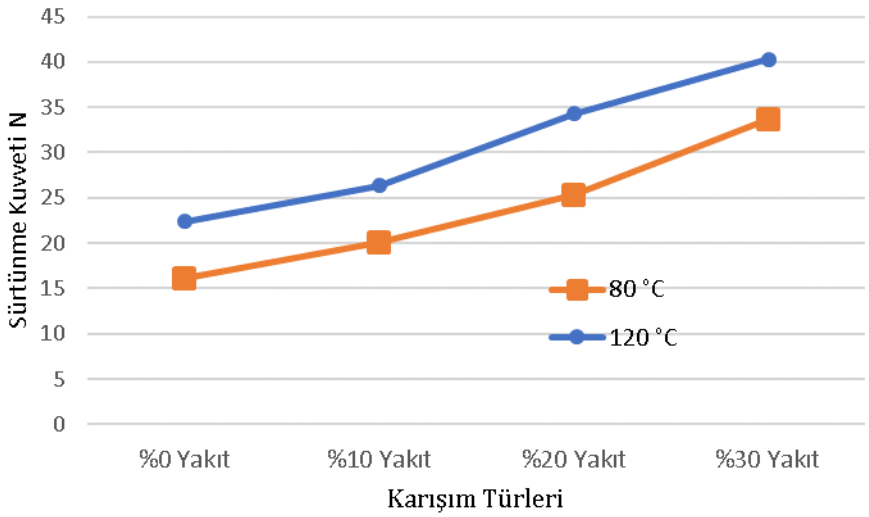
Şekil 3. Farklı sıcaklık ve karışım oranlarında (MDO) sürtünme grafiği

Şekil 3' te yağ içeriğine farklı oranlarda MDO karışması durumları ve sıcaklık parametrelerinin etkileri gözlemlenmektedir. İki farklı sıcaklık noktası için yapılan ölçümlerde sıcaklık artışının yaklaşık olarak her karışım yağlayıcı numunesi için benzer şekilde artış gözlemlemiştir. Şekil 3'te belirtilen her bir grafik farklı yağ yakıt karışımlarını ifade etmektedir. En büyük artış %39 ile yalnızca yağlama yağı içeren yağlayıcı için görülürken en düşük artış %30 yakıt içeren yağlayıcıda %20 olarak ölçülmüştür. Buradan yağlama yağının içerisinde bulunan düşük viskoziteye sahip yakıtın miktarı arttıkça, sıcaklığın yağlayıcı üzerindeki etkisinin azaldığı ortaya çıkmaktadır.

b. Yağlayıcı-yakıt karışımlarının etkisi

Şekil 4' te farklı sıcaklıklarda ve yağ içeriğine farklı oranlarda MDO karışması durumları etkileri gözlemlenmektedir. Yapılan ölçümler göstermiştir ki yağ içerisindeki yakıt miktarı arttıkça sürtünme kuvveti de artmaktadır. Yağlayıcı türüne bağlı MDO için yapılan

ölçümlerde en küçük sürtünme değeri 80 °C' %0 MDO içeren yağlayıcı ve en yüksek değer ise %30 MDO içeren karışım için olmuştur. Ölçülen sürtünme kuvvetleri en çok 40N en az ise 16N bulunmuştur. Şekilden anlaşılabileceği gibi yağlama yağının içerisine katılan dizel yakıtı yağın yapısını bozarak oluşan yağ filminin kalitesini düşürücü bir etki yapmaktadır.

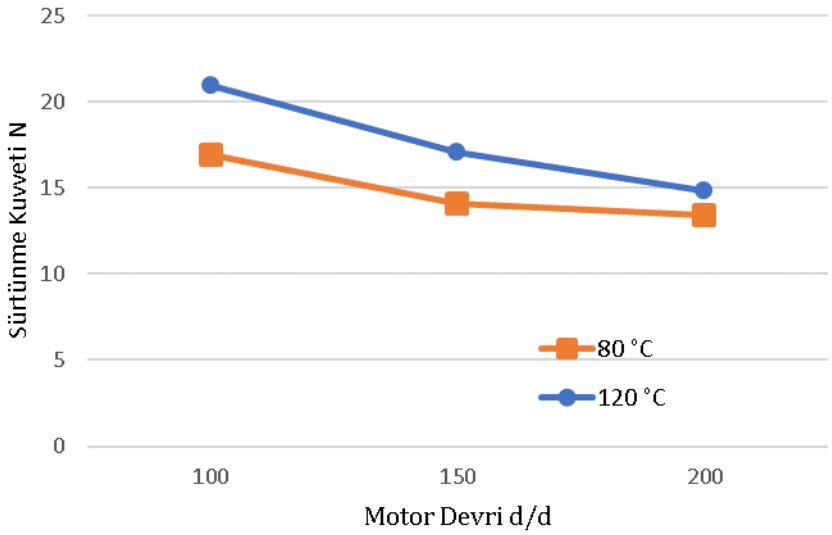


Şekil 4. Farklı Karışım içerikleri ve sıcaklıklarda sürtünme grafiği.

c. Yağ İçeriğinde HFO Olma Durumu

i. Devir etkisi

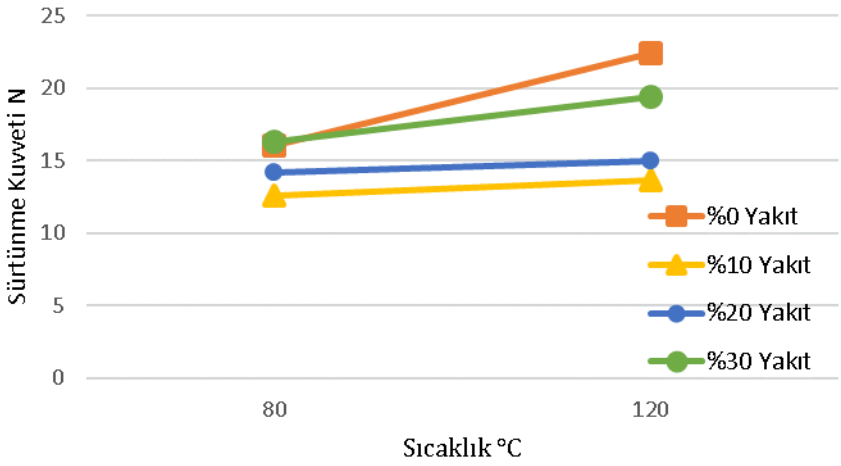
Şekil 5' te yağ içeriğine farklı oranlarda HFO karışması durumlarında devir ve sıcaklık parametrelerinin etkilerini gözlemlenmektedir. Farklı oranlardaki trendlerin aynı olmasından dolayı tek bir ortalama grafiğinde gösterilmiştir. Tıpkı dizel yakıtı ile yapılan ölçümlerde olduğu gibi HFO ile yapılan ölçümlerde de devir artışına bağlı olarak sürtünme kuvvetlerinin azaldığı görülmektedir. Ayrıca devir sayısı arttıkça kademeli olarak sıcaklığın sürtünme kuvveti üzerindeki etkisinin HFO için azaldığı görülmektedir. Yapılan ölçümlerde sürtünme kuvvetinin en fazla olduğu nokta 21 N ile 100 devir 120 °C'de, en düşük olduğu nokta ise 13,4 N ile 200 devir 80 °C'de gözlemlenmiştir.



Şekil 5. Farklı devirler için HFO sürtünme grafiği

ii. Sıcaklık etkisi

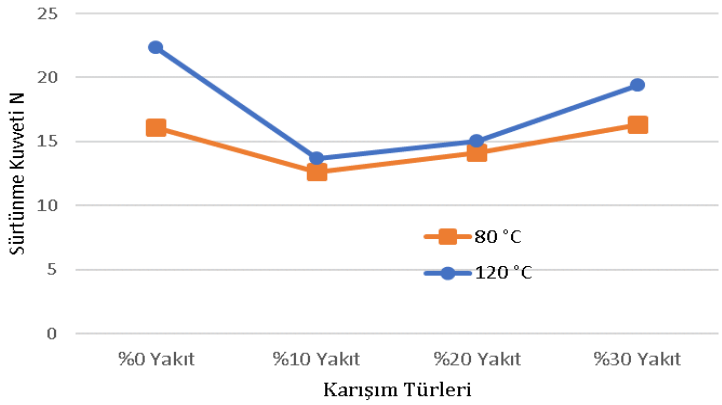
Şekil 6' da yağ içeriğine farklı oranlarda HFO karışması durumları ve sıcaklık parametrelerinin etkileri gözlemlenmektedir. Yağlama yağının içeriğindeki yakıt miktarının artması %8 ila %18 arasında değişen sürtünme kuvveti artışı gözlemlenirken tamamen yağlama yağı ile yapılan ölçüm için bu artış %39'dur. Buradan sıcaklık, %100 yağlama yağı için sürtünme kuvveti üzerindeki etkisi, artışının HFO-yağlama yağı karışımları için sürtünme kuvveti üzerindeki etkisinden daha fazla olduğu sonucu ortaya çıkmıştır.



Şekil 6. Farklı sıcaklıklarda HFO sürtünme grafiği

iii. Yağlayıcı-yakıt karışımlarının etkisi

Şekil 4' te farklı sıcaklıklarda ve yağ içeriğine farklı oranlarda HFO karışması durumları etkileri gözlemlenmektedir. Yağa katılan yüksek viskoziteye sahip HFO ile yağlayıcının viskozitesi artmıştır. Bu durum %100 yağ içeriğinde ölçülen sürtünme kuvveti değerlerinin HFO içeren yağlayıcılar için ölçümü yapılan sürtünme kuvveti değerlerinden yüksek olması ile kanıtlanmıştır. En düşük sürtünme kuvveti 80 °C'de %10 HFO karışımı için 12,6 N, en yüksek sürtünme kuvveti 120 °C'de %100 yağ için 22,4 N'dur. Bunların dışında yağın içerisindeki yakıt miktarı arttıkça yine sürtünme kuvvetinin de arttığı gözlemlenmiştir.



Şekil 7. Farklı Karışım içeriklerinde HFO sürtünme grafiği

4. Sonuçlar

Çalışmada deniz tipi farklı yakıt türlerinin yağlama yağları ile farklı oranda karıştırılarak oluşturulan numuneler üzerinde deneyler yapılmıştır. Yapılan ölçümlerde devir sayısı, sıcaklık, yağlayıcı türü parametreleri üzerinden segman-silindir gömleği yüzeyleri arasındaki sürtünme kuvvetine etkileri araştırılmıştır.

- Artan devir sayısı ile sürtünme kuvvetlerinin azaldığı görülmüştür. Devir sayısının etkisinin kirleticinin MDO olduğu koşullarda, kirleticinin HFO olduğu koşullardan daha yüksek olduğu görülmüştür.
- Sürtünme kuvvetlerinin artışında sıcaklığın etkili bir parametre olduğu görülmüştür. Her iki kirletici türü için de devir sayısı arttıkça sıcaklığın sürtünme kuvveti üzerindeki etkisinin de azaldığı buna rağmen sıcaklık artışı ile birlikte sürtünme kuvvetlerinde artış meydana geldiği gözlemlenmiştir.
- Kirleticinin MDO olduğu deneylerde yakıt miktarındaki artış sürtünme kuvvetlerinin artmasına neden olmuştur. Bu durum MDO' nun yağlama yağının yağlayıcı özelliğini bozmasıyla açıklanabilir. Öte yandan HFO'in kirletici olduğu deneylerde %100 yağlama yağı koşullarına göre bir düşüş yaşanmıştır. Bu durum HFO yakıtının viskozitesinin yüksek olması böylece yağ filminin dayanımın artması ile açıklanabilir.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Environmental Impacts of the Exhaust Gases from Ships

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ABSTRACT

This study discusses environmental impacts of exhaust gasses from ships and discusses their effects to human health. Pollution of the atmosphere in the World by the exhaust gases has increased with the continued growth in the number of transport vehicles such as ships, cars etc. But the total pollution of the atmosphere due to exhaust gasses is small when compared with industry, agriculture, commercial and residential heating, consumer and commercial products. Industry is main sources of air pollution. Emissions to the air from ships include nitrogen oxides (NO_x), sulfur oxides (SO_x), carbon mono-dioxide (CO-CO_2), hydrocarbons (HC), volatile organic carbons and different form of particulate matter (PM). Not all emissions to the atmosphere from ships originate from combustion fuels for propulsion. Cargo handling such as crude oil and compounds used in refrigeration systems cause emissions of volatile organic compounds.

Shipping emissions cause severe impacts on health and environment. Territorial waters, inland seas, canals, straits, bays and ports regions are significantly affected from exhaust gases. The exhaust gases have different effects on living organism and especially human health. Carbon dioxide, methane and nitrous oxide cause greenhouse effect. Hazardous air pollutants are those pollutants that cause or may cause cancer or other serious health effects. Particulate matter is a mixture of solid particles and liquid droplets suspended in the air. The finer fractions of these particles often stay airborne over long distances. It can take hours or days for PM_{10} to settle on the ground or sea. Fine particles can affect human health and they have climate-forcing impacts.

Keywords: Maritime transportation, Ship exhaust gasses, Nitrogen oxides, Particule matter.

Gemi Kaynaklı Baca Gazlarının Çevresel Etkileri

ÖZET

Bu çalışmada gemi kaynaklı baca gazlarının çevresel ve insan sağlığına etkileri ortaya konulmuştur. Baca gazları miktarının atmosferde artışı deniz, hava ve kara araçları sayısının gün geçtikçe artmasına paralel olarak devam etmektedir. Ancak atmosferdeki egzoz gazlarının ana kaynağını endüstriyel faaliyetler, tarım ve fosil yakıtların ısıtma amacı için kullanılması oluşturmaktadır. Gemilerden emisyon yoluyla atmosfere bulaşan baca gazı içerisinde ana bileşenler olarak; azot oksitler (NO_x), kükürt oksitler (SO_x), karbon mono-dioksit (CO-CO_2), hidrokarbonlar (HC), uçucu organik karbonlar ve farklı partikül maddeler (PM) bulunmaktadır. Deniz taşımacılığından kaynaklanan emisyonlar sağlık ve çevre üzerinde ciddi etkilere neden olmaktadır. Kara suları, iç denizler, kanallar, boğazlar, koylar ve liman bölgeleri egzoz gazlarından önemli ölçüde etkilenirler. Egzoz gazlarının canlı organizmalar ve özellikle insan sağlığı üzerinde farklı etkileri vardır. Karbondioksit, metan ve azot oksitler sera etkisine neden olurlar. Tehlikeli hava kirleticileri olarak değerlendiren baca gazları, kansere veya diğer ciddi sağlık etkilerine neden olan kirleticilerdir. Baca gazları içerisinde yer alan partikül maddeler (PM) atmosferde uzak bölgelere taşınarak insan sağlığını olumsuz olarak etkilerler.

Anahtar Kelimeler: Deniz taşımacılığı, gemi baca gazları, azot oksitler, partikül maddeler.

1. Giriş

Dünya ticaretinde taşınan yüklerin önemli bir bölümü yaklaşık %80'ni deniz yolu ile taşınmaktadır. Dolayısıyla dünya ticaretinde yaşanan gelişmeler deniz yolu taşımacılığını doğrudan etkilemektedir. Deniz yolu taşımacılığının diğer taşımacılık türlerine göre daha ucuz ve daha çevreci olduğu bilinmektedir. Deniz taşımacılığı en verimli taşımacılık modu olup karayolu, demiryolu ve havayolu taşımacılığına göre bir ton yük başına veya bir kilometre ulaşım için en az sera gazı emisyonuna neden olmaktadır [1]. Ancak uluslararası ticaret hacminin artışı hem gemi sayısında artışa neden olmuş ve hem de daha büyük tonajlı gemilerin deniz taşımacılığında yer almasına sebebiyet vermiştir. Bu durum denizlerde ve atmosferde gemi kaynaklı kirleticilerin artışına neden olmuştur. Her ne kadar atmosferdeki baca gazı kirliliğinin ana kaynağı daha çok endüstriyel faaliyetler, tarım ve fosil yakıtların ısıtma amacı için kullanılması olmakla birlikte, deniz taşımacılığından kaynaklanan emisyonların yerel ve küresel hava kalitesine olumsuz etkileri yadsınamaz düzeydedir. 2007-2012 tarihleri arasında dünya genelindeki toplam CO_2 emisyonunun %2,8'i deniz taşımacılığından kaynaklanmıştır. Ancak gelecekte kara kökenli emisyonlarda bir azalma olacağı beklenirken, deniz taşımacılığından kaynaklanan emisyonların yakın gelecekte %50 ve 2050 yılına kadar ise ekonomik gelişmelere bağlı olarak %250 oranında aratacağı ileri sürülmektedir. Denizlerin Gemilerden Kirlenmesinin Önlenmesi Sözleşmesi (MARPOL) Ek- 6'da belirtilen önlemlerin yerine getirilmesiyle bireysel olarak gemi kaynaklı SO_x emisyonu düşmeye devam edecektir. Ayrıca farklı tarihlerde inşa edilen gemilerde makine gücüne göre NO_x gazları emisyonuna getirilen sınırlamalar mevcuttur [2].

Çevreci olarak bilinen deniz taşımacılığından kaynaklanan emisyonlar sonucu atmosfere bulaşan gazlar, hava kirliliğine, küresel ısınmaya ve asit yağmurlarına neden olarak çevreyi etkilemektedir. Ağır yakıtlar kullanmaları nedeniyle gemi baca gazlarının insan sağlığı üzerine önemli etkileri vardır.

1. Materyal ve Metot

Derleme çalışması olan bu makale çeşitli kaynaklardan alıntılar yapılarak yazılmıştır.

2. Bulgular ve Tartışma

3.1 Gemi Baca Gazları

Gemilerin ana ve bazı yardımcı makinelerinden kaynaklanan gazlar deniz ve kara üzerinde hava kirliliğine neden olarak hem küresel iklim değişikliği probleminin artışına neden olmakta ve hem de canlı sağlığını önemli oranda etkilemektedir. Hava kirletici bu gazlar küresel bölgesel ve yerel boyutlarda çevre kirliliğine neden olmaktadırlar. Yakıt kullanımı sonucu gemilerden atmosfere bulaşan başlıca hava kirleticiler, azot oksitler (NO_x), kükürt oksitler (SO_x), karbon mono-dioksit (CO-CO_2), hidrokarbonlar (HC), uçucu organik karbonlar ve partikül maddelerdir (PM). Gemilerde emisyon oluşturan dizel motorları, buhar ve gaz türbinleri, jeneratörler ile kazanlardır. Gemi kaynaklı emisyonların yoğun olduğu bölgeler daha çok iç denizler, boğazlar, körfezler ve kanallardır. Emisyon oluşumunu etkileyen başlıca faktörler arasında gemi makineleri ve kullanılan yakıtın özellikleri, yanma verimi ile geminin operasyon durumu sayılabilir [3]. Taşımacılık sektörlerinin genelinde kullanılan yakıtın yaklaşık %16'sı deniz taşımacılığında kullanılmaktadır [4].

Gemi kaynaklı emisyonların belirlenmesine yönelik olarak Ülkemizde ve farklı ülkelerde yaygın olarak yerel çalışmalar yapılmıştır. İzmir limanına gelen gemilerin egzoz gazlarına yönelik yapılan bir çalışmada, seyirde, manevrada ve rıhtımda gemi kaynaklı NO_x, SO_2, CO_2, HC ve PM miktarlarının sırasıyla 1882.2, 1709.3, 100590.1, 135.7 ve 210.5 ton/yıl olduğu belirlenmiştir [5]. Diğer bir çalışmada, Çanakkale ve İstanbul boğazlarından transit geçen ve bu boğazlarda taşımacılık yapan gemilerden kaynaklanan emisyon yükleri saptanmıştır. İstanbul Boğazından geçen transit gemilerden yıllık 2720 ton, boğazda taşımacılık yapan gemilerden ise 4357 ton NO_x'in atmosfere yayıldığı bu çalışma ile tespit edilmiştir. Aynı çalışmada Çanakkale Boğazı için bu değer toplam olarak 8461 ton/yıl olarak belirlenmiştir [6]. Samsun ilinde hava kirliliğine gemi kaynaklı egzoz gazı emisyonunun etkisinin belirlendiği bir çalışmada; NO_x, CO_2, SO_2, HC ve PM yüklerinin sırasıyla 429.54, 20246.3, 338.3, 19.3 ve 38.8 ton/yıl olduğu tespit edilmiştir [7]. Başka

bir araştırmada ise Aliağa ve Nemrut körfezlerinde belirlenen emisyon düzeylerinin dünyadaki diğer benzer limanlardakinden daha yüksek olduğu belirtilmiştir [3].

3.2. Gemi Baca Gazlarının Küresel İklim Değişikliğine Etkileri

Küresel iklim değişikliği, doğal ve insanların çeşitli faaliyetleri sonucu, doğada meydana gelen olumsuz olaylardan kaynaklanmaktadır. Atmosfere sera gazları salınımı, insan faaliyetlerinin küresel iklim değişimine neden olan en önemli etkenlerden biridir. İklim değişikliği yeryüzünde birçok olumsuzluğa neden olmakta ve ekstrem hava olaylarının meydana gelmesine sebebiyet vermektedir. Atmosfere salınan sera gazlarına insanların birçok faaliyeti kaynak oluşturmakta ve bu kaynaklar içerisinde gemi baca gazları da önemli yer tutmaktadır. Sera etkisine doğrudan neden olan gazlar karbon dioksit, klorofloro karbonlar, metan, di azot mono oksit ve ozondur. Karbon monoksit (CO) ve azot oksit (NO) sera olayını dolaylı, ozon ve metan hem doğrudan hem de dolaylı olarak etkilemektedir. Ayrıca atmosferdeki partikül maddeler de sera etkisine neden olmaktadır [8]. Dolayısıyla gemi baca gazları bileşiminde yer alan CO_2, NO_x ve partikül maddeler doğrudan sera gazı etkisi gösterirken, CO ise dolaylı sera etkisine sahiptir. Amerika Birleşik devletlerinde yapılan bir araştırmada atmosferdeki sera gazlarının yaklaşık % 28'nin taşımacılıktan kaynaklandığı belirtilmiştir. Bu sektörden gelen emisyonların yarısının binek otomobilleri ile kamyonet ve hafif iş kamyonlarından, diğer yarısının ise nakliye kamyonları, ticari uçaklar gemiler, tekneler ve trenlerden kaynaklandığı aynı araştırmada ifade edilmiştir [9].

3.3. Gemi Baca Gazlarının Canlılar Üzerine Etkileri

Gemi baca gazlarının da içerisinde yer aldığı hava kirleticiler hava kalitesinin bozulması, asit yağmurları, sıcaklık değişimleri ve ozon tabakasının incelmesi gibi etkileri nedeniyle canlı sağlığını doğrudan ve dolaylı olarak etkilerler. Gemi baca gazı bileşenlerinin bazıları doğrudan canlı ve insan sağlığını etkilerken, bazıları ise doğrudan etkileri yanında neden oldukları atmosferik ve iklimsel olaylar sonucu canlı sağlığını dolaylı olarak da etkilerler. Çeşitli kaynaklardan ve deniz taşımacılığından atmosfere bulaşan hava kirletici gazlar insanlarda, akciğer kanseri, bronşit, eklem romatizması, göz rahatsızlıkları, nefes darlığı,

kan zehirlenmesi ve ruhsal bozukluk gibi birçok hastalığa neden olurlar. Ayrıca gemi baca gazı içerisinde yer alan maddelerin bir arada bulunduklarında canlı sağlığına etkileri, her birinin ayrı ayrı yaptığı etkiler toplamından daha fazladır [10]. Fosil yakıtların yakılmasıyla atmosfere bulaşan, gemi baca gazlarının da içerisinde yer aldığı hava kirleticilerden bazıları sera etkisi yaparak küresel ısınmaya ve SO_2 ile NO_x asit yağmurlarına neden olarak insan ve diğer canlılara zarar vermektedir. Deniz ve okyanuslarda küresel ısınmaya bağlı sıcaklık artışı canlıların beslenme, üreme ve göç faaliyetlerini olumsuz olarak etkilemekte ve tür sayısının ve biyokütlenin azalmasına neden olmaktadır [11]. Ayrıca iklim değişikliği, insanların sosyoekonomik durumunun bozulması, yetersiz beslenme, su ile bulaşan hastalıklarda artış, deri kanserine yakalanma gibi birçok olumsuzluğa neden olmaktadır [8]. Gemi baca gazlarının dolaylı etkilerinden biri de bu gazların neden olduğu asit yağmurlarının çevreyi ve canlıları olumsuz etkilemesidir.

4. Sonuç

Gemi kaynaklı emisyonlar, hava kirliliğine neden olmaları ve insan sağlığına zararlı etkileri nedeniyle uluslararası alanda önemli bir problem haline gelmiştir. Bu nedenle Denizlerin Gemilerden Kirlenmesinin Önlenmesi Uluslararası Sözleşmesi'ne (MARPOL 73/78) gemi kaynaklı hava kirliliğinin önlenmesine yönelik bazı kurallar getiren yeni bir ek (Ek VI) ilave edilmiştir. Bu protokol uyarınca gemilerin baca gazları içerisinde yer alan azot oksit ve kükürt dioksit emisyonlarının sınırlandırılmasına yönelik bazı düzenlemeler getirilmiştir. Söz konusu düzenlemelerle gemi yakıtı içerisindeki kükürt ve sülfür oranları sınırlandırılmış, 130 kW ve üstü güce sahip olan tüm yeni gemi dizel motorlarının NOx emisyonu bakımından gerekliliklere uygun olması şartı konulmuş ve Ek kapsamındaki gemiler için "Uluslararası Hava Kirliliğini Önleme Sertifikası"nın düzenlenmesi zorunlu kılınmıştır [12].

Gemi baca gazlarının çevresel etkilerinin azaltılması için MARPOL Ek VI da belirtilen tedbirler yanında, emisyon oluşumunu etkileyen faktörlerin kontrol altına alınması ve gemilerde emisyon azaltma yöntemlerinin mutlaka uygulanması gerekmektedir.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Classification Analysis for Studied Fields in Maritime

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ABSTRACT

The aim of this study is to identify the issues that are focused on maritime studies, and then to create an idea to increase the diversity of research areas and methods by comparing them with the studies conducted in management and industrial engineering. A classification method was chosen in this study due to s having a lot of advantages to categorize different types of studies related with maritime issues. Using a classification system helped to categorize different characteristic features logically and systematically. It was chosen in mainstream databases (Science Direct, Web of Science, ULAKBİM, Dergipark, Google Scholar, Elsevier, ResearchGate, Springer and Taylor & Francis) which were allowed by Istanbul Technical University library network. The articles published in the last 5 years have been analyzed in this study. In the search strategy, the terms related to maritime were used to locate the studies which meet the inclusion criteria. A wide range of research was conducted in order to understand the current maritime related study. In this study, the lack of similar studies demonstrated and shown found to be inadequate in Turkey. Considering the general perspective of maritime research, methodical deficiencies are observed. Further analysis according to the methods of the research revealed that there must be difference in methods for each preferred maritime fields. As a result of repeated studies on similar subjects, maritime science cannot demonstrate a rapid development. In other disciplines (management and industrial engineering) studies show variability in subject and method.

Keywords: Maritime, Research Methods, Literature review, Classification Analysis

1. Introduction

After the Industrial Revolution and World War II, maritime, industrial and management scientific study fields became important. While industrial engineering focuses on manufacturing and service systems, management engineering focuses on management and innovation. Maritime field is related to transportation of goods. It is thought that these three disciplines have common topics. For this purpose, published research articles in these fields are examined.

During a literature review, it can be noticed that 'cognitive', 'efficiency ', 'human factor', 'organizational factors' and 'risk analysis' are the prominent common keywords for the studies in these three fields [1,2,3,4,5,6,7,8,9,10,11,12,13,14].

Lim et al. (2018) conducted a risk analysis study in maritime domain. A detailed literature review of over 180 papers published between 1986 and 2017 was made. Using comparative analysis, the papers were classified according to the authors' nationality, focus, methodology, security concern type, research contribution and Denizel et al. classification [15].

Kolus et al. (2018) conducted a systematic literature review to identify peer-reviewed papers to examine the relationship between production quality and human factors in manufacturing. Having analyzed 73 papers, human factors were classified and sub-categories were labelled [16].

Oldenburg et al. (2013) carried out the systematic review of maritime studies on stress and strain on seafarers. Analyzing 13 maritime studies on stress or strain in seafaring, the aim of the study, the examined study population, the year of investigation, the measurement of stress and strain among the seafarers and the study results were considered [17].

Lee and Shin (2014) measured the performance of industrial engineering journals with an efficiency perspective, using data envelopment analysis (DEA) [18].

In this study, the terms such as 'cognitive, efficiency, human factor, organizational factors and risk analysis' were chosen as keywords to make a literature analysis in these three fields. 624 research papers were classified according to journal ranks, number of authors, study fields and topics.

2. Material&Method

During this study a systematic literature review was followed (Kitchenham,2004) . These 9 steps are shown in Figure 1. Step 4 is set up by choosing in mainstream databases (Science Direct, Web of Science, ULAKBİM, Dergipark, Google Scholar, Elsevier, Researchgate, Springer and Taylor & Francis) which were allowed by Istanbul Technical University library network. Selection of studies step was determined by selecting keywords and SJR ranking system checked to asses study quality [19].

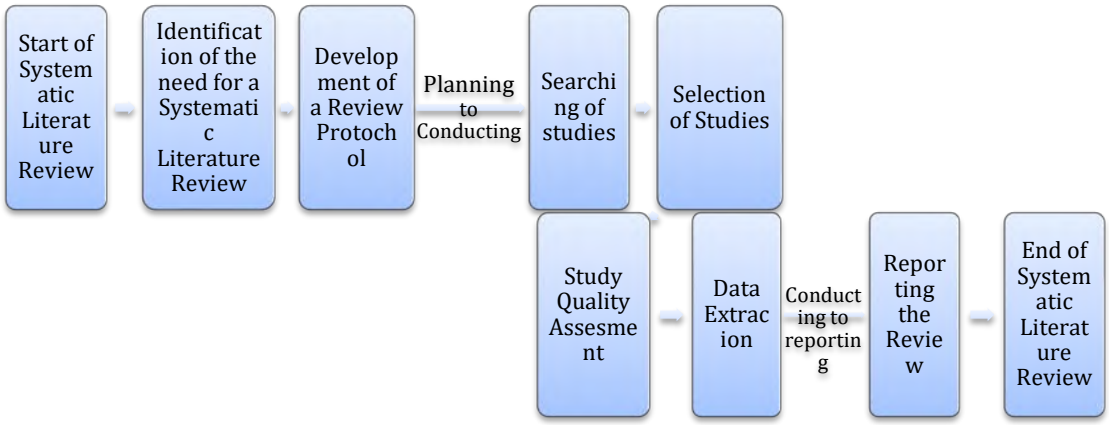

Figure 1. Systematic literature review

The articles published in the last 5 years have been selected. Research articles were reviewed according to 5 keywords which are cognitive, efficiency, human factor, organizational factors, risk analysis in 3 fields maritime, management engineering and industrial engineering. 624 research articles were also reviewed, and Figure 2 shows the method. Number of authors and impact factors are retrieved. Descriptive statistics were calculated for continuous (number of authors) variables (mean, standard deviation (SD), minimum, maximum, median), categorical variables (N, %). Articles are classified by

keywords and research fields. The Fisher's Exact test was used for categorical variables and expressed as observation counts (and percentages). Statistical significance was accepted when two-sided p value is lower than 0.05. Non-parametric statistical methods were used for skewed distribution. For comparison of two non-normally distributed groups Mann Whitney U test and for more than two non-normally distributed groups Kruskal Wallis test was used.

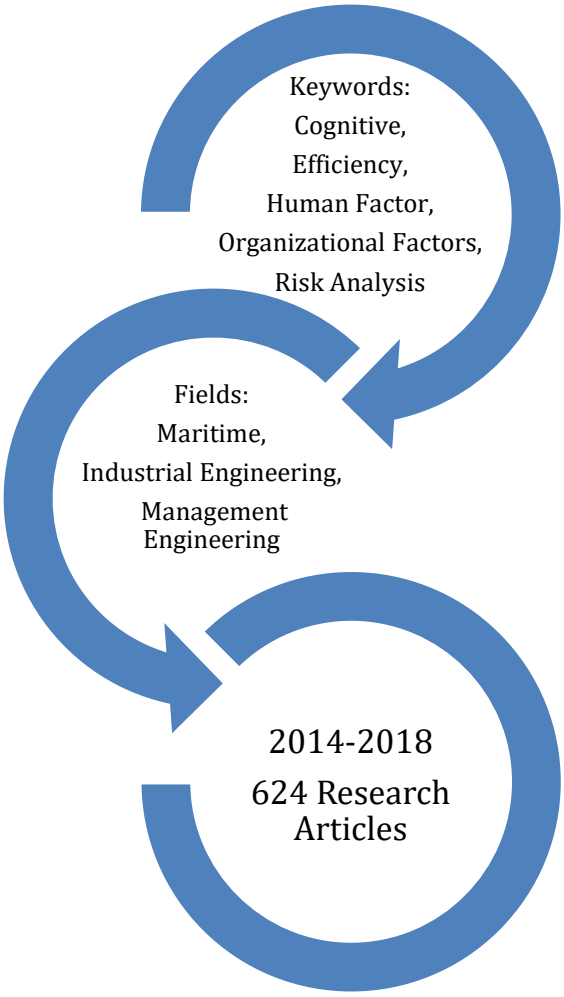

Figure 2. Systematic literature review results

3. Results

Frequencies and percentages of fields, topics, ranks are shown in Table 1. According to the results, 248 (%45,4) of the 624 research articles were on maritime and 204 (%32,7) of the total articles were on management engineering. The topics which were studied more are on efficiency (%30,8) and human factor (%20,7) in 654 research articles. 333 (%53,4) articles are ranked in Q1 and 120 (%19,2) articles in Q2.

Table 1. Distribution of Fields, Topics and Journals' rank

		N	%
Fields	Maritime	283	45,4
	Management Engineering	204	32,7
	Industrial Engineering	137	22,0
Topics	Cognitive	77	12,3
	Efficiency	192	30,8
	Human Factor	129	20,7
	Organizational Factors	67	10,7
	Risk Analysis	159	25,5
Ranks	Q1	333	53,4
	Q2	120	19,2
	Q3	44	7,1
	Q4	8	1,3
	Others	119	19,1

In figure 3, Q1 articles are higher than the others. Most of the research articles that were published are on Maritime. This was followed by Management Engineering studies. The distribution of the topics does not differ much.

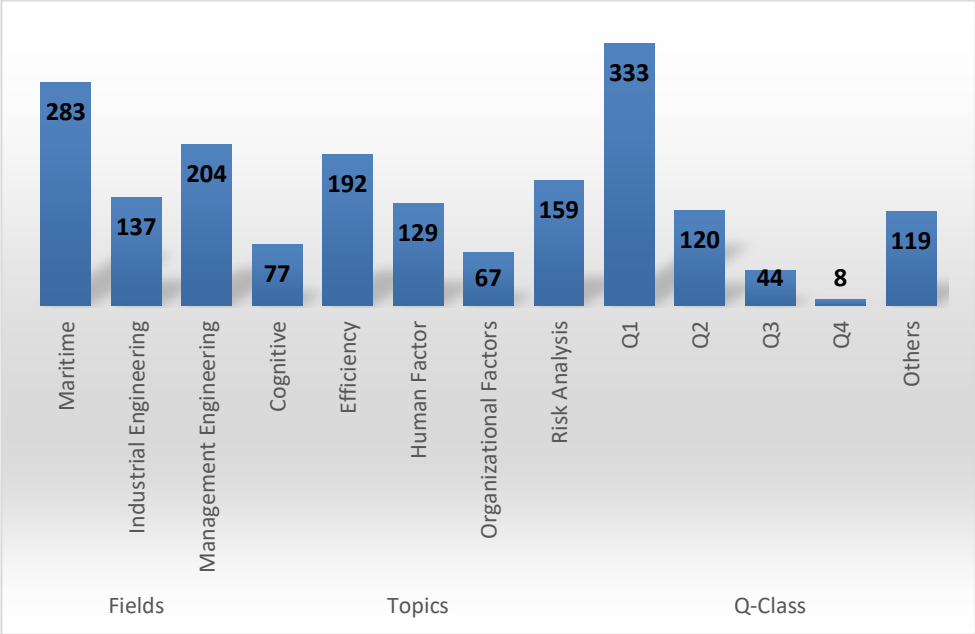

Figure 3. Frequency of fields, topics, ranks

25 most commonly used methods in the selected fields are shown in Table 2. Descriptive and informative methods (%12,3) were mostly applied in maritime. Machine learning and optimization methods (%10,8) closely follow the first group. Similarly, most common methods used in industrial and management engineering are machine learning and optimization methods (%23,0, %18,9). Then descriptive/ Informative methods (%16,1) takes place for industrial and management engineering. Fuzzy methods (%9,9) take the third order for industrial engineering as well as interview analysis methods (%16,7) used for management engineering.

Table 2. Distribution of Methods by Fields

	Maritime		Industrial Engineering		Management Engineering		Total	
Methods	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Descriptive/ Informative	26	12,3	14	16,1	23	17,4	63	14,6

Machine learning / Optimization	23	10,8	20	23,0	25	18,9	68	15,8
Fuzzy methods	21	9,9	8	9,2	8	6,1	37	8,6
Simulation	15	7,1	11	12,6	10	7,6	36	8,4
Survey	15	7,1	2	2,3	5	3,8	22	5,1
Univariate	15	7,1	5	5,7	7	5,3	27	6,3
Regression analysis /GLM	11	5,2	4	4,6	4	3,0	19	4,4
AHP	8	3,8	1	1,1	3	2,3	12	2,8
CREAM	8	3,8	0	0,0	0	0,0	8	1,9
Bayesian	8	3,8	3	3,4	3	2,3	14	3,2
Interview analysis	7	3,3	7	8,0	22	16,7	36	8,4
HFACS	6	2,8	0	0,0	3	2,3	9	2,1
FMEA	6	2,8	0	0,0	3	2,3	9	2,1
Risk Models	6	2,8	3	3,4	7	5,3	16	3,7
Data Envelopment Analysis	5	2,4	3	3,4	2	1,5	10	2,3
FSA	5	2,4	1	1,1	1	0,8	7	1,6
DEMATEL	5	2,4	1	1,1	0	0,0	6	1,4
Factor analysis	4	1,9	0	0,0	2	1,5	6	1,4
Sensitivity analysis	4	1,9	0	0,0	3	2,3	7	1,6
Situation Awareness Recovery (SAR)	4	1,9	0	0,0	0	0,0	4	0,9
EEDI calculation	3	1,4	0	0,0	0	0,0	3	0,7
TRACEr	3	1,4	0	0,0	0	0,0	3	0,7
HEART	2	0,9	0	0,0	0	0,0	2	0,5
Econometric models	2	0,9	0	0,0	1	0,8	3	0,7
CPS	0	0,0	4	4,6	0	0,0	4	0,9
Total	212	100	87	100	132	100	431	100

In figure 4, frequencies in maritime are listed from largest to smallest order. Therefore, the distribution is skewed. In general, it is seen that the interview analysis is higher than the other fields in management engineering. Descriptive and informative methods are mostly used in all the fields.

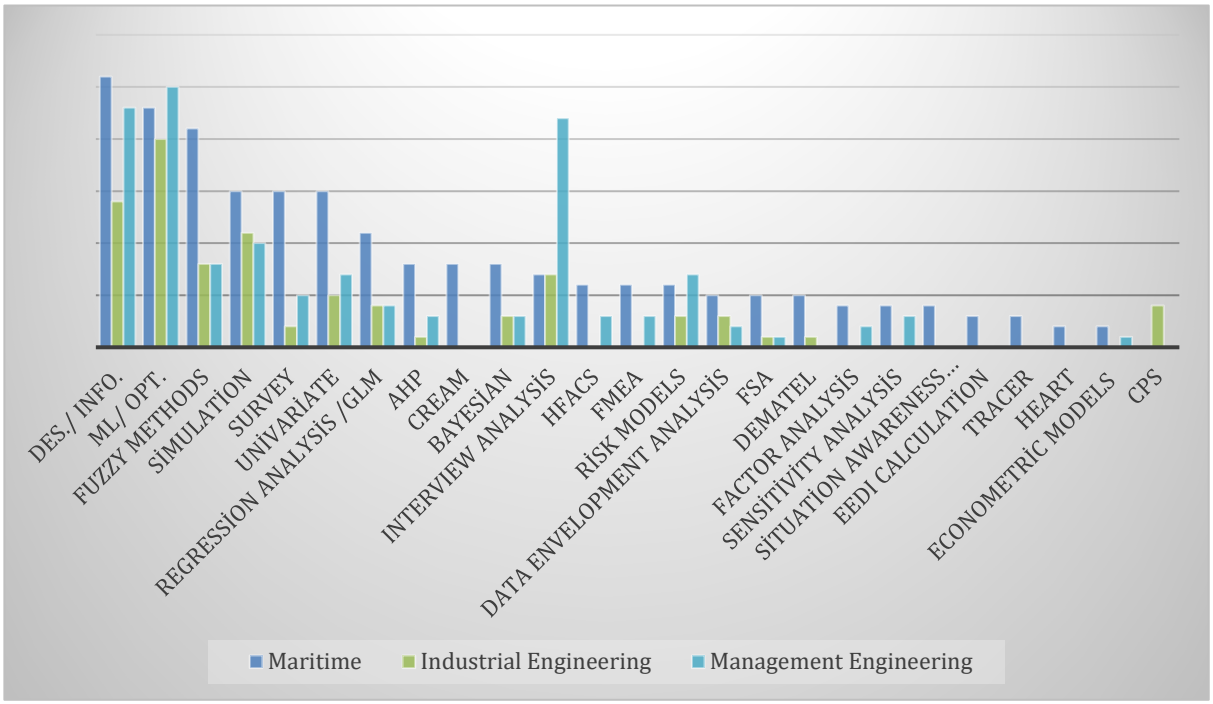

Figure 4. Frequency of methods

The relationship between fields and topics are investigated and univariate analysis show that there is statistically significant difference between them (Fisher's Exact p<0,001). The most studied topic in maritime is human factor, while it is risk analysis in industrial engineering and efficiency in management engineering (Table 3).

Table 3. Topics by fields

N %	Cognitive		Efficiency		Human factor		Organizational factors		Risk Analysis		p
Maritime	27	35,1	81	42,2	90	69,8	17	25,4	68	42,8	
Industrial Engineering	19	24,7	51	26,6	7	5,4	25	37,3	35	22,0	**<0,001**
Management Engineering	31	40,3	60	31,3	32	24,8	25	37,3	56	35,2	

Fisher's Exact test

The difference is clearly seen in Figure 5. Human factor was studied less in industrial engineering unlike in maritime. Efficiency was studied more in maritime than the other fields and finally organizational factors are studied more in both industrial and management engineering than maritime.

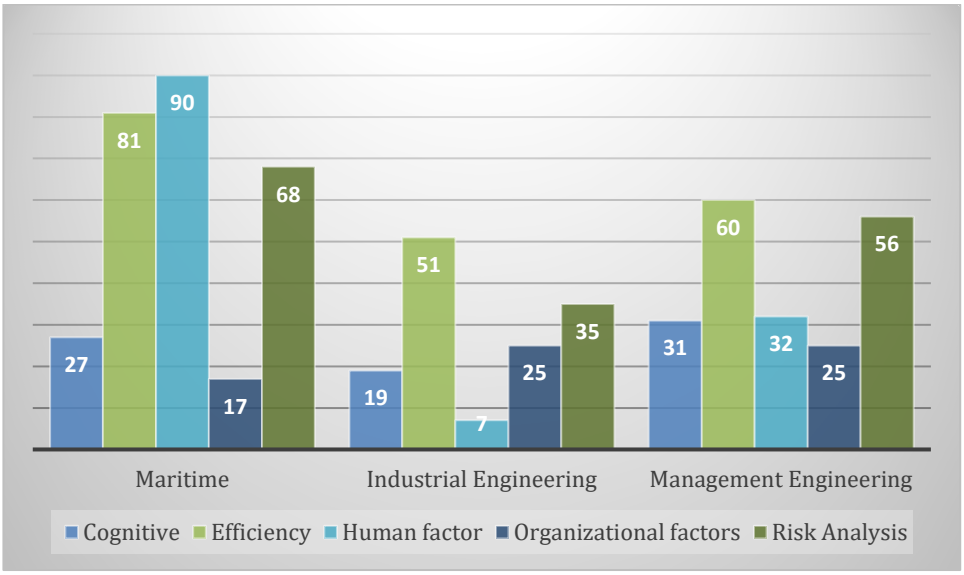

Figure 5. Frequency of topics by fields

The relationship between ranks and topics are compared and it is seen that there is statistically significant difference between them (Fisher's Exact p=0,012). Efficiency and risk analysis are published in Q1 journals more than the other fields. There are fewer publications in Q4 journals compared to others (Table 4).

Table 4. Topics by Ranks

N %	Cognitive		Efficiency		Human factor		Organizational factors		Risk Analysis		p
Q1	42	54,5	92	47,9	71	55,0	25	37,3	103	64,8	
Q2	14	18,2	41	21,4	27	20,9	5	7,5	33	20,8	
Q3	3	3,9	15	7,8	14	10,9	8	11,9	4	2,5	**0,012**
Q4	0	0,0	2	1,0	0	0,0	1	1,5	5	3,1	
Others	18	23,4	42	21,9	17	13,2	28	41,8	14	8,8	

Fisher's Exact test

A significant gap can be seen in human factor and cognitive articles in Q4 journals. Efficiency articles are published more in Q1 journals than the other fields. Besides, efficiency articles are published more in Q2, Q3 and other journals (Figure 6).

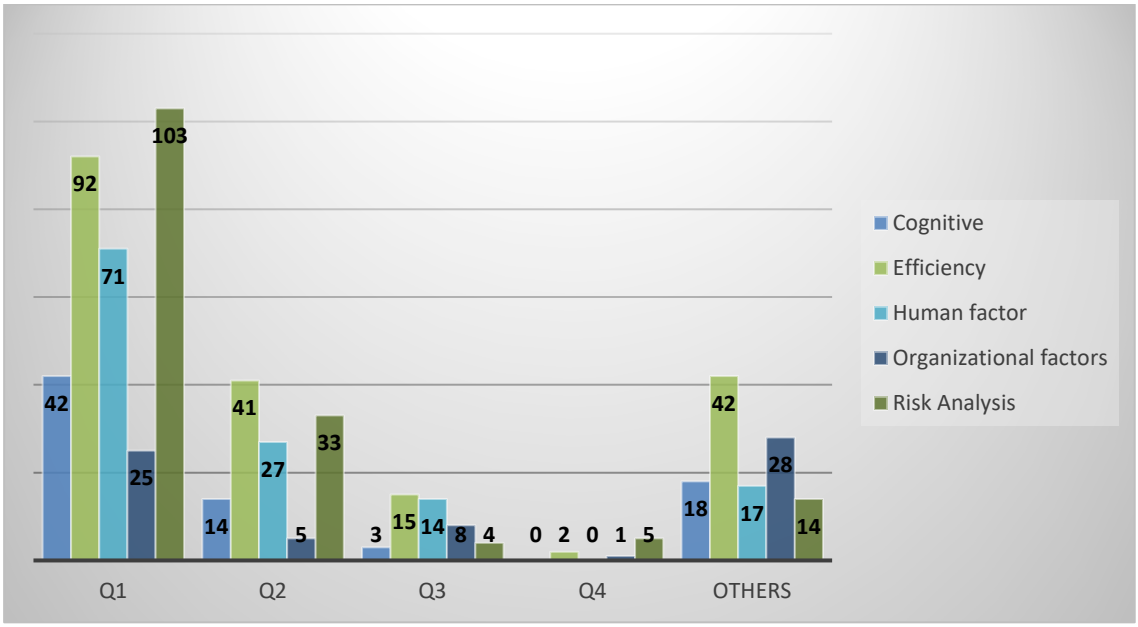

Figure 6. Frequency of topics by Ranks

The relationship between ranks and fields are investigated and it is found that there is no statistically significant difference between them (Fisher's Exact p=0,050). The ordering of the journals is in similar fashion (Table 5).

Table 5. Fields by Ranks

N %	Maritime		Industrial Engineering		Management Engineering		p
Q1	152	53,7	79	57,7	102	50,0	
Q2	54	19,1	16	11,7	50	24,5	
Q3	22	7,8	5	3,6	17	8,3	0,050
Q4	5	1,8	0	0,0	3	1,5	
Others	50	17,7	37	27,0	32	15,7	

Fisher's Exact test

All fields have almost the same distribution and it is seen in Figure 7 that research articles are mostly ranked Q1 in Maritime. Industrial engineering studies take the second order in Q1 journals.

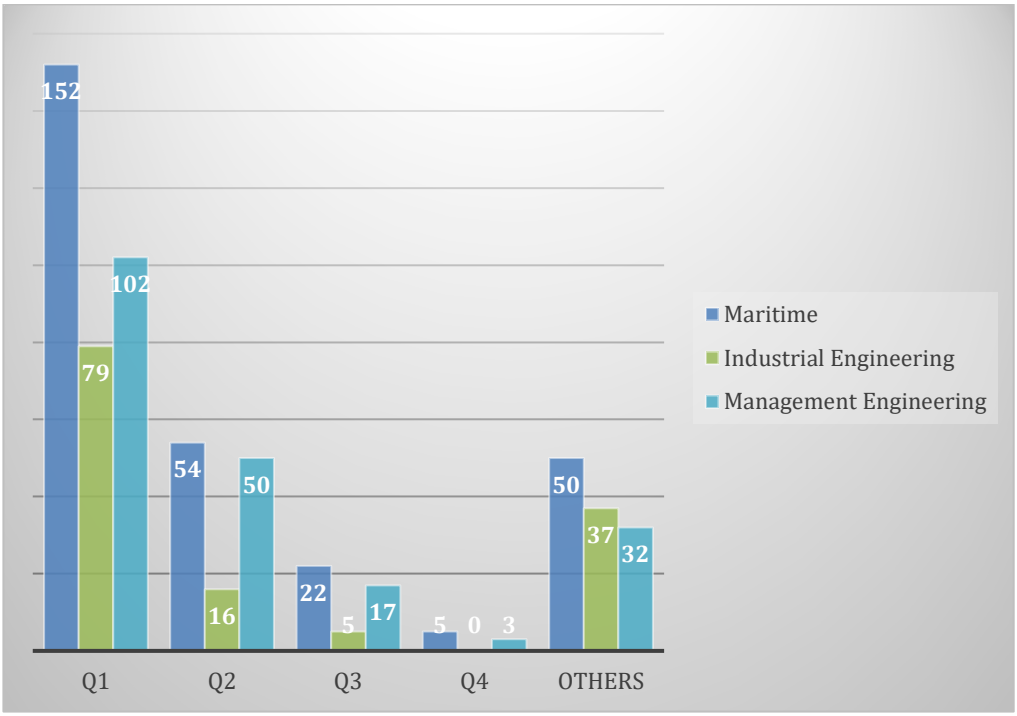

Figure 7. Frequency of fields by Ranks

The relationship between ranks and topics are evaluated according to each field. It is seen that there is statistically significant difference between topics and ranks in Management Engineering (Fisher's Exact p=0,006). Risk analysis articles are published more in Q1 journals than the others. Besides, efficiency articles take first order in Q2 journals in Management Engineering. There are only 3 articles are published in the Q4 ranked journals compared to others (Table 6).

Table 6. Ranks by fields and topics

	N %	Q1		Q2		Q3		Q4		Others		p
Maritime	Cognitive	13	8,6	6	11,1	2	9,1	0	0,0	6	12,0	0,126
	Efficiency	42	27,6	17	31,5	8	36,4	1	20,0	13	26,0	
	Human Factor	51	33,6	14	25,9	10	45,5	0	0,0	15	30,0	
	Organizational Factors	9	5,9	0	0,0	0	0,0	1	20,0	7	14,0	
	Risk Analysis	37	24,3	17	31,5	2	9,1	3	60,0	9	18,0	
Industrial Engineering	Cognitive	10	12,7	3	18,8	1	20,0	0	0,0	5	13,5	0,252
	Efficiency	27	34,2	7	43,8	1	20,0	0	0,0	16	43,2	
	Human Factor	6	7,6	0	0,0	1	20,0	0	0,0	0	0,0	
	Organizational Factors	8	10,1	1	6,3	2	40,0	0	0,0	14	37,8	
	Risk Analysis	28	35,4	5	31,3	0	0,0	0	0,0	2	5,4	
Management Engineering	Cognitive	19	18,6	5	10,0	0	0,0	0	0,0	7	21,9	**0,006**
	Efficiency	23	22,5	17	34,0	6	35,3	1	33,3	13	40,6	
	Human Factor	14	13,7	13	26,0	3	17,6	0	0,0	2	6,3	
	Organizational Factors	8	7,8	4	8,0	6	35,3	0	0,0	7	21,9	

Risk Analysis	3 8	37, 3	1 1	22, 0	2	11, 8	2	66, 7	3	9,4

Fisher's Exact test

According to a number of authors' descriptive statistics the average changes for each topic. There is statistically significant difference between topics for number of authors' distribution (Kruskal Wallis p<0,05). It is seen in Table 7 that post-hoc pairwise comparisons, the number of authors are higher in efficiency than organizational factors studies (Mann-Whitney U p<0,005 Bonferroni correction).

Table 7. Descriptive statistics for number of authors by fields, topics, Ranks

		Mean±SS	**Med.(Min.-Max.)**
Total		3±2	3 (1-22)
Fields	Maritime	3±2	3 (1-22)
	Industrial Engineering	3±1	3 (1-9)
	Management Engineering	3±2	3 (1-9)
	p	0,268	
Topics	Cognitive	3±2	3 (1-7)
	Efficiency	4±2	3 (1-9)
	Human Factor	3±2	3 (1-10)
	Organizational Factors	3±1	3 (1-9)
	Risk Analysis	4±2	3 (1-22)
	p	**0,010**	
Ranks	Q1	4±2	3 (1-22)
	Q2	3±2	3 (1-9)
	Q3	3±2	3 (1-8)
	Q4	4±2	3 (1-8)
	Others	3±1	3 (1-7)

p	0,683

Kruskal Wallis test

The average number of authors do not differ significantly for each field. The only point that attracts attention in maritime, have been published by 22 authors and it is an outlier for all data (Figure 8).

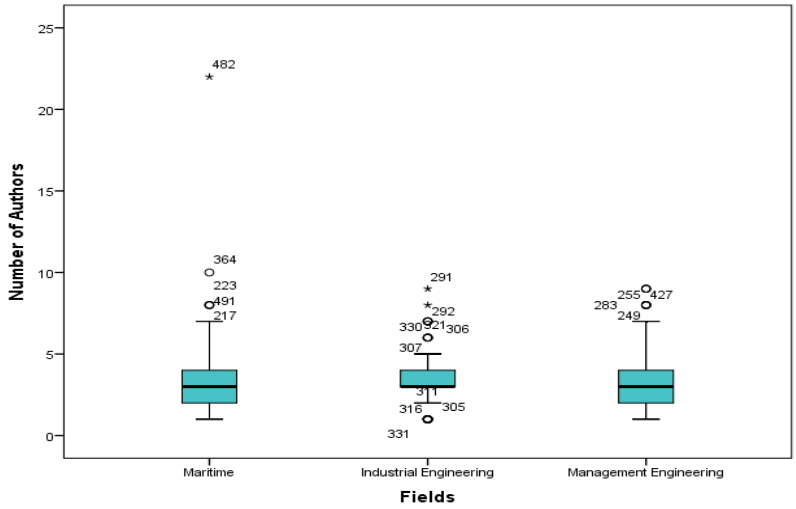

Figure 8. Boxplots for number of authors by fields

The distribution of authors differs significantly for each topic. The only point that attracts attention in risk analysis, have been studied by 22 authors and it is an outlier for all data (Figure 9).

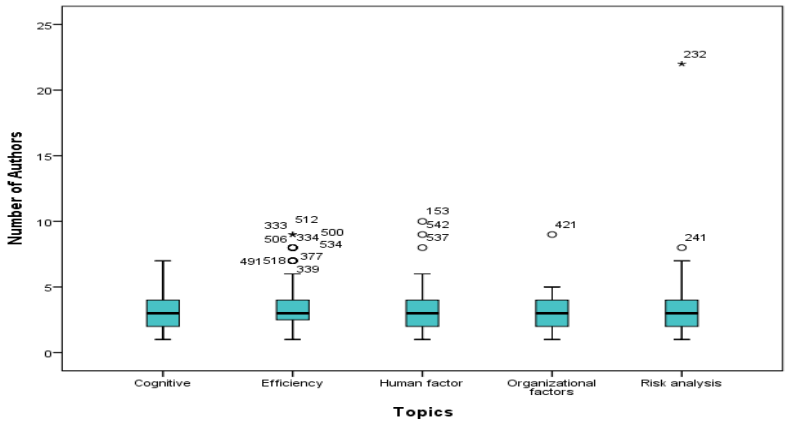

Figure 9. Boxplots for number of authors by topics

The average number of authors do not differ significantly for journals' ranks. The only point that attracts attention in Q1, have been published by 22 authors and it is an outlier for all data. Furthermore, there are extreme values in Q1, Q2, Q4 ranked journals for number of authors' distributions (Figure 10).

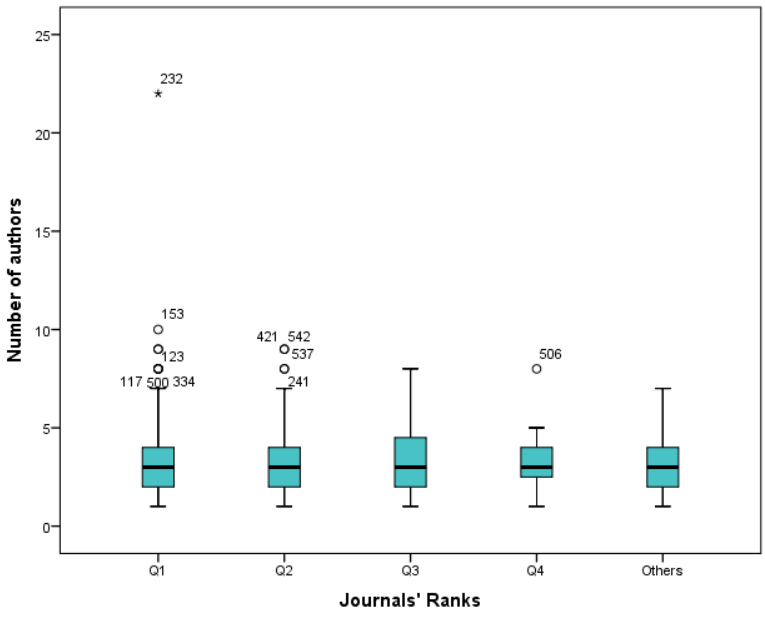

Figure 10. Boxplots for number of authors by Ranks

The relationship between number of authors' and topics for each field are investigated in Table 8. It is found that there is statistically significant difference between topics and number of authors' distributions in Management Engineering (Kruskal Wallis p<0,05). According to post-hoc pairwise comparisons, it can be seen that there is no significant difference between paired topics in Management Engineering (Mann-Whitney U p>0,005 Bonferroni correction). The average number of authors are higher in efficiency studies than all the other topics.

Table 8. Descriptive statistics for number of authors by topics for selected fiedls

		Mean±SS	**Med.(Min.-Max.)**
Maritime	Cognitive	3±2	3 (1-7)
	Efficiency	3±2	3 (1-8)
	Human Factor	3±2	3 (1-10)
	Organizational Factors	3±1	3 (1-4)
	Risk Analysis	4±3	3 (1-22)
	p	0,348	
Industrial Engineering	Cognitive	3±1	3 (1-6)
	Efficiency	4±2	3 (1-9)
	Human Factor	4±1	4 (2-4)
	Organizational Factors	3±1	3 (1-5)
	Risk Analysis	4±1	3 (2-7)
	p	0,335	
Management Engineering	Cognitive	3±1	3 (1-7)
	Efficiency	4±2	4 (1-9)
	Human Factor	3±2	3 (1-9)

Organizational Factors	3±2	3 (1-7)
Risk Analysis	3±1	3 (1-6)
p	**0,025**	

Kruskal Wallis test

The average number of authors differ significantly for topics in Management Engineering. The only point that attracts attention in maritime risk analysis, have been published by 22 authors and it is an outlier for all data. There can be seen extreme values in other topics (Figure 11).

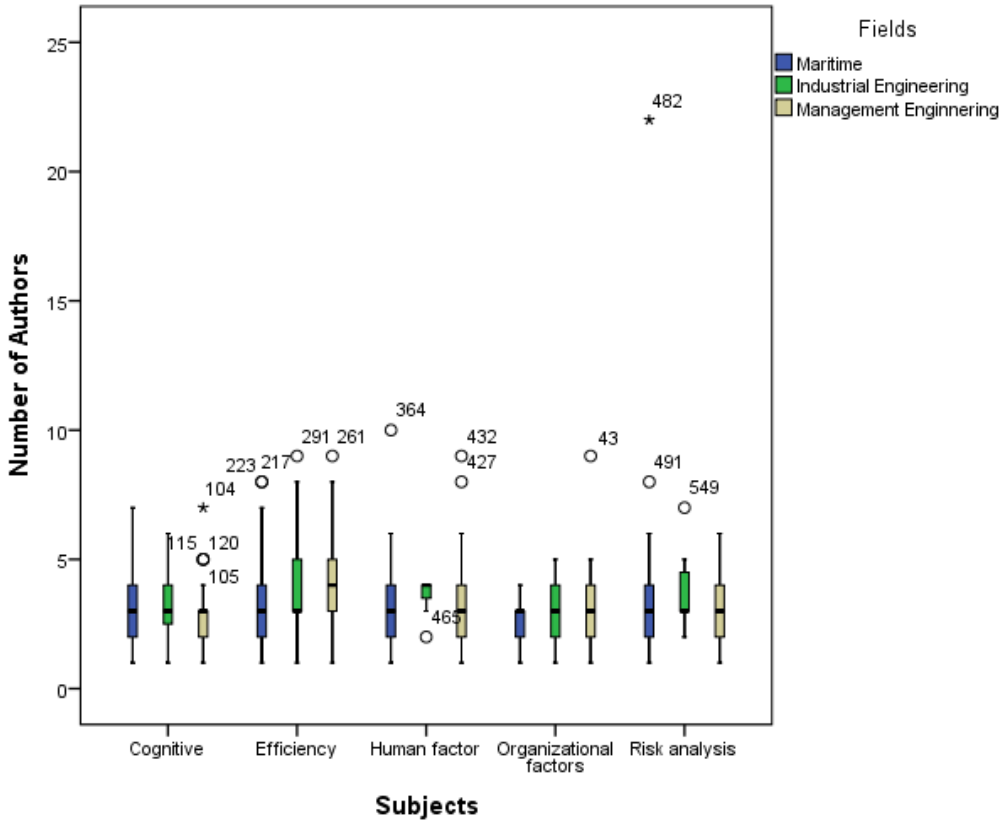

Figure 11. Boxplots for number of authors by fields and topics

4. Discussion and Conclusion

In this study, it is aimed to identify the topics that are focused on maritime studies, and then to create an idea to increase the diversity of research topics and methods by comparing them with the studies conducted in management and industrial engineering. It is found that the majority of the studies are in maritime. It is found that the efficiency is studied more than any other topic. According to the journals' ranks, most of the publications were in Q1. Descriptive and informative methods are commonly used in maritime, while machine learning and optimization methods are used in industrial and management engineering. The studies are commonly published about human factor in maritime, while efficiency is studied more in industrial and management engineering.

In maritime studies, papers are commonly related to human factor published in Q1 journals and papers are commonly related to efficiency published in Q2 journals. While the average number of authors is 3, there is only one publication that focuses on risk analysis with 22 authors in maritime.

To sum up, other topics, apart from the human factor, can be carried out in maritime researches and different methodologies like machine learning and optimizations can be used more than descriptive and informative methods.

The limitation of this study is due to the short period of time and having only 5 keywords. Topics can be varied and the range of years can be expanded in following studies.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Preparing Dataset for Deep Learning Based Ship Detection

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ABSTRACT

Autonomously detection and classification of ship targets which may cause collision in the vicinity is challenging problem. Although there are AIS and RADAR equipment to detect targets around, in order to mitigate their failures, there should be vision based detection system imitating human sensing. Detecting objects in the image has growing attentions in the field of computer vision. There are deep learning architectures to train model achieving this task accurately. By using video cameras spotting all around the vessel, we can record images and examine them in real-time via trained model. In this paper, we conduct a detailed literature review on ship recognition system to find out gaps. We find that there are datasets designed to classify ship types, however, those are not enough to conduct localization, detection or segmentation of ships in the image. We define eight main classes related to Bulk Carriers, Dry/Cargo/Passenger and Fishing and collect images accordingly. We create large dataset satisfying requirements for deep learning based training to achieve detection and classification of ships in the image.

Keywords*:* Ship detection, Ship recognition, Deep Learning, Computer Vision.

1. Introduction

Day by day, autonomous ship concept has received increasing attentions. Thus, technological [1-4] and non-technological [5-7] issues about realization of autonomous seaborne transportation have been discussed in the literature . It may come up with a name such as unmanned, remote or smart vessel in the near future and it has potential to be core of our global transportation system. Looking at the technological perspective, autonomously prediction of threats and taking relevant precautions during voyage would be the most important part for navigational safety of autonomous vessel. There are two electronic navigational equipment for detecting ship in the vicinity, AIS and RADAR. However, those devices are equipped to be an assistant for watchkeeping officer. We should consider a system which is so close to human sensing or more than it to perceive and detect targets making foul. Fundamental need of this system is recognizing all targets around vessel. We should think about sensors which can imitate human senses. Vision-based sensors such as IR (Infrared Radiation), FLIR (Forward Looking Infrared) RGB (Red, Green, Blue) can be appropriate to feed this system.

In the field of computer vision, there are vision-based approaches by using deep learning to recognize objects in the image. Regarding object recognition, we should clarify the terms which are classification, localization, detection and segmentation. Image classification is to classify images based on the dominant object inside of it. It can only tell about whether there is queried object in the image or not if it is dominant. AlexNet [8] is the well-known algorithm for image classification tasks. It can classify images up to 1000 object categories. After AlexNet, R-CNN [9], MultiBox [10], SPPNet [11], VGGNet [12] and Inception [13] are developed in order to find location of dominant object in the image called as object localization. They use bounding box proposal represented as a 4-element vector storing center location and its width and height of the object with its confidence score of how likely the box contains an object. By using non maxium suppression (NMS) overlapping bounding boxes can be merged to find most confident box which contains object [14]. To find locations of every objects in the image with high accuracy, Fast R-CNN

[15], YOLO [16] and Faster R-CNN [17] are developed. We can call this task as an object detection. It is all about localize and classify all objects appearing in the image. It has process of proposing a regions and then classifying the object inside of them. Recent development in the object recognition is the segmentation of objects. Faster R-CNN are extended for instance segmentation by adding a branch for predicting class-specific object mask, in parallel with the existing bounding box repressor and object classifier [18]. This extended version of Faster R-CNN is called as Mask R-CNN [18]. Now we can segment each object in the image by using Mask R-CNN approach. Examples of mentioned recognition tasks can be seen in Figure 1.

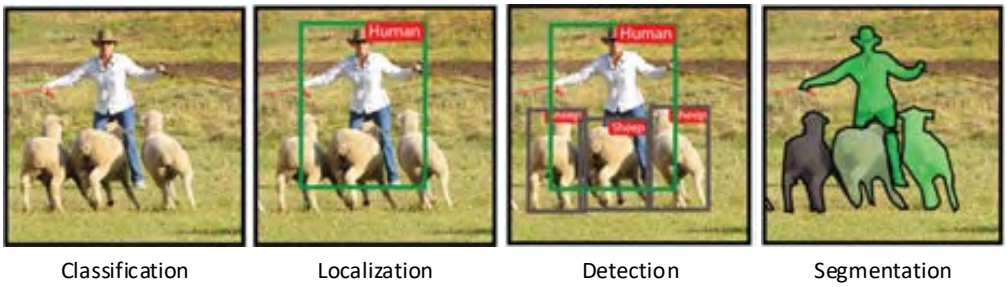

Figure 1. Example of object recognition tasks [19].

In this study, we conduct detailed literature review to find out relevant studies about vision-based ship target recognition systems. According to the gap, there is no large dataset both for detection and segmentation of maritime vessels in the image. In this paper, we focus on detection of ship and in order to fill this gap, we prepare a large image dataset which contains both ship images and location of ship in the images. We also classify images based on StatCode 5 ship type coding system by HIS Markit [20]. We collect relevant images from *Shipspotting*[1] public website.

2. Systematic Literature Review

In this research it is aimed to cover the whole studies on ship recognition researches in the lights of research questions. Those questions are considered to enable effective

[1] http://www.shipspotting.com/

evaluate of relevant literature. It is important to know which approaches the authors use to reveal issues on vessel recognition. Progress of research should be well designed and there should be some new ideas to fill gaps in studied topic. Table 1 shows fallowed research questions used to conduct the systematic literature review.

Table 1. Research questions for the systematic review.

ID	Research Question
1	How is ship recognition system being discussed?
2	Which approach or method is fallowed to create ship recognition system?
3	Which types of ship are selected?
4	Which input type is used?

We have carried out a systematic literature review using the approach suggested by Keele [21]. The review process involved three stages with several activities:

1. Planning the review: to define the need for a systematic review; to raise the research questions; and to define the review protocol: data sources, search strategy and terms, study selection criteria, data extraction and data synthesis.
2. Conducting the review: to select and review studies; to answer the research questions; and to present the results, discussions and conclusions.
3. Reporting the review: to write up the results of the review and format the final document.

The electronic database sources used in this review included those identified as relevant to topic; (1) Science Direct; (2) Scopus; and (3) Google Scholar. Articles of the last 5 years were reviewed (from January 2014 to January 2019).

The search terms included "recognition", "ship" both separately and conjointly. In addition, we used terms related to topic, for example, “artificial intelligence”, “image

processing and computer vision", pattern recognition", "maritime", "vessel", "classification", "detection", "segmentation", machine learning" and "deep learning". Examples of used search strings are presented in Table 2.

Table 2. Search Strings.

No	Search strings
1	"ship" AND ("recognition" OR "detection" OR "classification" OR "segmentation")
2	"ship" AND ("recognition" OR "detection" OR "classification" OR "segmentation") AND ("machine learning" OR "deep learning")
3	"maritime" AND "vessel" AND ("recognition" OR "detection" OR "classification" OR "segmentation")
4	"maritime" AND "vessel" AND ("recognition" OR "detection" OR "classification" OR "segmentation") AND ("machine learning" OR "deep learning")

A number of different criteria were specified to select appropriate studies for inclusion and exclusion in/from the review. The studies that met the following conditions were included:

1. Research papers.
2. Studies that discuss issues related to ship recognition.
3. Studies that propose an approach, process or methodology to create ship recognition model.
4. Studies published between January 2014 and January 2019.
5. Papers written in English.

For each study included in the review that was related to the ship recognition, we identified and extracted information regarding the following elements:

1. The authors and year of a study.
2. Discussions about ship recognition related issues and main focuses.

3. Defining for what reason which types of ship are selected and which input type is used.
4. The stages, steps or phases defined to develop ship recognition algorithm.

The extracted information about the studies was grouped, summarized and tabulated in table based on their different approaches to ship recognition. Table created to summarize an overview of each study, detailing:

1. The authors.
2. Year of the study.
3. Main focus.
4. Selected ship types.
5. Used input type
6. Used or developed methods.
7. Main findings and recommendations.

Using the defined inclusion criteria, a total of 12 were identified as relevant to the current review. Figure 2 provides a flow diagram documenting the results of the study selection process.

Figure 2. Study Selection Process.

3. Results

This section summarizes the results obtained after conducting the systematic review. Main focus and main findings of researches in the literature are shown in Table 3. The analysis of the results focuses on answering research questions are presented in Discussion section.

Table 3. Summary of Researches in the Literature

No	Authors	Year	Main focus	Ship Types	Input Type	Methods	Main findings and recommendations
1	Zhang, M. M. Choi, J. Daniilidis, K. Wolf, M. T. Kanan, C.	2015 [22]	Creating dataset (VAIS)	Merchant, Sailing, Medium Passenger, Medium Other, Tug, Small	RGB images (1.6K) & infrared images (1.2K)	Gnostic fields & CNNs	Using mentioned classifiers, they are able to achieve 87.4% mean per-class recognition accuracy during the day and 61.0% at night.
2	Bousetouane, F. Morris., B.	2015 [23]	Classification	Cabin Cruiser Vessel, Canoe Vessel, Kayak Vessel, Motor Boar Vessel, Paddle Board Vessel, Raft Vessel, Rowboat Vessel, Sail Boat Vessel, Water Taxi Vessel	RGB images (58K)	CNNs (OverFeat, GoogLeNet, VGG, and AlexNet)	The features extracted from deeper CNNs (e.g. Overfeat, GoogLeNet, etc.) performe better than less-deep (e.g. AlexNet). This means that deeper CNN architecture results in more discriminative features and are better suited for the FGC task.
3	Gundogdu, E. Solmaz, B. Yucesoy, V. Koc, A.	2016 [24]	Creating dataset MARitime VEsseLs (MARVEL).	Container Ship, Bulk Carrier, Passengers Ship, Ro-Ro Ship, Tug, Yacht, Sailing Vessel, Heavy Load Carrier, Livestock Carrier, Fire Fighting Vessel, Wood Chips Carrier, Patrol Vessel, Platform, Standby Safety Vessel, Combat Vessel, Training Ship, İcebreaker, Replenishment Vessel, Tanker, Fishing Vessel, Supply Vessel, Carrier/Floating, Dredger	RGB images (400K)	SVM, AlexNet & VGG-F	They detect 26 super classes between 197 vessel categories. They obtain promising results for vessel classification, 73%, vessel verification, %91 by using their MARVEL dataset.
4	Bousetouane, F. Morris, B.	2016 [25]	Detection & Classification	Kayak, Paddle Board, Raft, Rowboat, Canoe	RGB images (not defined)	SVM and Fast R-CNN	They show that HOG+Fast R-CNN achieve faster evaluation speed and higher accuracy for the detection in wide-area surveillance than traditional detection algorithms.
5	Yongqiang, L. Tie, L. Wei, Y. Dong, C. Qi, Z. Mingli, D.	2016 [26]	Detection & Classification	Warship, Merchant Ship	Simulation data consisting of physical, sound and magnetic fields (400)	SVM	By using simulated multi-physical fields, they design a ship classifier based on SVM. They claim that the model in this paper has good identification speed and accuracy.
6	Kumar, A. S. Sherly, E.	2017 [27]	Classification	Container Ship, Fishing Boat, Coast Guard, Tanker, Warship	RGB images (1.5K)	CNNs (VGG16)	Average accuracy of classification is 88.7% (excluding war ships which has lowest accuracy 53%). Attaching the pre-trained CNN to an SVM can increase performance and accuracy of vessel classification.

7	Bartan, B.	2017 [28]	Classification	Aircraft Carriers, Bulkers, Cruise Ships, Fire-fighting Vessels, Fishing Vessels, Tour Boats, Motor Yachts,… (the name of classes 6,9,10 are not mentioned in paper)	RGB images (16.8K)	SVM, CNNs (Custom & AlexNet)	The test accuracy is 76% for the CNN from scratch, and 88% for the CNN with AlexNet. Although there is no overfitting for the preprocessing followed by SVM method, the attained accuracy is low compared to the other two methods.
8	Du, Q. Zhang, Y. Yang, X. Liu, W.	2017	[29] Classification	Bulk Carrier, Container Vessel, Tanker, Passenger Ship, Speedboat	RGB images (1K) Model images (1K)	KNN	Authors select Hu invariant moments and ART to extract the regional shape feature of the ship targets. 7 regional shape eigenvalues with highest distinction are selected. They use those features to create a model by utilizing KNN. They obtain high accuracy (95.8%) and support an idea that 7 regional shape eigenvalues are effective in classifying the types of the ship targets.
9	Miličević, M. Zubrinic, K. Obradovic, I. Sjekavica, T.	2018 [30]	Classification	MARVEL-26 super classes	MARVEL Dataset; RGB images (26K)	CNNs (Custom, VGG19, InceptionV3, Xception, ResNet50)	Given the limited number of learning examples, the 78% accuracy achieved with the VGG19 network, this means that transfer learning is a very good result in the context of 26 classes.
10	Santos, C. E. Bhanu, B.	2018 [31]	Classification	Merchant, Sailing, Medium Passenger, Medium Other, Tug, Small	VAIS Dataset; RGB images (1.6K) & infrared images (1.2K)	Developping; DyFusion approach, Using; CNNs	They propose a fusion approach that estimates the probability of contextual information. By using both simulated sensor data and contextual information (multi-sensor), they achieve improved results (88%) compared to the baseline approaches.
11	Leclerc, M. Tharmarasa, R. Florea, M. C. Boury-Brisset, A.-C. Kirubarajan, T. Duclos-Hindié, N.	2018 [32]	Classification	MARVEL-26 super classes	MARVEL Dataset; RGB images (230K)	CNNs(AlexNet, Inception, ResNet)	Their transfer learning architecture and parameter choices achieve 78.73% accuracy, a significant improvement over the current state of the art of 73.14% [24].
12	Fu, H. Li, Y. Wang, Y. Li, P.	2018 [33]	Detection	Detecting ships without classifying	RGB images (1008)	Faster R-CNN	In the case of good environmental situations, high quality, clear pictures and single big targets, their algorithm works effective (%97). They notice that with improved training data set Faster R-CNN can able to detect accurately ships which are multi and small targets.

4. Discussion and Creating Dataset

As stated in Table 3, there are two researches on creating public dataset including ship images for ship recognition. VAIS is the first publicly available dataset of paired visible and infrared ship imagery. It contains of 2865 images (1623 visible and 1242 IR) from six different types of ship. Corresponding pairs of RGB and IR images (1088) makes this dataset unique, however, dataset size is so small for achieving high accuracy by using deep leering approaches. MARVEL is the larger-scale image dataset which contains around RGB images of 400.000 ships extracted from 2.000.000 images. They also construct 26 super-classes from 109 ship types by using a semi-automatic clustering scheme (around 230K images). This dataset is well designed for vessel verification, retrieval and classification issues. Besides, some researchers create their own dataset relevant to their problem. However, none of them have more multi classes and more examples than MARVEL has. In this perspective MARVEL is also unique dataset like VAIS, however, both of them are not designed for vessel detection or segmentation issues. They don't have any bounding box information for ships in the image. Some researches create their own small dataset for ship detection by using transfer learning approach to show that if there is large dataset, task of ship detection could be achieved with high accuracy. Besides being too small (maximum of them is 1008 RGB images), those datasets are lack of relevant and detailed categorization. In the light of those findings, we conduct detailed data collection procedure to fulfill absence of large dataset for ship detection in the literature. We collect relevant data from *Shipspotting* public website containing 2.518.423 ship images. First we define main classes for this paper between 175 categories (which has actually 104 relevant ship classes) by using StatCode 5 ship type coding system.

In StatCode 5, there are two categories at level 1 which are Cargo Carrying and Work Vessel. In this research we focus on Cargo Carrying class. When we look at to level 2 categories of Cargo Carrying class, we find three classes which are Bulk Carriers, Dry/Cargo/Passenger and Fishing. We choose relevant sub Level from those classes based on their number of images in the *Shipspotting* website. According to our evaluation finally we define 8 different classes shown in Table 4.

Table 4. Selected Main Classes and Comparison with StatCode 5 Classes

Shipspotting Categories	StatCode 5 Classes	
	Class	Level
Bulk Carrier	Bulk Carrier	4
Container Ship	Container Ship	4
Chemical Tanker	Chemical Tanker	4
Crude Oil Tanker	Crude Oil Tanker	4
Gas Tanker	Liquefied Gas	3
Ro-Ro	Passenger/Ro-Ro Cargo Ship	4
Cruise Ship	Passenger (Cruise) Ship	4
Fishing Vessel	Fishing Vessel	4

After selection of classes, we download 20.000 images averagely for each classes from *Shipspotting.* Then we create dataset which contains 10.000 images for each class by eliminating same images. Also, we label each ship position in the images and create box information csv file which contains image ID with top left point (Xmin, Ymin) and bottom right point (Xmax, Ymax) of the boxes. Finally, we form unique dataset to use it for object detection algorithms such as Fast-RCNN, YOLO and Faster-RCNN. Example of our dataset can be seen in Figure 3.

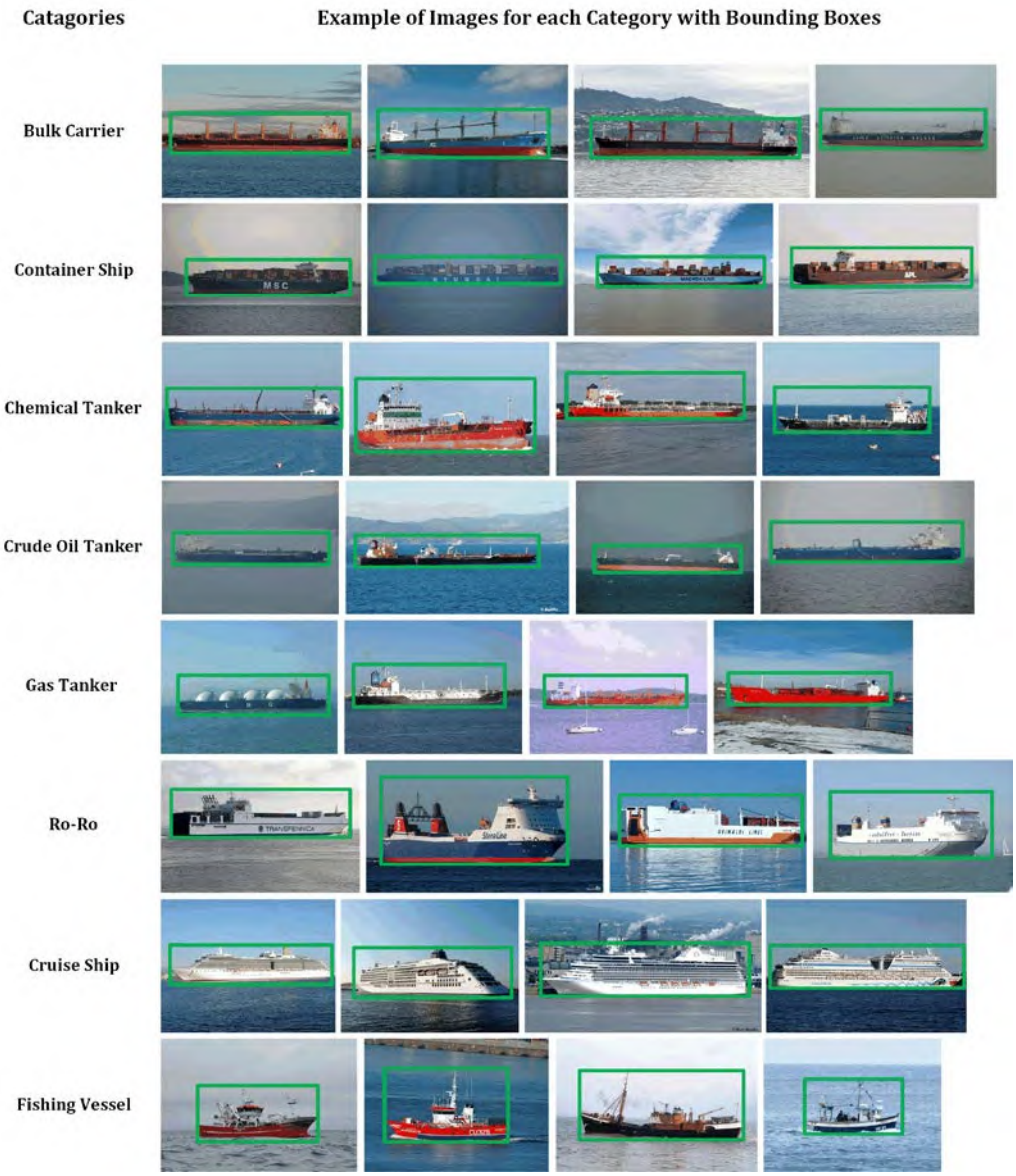

Figure 3. Example of our dataset. Top left point of green box is defining Xmin & Ymin and bottom right point of green box is Xmax & Ymax.

5. Conclusion

By looking autonomous ship perspective, there should be a system which is so close to human sensing or more than it to predict threats and to take relevant precautions during voyage. There are AIS and RADAR systems to detect targets around vessel, however, those

devices are equipped to be an assistant for watchkeeping officer. They cannot be the main system of automatic detection of targets in the vicinity or there should be another system to mitigate failures related to them.

In the field of computer vision, there are vision-based approaches by using deep learning to detects objects in the image. Vision-based sensors can be appropriate to feed ship detection system. There are deep leering architectures to achieve detection task accurately such as Fast-RCNN, YOLO and Faster-RCNN.

In this study, we conduct detailed literature review to find out relevant studies about vision-based ship target recognition systems. We find that there are datasets designed to classify ship types, however, those are not enough to conduct localization, detection or segmentation of ships in the image. In this paper, we focus on detection problem and define main classes related to Bulk Carriers, Dry/Cargo/Passenger and Fishing based on StatCode 5 and Shipspotting website. We created a large dataset (totally 80.000 images) from eight different ship types. Dataset has 10.000 images for each class and contains ship locations in the images. Authors are expecting high accuracy from model trained via feeding mentioned deep learning architecture by this large dataset.

In our planned future research, we will compare results from Fast-RCNN, YOLO and Faster-RCNN by using our created large dataset. Also, we are planning to make our dataset publicly available to encourage works in the field of automatic ship detection algorithms.

6. Acknowledgment

Authors would like to thank Cemal KARAGOZ, Deniz YETIM, Soner KUBBE and Meric TURGUTTEKIN for their assistance to define locations of ships in the relevant images. They made a great contribution to this manuscript.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Determining Maritime Educational Needs for Energy Efficiency Within the Scope of MarEd Project (Erasmus+Programme)

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ABSTRACT

The World marine transportation have to take operational and technical actions to reduce carbon emissions due to the climate change. IMO (International Maritime Organization) developed a new way to minimize the carbon emissions and ensure energy efficiency for ships with MARPOL (International Convention for the Prevention of Pollution from Ships) Annex VI which was entered into force on January 1, 2013. Energy efficiency in maritime transportation has become a necessity resulting from the marine fuel costs, higher taxes and air pollution regulations. Recent studies show that, ship owners and operators have taken many measures for energy efficiency onboard which enables less fuel consumption and reducing the carbon emissions. SEEMP aims to increase the energy efficiency through operationl applications that are developed to use existing technologies on board with crew awareness and training on energy efficiency. Along with many ways to boost ship energy efficiency in marine sector, however, these ways are not effectively implemented due to the insufficient education of staff/ lack of expertise and existence of barriers to energy efficiency. Efficient use of energy will be only possible by increasing the awareness of people who operate ships, including seafarers and shore-based personnel.

The project MarEd (Maritime Education for Energy Efficiency) will develop a tool for training all marine staff to acquire qualification in different level of job including both on board personnel such as ship captains, chief engineers, officers and etc. and energy efficiency dedicated staff in shipping companies such as superintendents, fleet managers, energy managers and etc. through a distance learning course that provides modules to teach and understand the implementation of energy efficiency policies and MARPOL Annex VI. The project MarEd mainly aims to define all

energy efficiency gaps in the shipping industry and create a distance learning modules to train staff and improve the familiarity and knowledge about the energy efficiency.

The main aim of the paper is to identify a framework based on training needs about ship energy efficiency. The study will be conducted in the form of a questionnaire survey which will be carried out by staff working on board and at shipping companies. Data will be gathered from all partner's networks and their respective national maritime communities at various/plenty of time afterwards, the survey results will be investigated statistically and gaps related to training will be determined. These gaps, training needs and potential contributions of study will be discussed analytically within the scope of MarEd project.

Keywords: Energy Efficiency, Maritime Education, Training Needs, MarEd Project.

1. Introduction

Energy efficiency is one of the substantial areas that needs to be handled with precision. It is directly related to the sustainability of economic growth and social development goals, but also plays a key role in reducing total greenhouse gas emissions. Energy efficiency improvements provide many benefits which are directly related to health, economic, social and environment field. International Energy Agency provides Energy Efficiency Market Report and it shows that improvement in energy efficiency is approximately 17% from 2000 to 2017 globally [1]. Energy usage in the world would be 12% more if no steps were taken but all measures are still insufficient. United Nations Conference on Trade and Development (UNCTAD) points out that over 80 percent of global trade by volume is transported and handled by ships and the demand for the maritime sector is increasing over the years and every year, 1 billion tons of carbon dioxide is released into the atmosphere with maritime transportation and that stands for the 2.5 percent of global greenhouse gas emission due to the fuel combustion [2]. Energy efficiency is a challenging field that can be addressed at many different levels. IMO (International Maritime Organization) gives great importance to air pollution caused by emissions of greenhouse gases from ships and carried out many studies about this issue. For maritime industry, energy efficiency is directly associates with air pollution from ships. That is why decreasing of greenhouse gas emission is an important solution.

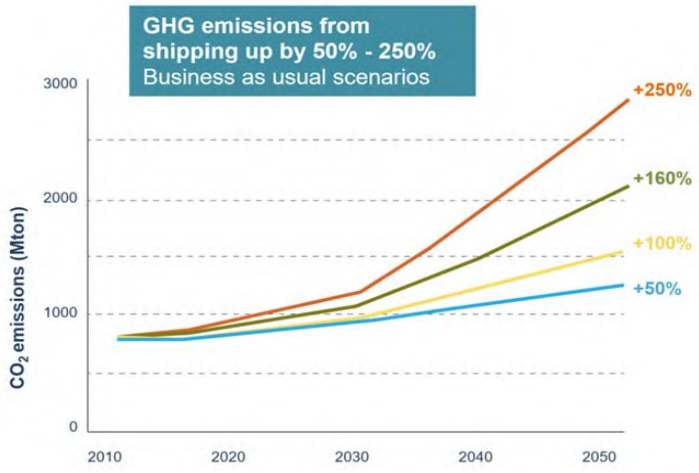


Figure 1. Evolution of GHG emissions from shipping depending on various economic growth and energy development projections [3].

About 3.1% of total annual anthropogenic greenhouse gas (GHG) emissions are resulted from CO2 emissions that are released into the atmosphere as a consequence of marine transportation that shown in Table 1. This is a value that should be taken into consideration even though the amount of CO2 in other transport systems is relatively low. The result of IMO GHG3 Executive summary and report [3]; greenhouse gas emission may reach up to 50%-250% and this estimated scenario depends on the increasing in number of ships due to economic growth and energy efficiency improvements (Figure1).

Table 1: Shipping CO2 Emissions Compared With Global CO2 (Values In Million Tonnes CO2) [3].

Year	Global CO21	Total shipping CO2	Percentage of global	International shipping CO2	Percentage of global
2007	31,409	1,100	3.5%	885	2.8%
2008	32,204	1,135	3.5%	921	2.9%
2009	32,047	978	3.1%	855	2.7%
2010	33,612	915	2.7%	771	2.3%
2011	34,723	1,022	2.9%	850	2.4%
2012	35,640	938	2.6%	796	2.2%
Average	33,273	1,015	3.1%	846	2.6%

The emission rate could be reduced by the implementation of technical and operational measures for up to 75% [4]. The enhancement of efficiencies could cut down the fuel consumption, escalate the profit, reduce higher taxes and has an environmental impact in the maritime transportation. Although the effects of individual measures are small, all

measures taken by shipping companies throughout the entire fleet will contribute significantly to the world. The improvement of energy efficiency of ship operation does not necessarily depend on merely to ship management. Rather, it may depend on many stakeholders including ship repair yards, ship owners, operators, charterers, cargo owners, ports, and traffic management services.

Recent studies show that ship owners and operators have many measures for energy efficiency onboard which contributes less fuel consumption and reducing the carbon emission [5]. SEEMP (Ship Energy Efficiency Management Plan) aims to increase the energy efficiency, through operational applications that are developed by using existing technologies on board with crew awareness and training on energy efficiency. For effective and steady implementation of the adopted measures, raising awareness and providing necessary training for personnel both on shore and on board are important elements. Such human resource development is encouraged and should be considered as an important component of planning as well as a critical element of implementation. Along with many ways to boost ship energy efficiency in marine sector, however, these ways are not effectively implemented due to the insufficient education of staff/ lack of expertise and existence of barriers to energy efficiency. Efficient use of energy will be only possible by increasing the awareness of people who operate ships, including seafarers and shore-based personnel.

The project MarEd (Maritime Education for Energy Efficiency) will develop a tool to train and acquire qualification for all marine staff in different levels of job including both on board personnel such as ship captains, chief engineers, officers etc. and staff in shipping companies whose particular aim is energy efficiency, such as superintendents, fleet managers, energy managers etc. through a distance learning course that provides modules to teach and understand the implementation of energy efficiency policies and MARPOL Annex VI. The project MarEd mainly aims to define all energy efficiency gaps in the shipping industry and create distance learning modules to train staff and improve the familiarity and knowledge about the energy efficiency.

The main aim of the paper is to identify a framework based on training needs about ship energy efficiency. The study was conducted as a form of a questionnaire survey which were carried out by crew and the shipping companies. Used method includes a web-based survey and literature studies. Survey questions were prepared in accordance with energy efficiency regulations and implementations to measure personnel's awareness and knowledge. The results of the survey were examined statistically and gaps related to training were determined.

2. Regulatory Framework in Maritime Transportation

In recent years, air emissions have become an important agenda for human health, land and marine ecosystems by the scientific community and policy makers. NOx (Nitrogen Oxides), SOx (Sulphur Oxides) and Particulate Matters (PM) are amongst the air pollutants which are toxic substances for ecosystem [6]. With the industrial developments in the world, transportation systems have grown, and unfortunately fossil fuels are widely used today. There is a positive correlation between economic growth and transportation growth and we need to be aware of the role of fossil fuels on global warming. The exhaust gases that results from the combustion of fossil fuels cause not only air pollution but also climate change and global warming. Intergovernmental Panel on Climate Change (IPCC) concludes that [1];

"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level."

Co2 gas is the biggest problem causing global warming among all gases released into the atmosphere due to its total amount. According to Kyoto Protocol [7], greenhouse gases has identified as; Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF6).

Table 2 presents the emission estimates for international shipping which was obtained at the IMO Third GHG Study 2014. When the greenhouse gases from the vessels are released

into the atmosphere between 2007 and 2012, it can be seen that among these gases, the CO2 weighs much more when compared with the others.

Table 2: Bottom-Up CO2 Emissions Estimates With Climate-Carbon Feedbacks From Total Shipping (thousand tonnes) [3].

	2007	2008	2009	2010	2011	2012
CH4	6,018	6,657	6,369	8,030	9,802	9,802
N2O	14,879	15,404	13,318	12,453	12,707	12,707
CO2	1,100,100	1,135,100	977,900	914,700	938,100	938,100
Total	1,120,997	1,157,160	997,587	935,183	1,044,835	960,608

To reduce the use of fossil fuels, IMO has introduced some rules and practices, all of which are described as energy efficiency. UNCLOS and MARPOL determine the international rules on air pollution and emissions in the maritime sector. The main purpose of MARPOL is to prevent pollution from ships which consists of six annexes and entered into force on 2 October 1983 [8].

MARPOL Annex VI deals with air pollution from ships that was entered into force on 19 May 2005 and set up rules on sulphur oxide (SOx) and nitrogen oxide (NOx) emissions from ship exhausts. With the revised MARPOL 73/78 Annex-VI;

In 2008, IMO released the amendments to MARPOL Annex VI about NOx Technical Code and energy efficiency regulations and especially controls the GHG emissions for ships in 2011 [9]. The Annex VI focus on air pollution, GHG emissions, bunker operations, special areas and reception facilities, etc. which is depicted in Figure 2.

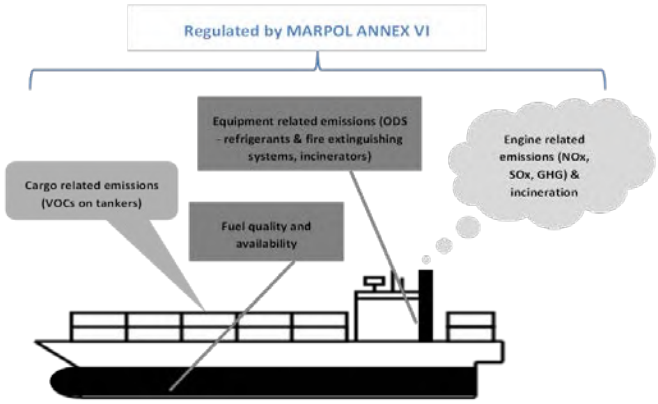


Figure 2: "MARPOL 73/78" Annex-VI [10].

MARPOL Annex VI has introduced important applications for energy efficiency on ships and the main aim of these applications is to reduce GHG gases from ships with technical and operational measurements. These applications are [9]; Energy Efficiency Design Index (EEDI) [11], for new ships and Ship Energy Efficiency Management Plan (SEEMP), for all ships are mandatory from 01 January 2013. The Energy Efficiency Operational Indicator (EEOI), voluntary.

The EEDI is a necessary criteria used for the new ships which evaluates the energy efficiency of a ship in relation to gCO2 (generated) / tonne. mile (cargo carried). EEDI is the basic implementation for sustainable maritime industry in terms of more efficient ships [9]. The object of a Ship Energy Efficiency Management Plan (SEEMP) is to establish a system for a company to improve the energy efficiency of a ship's operation that is mandatory implementation for all ships. The SEEMP should be designed as a ship-specific plan by the ship owner, operator or any other party concerned, e.g., charterer that seeks to improve a ship's energy efficiency [12]. There are many options for ship owners and operators to increase energy efficiency on board, these options vary according to the ship's type, cargoes, routes and other factors. The SEEMP identifies energy-saving measures and best practices into the following categories; fuel efficient operations, optimized ship handling, hull and propulsion, machinery and equipment, cargo handling optimization, energy conservation and awareness according to Sample SEEMP template from IMO guidelines. According to IMO [9]; IEE Certificate issued to the ship by the

Administration after verifying the EEDI Technical File and SEEMP. Monitoring and recording of the ship's energy use, coordinated work with the shore office and regular reporting, encouraging energy awareness on board and making suggestions for energy saving are important steps for energy efficiency sustainability. Furthermore, the Energy Efficiency Operational Indicator (EEOI) is a quantitative monitoring method which enables to measure and compare CO2 emissions for each ship of a company [13]. EEOI is a monitoring formula that was developed by the IMO and companies calculate it with utilizing data obtained from existing records such as official and engineering log-books and oil record books. There are many options to measure the energy efficiency options with easy software programs to compare a ship with others [14].

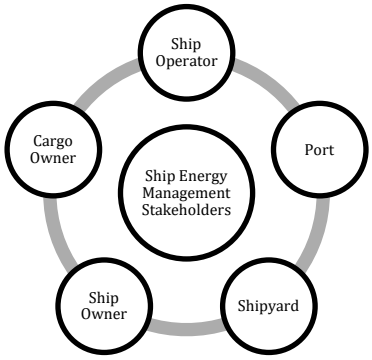


Figure 3: Ship Energy Management Stakeholders. Adopted From M2 Ship Energy Efficiency Regulations And Related Guidelines [15].

As a result, IMO has introduced operational and technical applications for increasing energy efficiency on ships. Energy efficiency is not only a matter of concern to the ship or the companies, but also to many stakeholders. Figure 3 presents the overview of the stakeholders of ship energy management [15]. Therefore, the cooperation between the stakeholders is an essential element for developing energy saving.

3. Objective and Method of the Study

Changing the energy consumption habits of the maritime transportation in years is a complex task to increase energy efficiency. Several studies have revealed that there are many measures to reduce CO2 emissions which are directly related to energy efficiency but there are some challenges and barriers in implementing these measures [16], [17],

[18], [19], [20]. Mohammud Hanif et al. conducted surveys about energy efficiency barriers after evaluating previous surveys [20] and in their detailed survey of energy efficiency barriers, they concluded that there are four main barriers; lack of knowledge, competence, awareness and challenges in operation are the challenging obstacles for implementing energy efficiency measures. While all stakeholders of maritime industry give great support to raise the awareness, above mentioned difficulties can be eliminated by training of the ship's crew and the shore staff.

The objective of the study is to construct the structure of the training needs for Energy Efficiency and to measure awareness of Ship Energy Management Stakeholders. The study was conducted in the form of a survey, with the data being gathered via a web-based survey to reach users extensively. The surveys were prepared within the scope of the MARED project by partners and the results will be used in the training module. The Project consortium is made up by private companies, public bodies and universities from Turkey, United Kingdom, and Greece, who all have an extensive experience in the maritime sector. Moreover, this survey has taken advantage of the project team member's operational and technical experiences and in order to develop the survey of the MarEd Project, regulations, implementations and previous studies of maritime energy efficiency were systematically investigated. Istanbul Technical University incorporated the comments of partners and finalized the questionnaire and forwarded it to the partners for final check before sending. Project partners sent final questionnaire to their networks and their respective national maritime communities and collect them to detect insufficiency in the knowledge of target groups/lack of expertise and existence of barriers to energy efficiency.

We developed two questionnaires for ship' crew and shore staff (energy management stakeholders) by using the five likert scale. Each survey divided into two parts; in the first part of the survey, we asked demographic questions. In the next part, we asked questions to evaluate the knowledge about international energy efficiency regulations, awareness and energy efficiency measures of the stakeholders with varied concepts. Finally, the most important barriers to energy efficiency implementation and best practices are tried to be

collected by asking to the stakeholders. This questionnaire asked for their observations, opinions and experiences on how a ship can be operated more efficiently.

4. Results of the Study

The study was conducted in the form of a questionnaire survey which was carried out via a web-based survey by the stakeholders. By the end of the survey period, data had been collected from 100 individuals of Shipping Fleets in Turkey, 50 of whom were on board personnel such as ship captains, chief engineers, officers and etc. And the others were shore-based personnel such as superintendents, fleet managers, DPA and etc. Figure 4, 5 presents an overview of participants for both questionnaires.

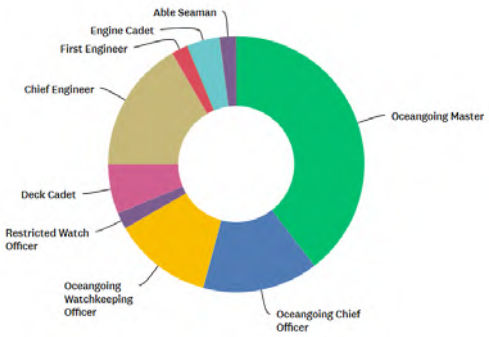


Figure 4: Distribution of Seafarers

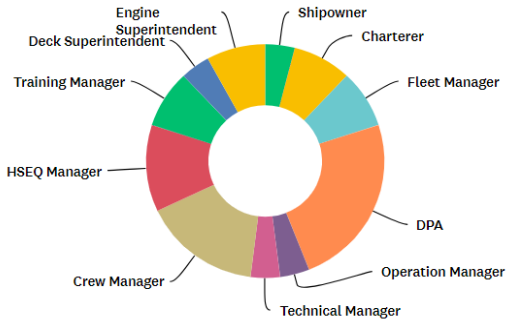
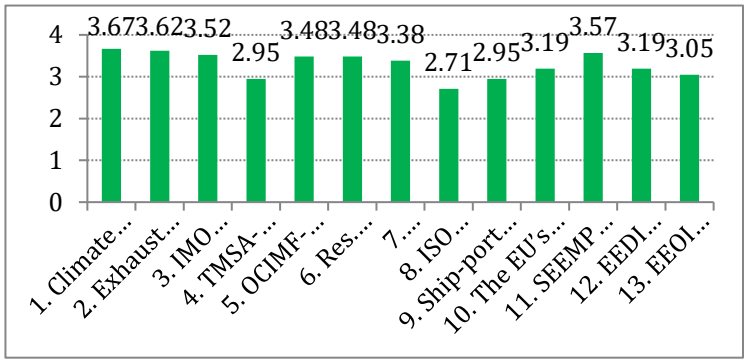


Figure 5: Distribution of Shore Staff

Simple statistical analysis was used to identify a framework based on training needs about ship energy efficiency. Firstly, the results of the survey conducted for the seafarers are as follows "*Maritime Energy Efficiency Awareness and Training Needs Questionnaire (Crew)*":

The majority of them worked in oil/chemical tanker while the rest of them were employed in container, dry cargo, bulk, and Ro-Ro ships and the average work experience of respondents are usually between 6 and 10 years. In the second part of the survey study, the knowledge level of seafarers about Energy Efficiency rules and regulations was investigated. In response to this part of the survey, it is indicated that all marine staffs in different levels of job have some knowledge about the regulatory framework which is shown in Table 3.

Table 3: Average Scores Of Degree Of Knowledge In Each Of The Regulatory Framework.

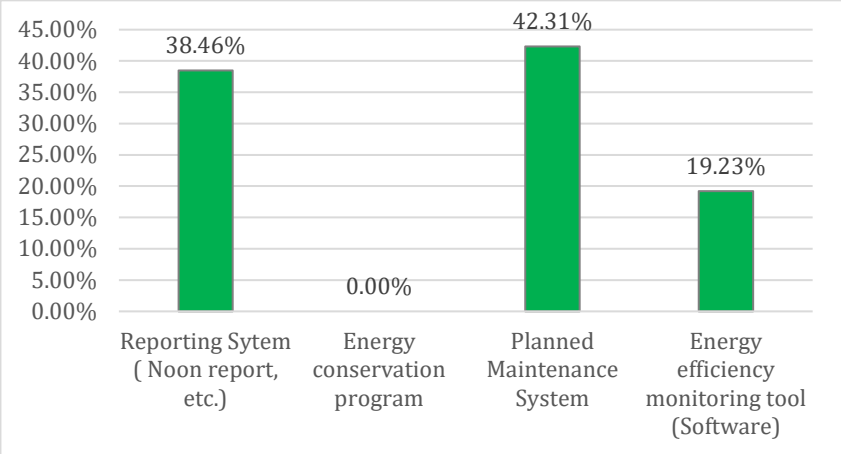


According to the survey, improvements that are needed to achieve energy efficiency on board has been given below; Energy efficiency regulations, shore office performance support management decisions (Ship owner, shipper, contract department, ...), crew Initiative and Problem Solving Skills (Via Education and Training). A certain part of the respondents stated that they did not receive enough training about energy efficiency before joining the vessel (38,1%), that the shipping companies did not inform the seafarers about energy efficiency (38,1%) and the example cases of ship energy efficiency management was not illustrated in the trainings (47,62%). Only 37% of respondents stated that they knew a little knowledge of how to make fuel efficient operations (improved voyage planning, weather routing, just-in-time, speed optimization, optimized shaft power). The next section of the survey was concerned with the awareness and best practices of energy saving; 47.62% of respondents say they are aware of specific energy saving practices on board accommodation area, but only 42.86% emphasized that it is important to encourage the crew to consider energy efficiency on board. Only 38.10% of respondents stated that their satisfaction on ship energy efficiency measures are implemented according to SEEMP and international rules & regulations. However, it is clear that these practices and ratios are insufficient to implement energy efficiency.

The other results of the survey conducted for the seafarers are as follows *"Maritime Energy Efficiency Awareness and Training Needs Questionnaire (Shore Staff)":*

34.62% of the shore staff participants had more than 10 years of professional experience and 34.62% were employed in dry cargo shipping companies. The finding that several stakeholders stated that, only 19.23% shore staff uses energy efficiency monitoring tool (Software) to monitor and analyze energy /fuel consumption (EEOI, SOx, NOx) of vessel throughout the fleet, others have used other methods of reporting system (Noon report, etc.) and planned maintenance system. This figures shows in Table 4.

Table 4: Distribution Of The Energy /Fuel Consumption (EEOI, Sox, Nox) Analysis Methods.

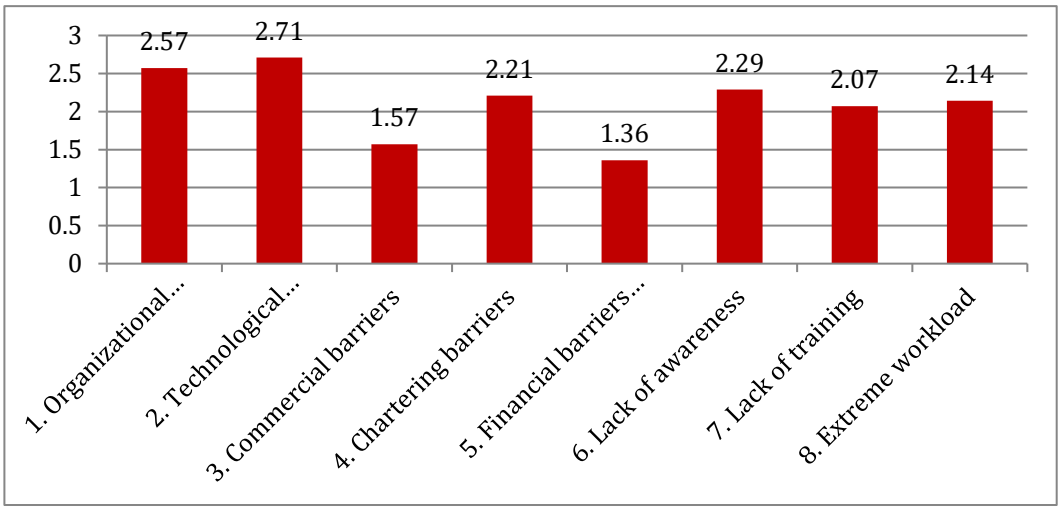


Shore staff have more knowledge on energy efficiency regulatory framework than seafarers. 42.86% of the respondents stated that their company regularly train ship's crew about energy efficiency. 42.86% of the respondents indicated that Energy awareness culture is promoted among the employees in the organization, but 21,43 % of the stakeholders underlined that potentials for further energy efficiency are not identified.

Crew initiative and problem solving skills (via education and training) and the availability of new low carbon technologies and management decisions and support (ship owner, shipper, contract department…) are the most issues to be improved to achieve energy efficiency on board. In response to Question 13, most of the respondents indicated that

42.86% of shore staff opine that their crew's knowledge on ship energy efficiency measures is fair.

Table 5: Average Weighted Of The Barriers Related To Ship Energy Efficiency Implementation.



Technological barriers, organizational barriers and lack of awareness are the most three important barriers related to ship energy efficiency implementation presents in Table 5. In summary, these results show that training is the most important step to increase awareness of energy efficiency.

5. Conclusion and Discussions

Considering present technological improvements, there would also be an increase in maritime sector along with other transportation methods. Increasing greenhouse emissions and consecutive global warming would take place due to the fossil fuels that is commonly used in marine vessels. Maritime sector has introduced new applications and taken many steps towards these issues. Presently, energy efficiency is one of the top trend topics and should be approached seriously. Despite the precautions and regulations related to energy efficiency in maritime sector, it is clear that there are some difficulties and barriers in the application. The present study was design to determine the existence of barriers to energy efficiency and to assess the training needs for stakeholders. One of

the more significant findings to emerge from this study is that efficient use of energy is provided with increasing the awareness of stakeholders. This study has shown that the stakeholders partially familiar with the regulations and implementations of energy efficiency measures properly and do not receive adequate training. The following conclusions can be drawn from the result of the survey is that;

- All stakeholders have insufficient knowledge about energy efficiency regulations and implementations.
- Seafarers cannot get enough energy efficiency trainings before joining the vessel and on board.
- Seafarers were not motivated to energy saving best practices by the shipping company.
- Shore staff consider their employees to be insufficient about energy efficiency measures.
- Company implementations according to SEEMP and international rules & regulations are fair.

Stakeholders awareness may be increased through the use of appropriate training based on adopted measures and regulations for more efficient operations on board. In addition, more efficient ships will not only reduce air pollution from ships emission, but also escalate economical profit of the ship owners, charterers and operators.

In the further research, 300 people will be involved with the research questionnaire within the scope of the MarEd project. Data management and analysis will be performed using by SPSS to find the training requirements and gaps. These findings will provide insights for the MarEd online Training Course, the project would provide an assessment tool for users as well. The MarEd project will contribute to increase the awareness and knowledge of stekeholders on maritime energy efficiency, therefore it will help minimise global warming by reducing carbon dioxide emissions

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Evaluating Efficiency Improvement Potential of an Organic Rankine Cycle for a Marine Diesel Power Plant by Applying Advanced Exergy Analysis

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ABSTRACT

Marine Environment Protection Committee of International Maritime Organization has developed regulations in action to limit the environmental effects and emissions originated from marine vessels. Concurrently, fuel prices are rising and expected to continue its trend in foreseeable future. Thus, marine power systems are in a need of improvement in terms of efficiency and fuel economy and also mitigation of irreversibilities within power production systems. In this respect, it is important to have a knowledge of system improvement potential when changes are planned on an energy system. Exergy analysis is a tool to account for irreversibilities within an energy system. However, it lacks the ability of providing the true potential of improvement and the origins of irreversibilities. Advanced exergy analysis is a method to enhance the results of conventional exergy analysis by splitting exergy destruction into avoidable, unavoidable, endogenous, exogenous parts and their combinations. It is useful to reveal more information on the parts that could be further improved. Moreover, recently introduced new modified exergy efficiency and overall efficiency improvement criteria based on advanced exergy analysis can play a key role to determine the system limits in respect to technological, metallurgical and economic constraints. In this paper, a conceptual organic Rankine cycle waste heat recovery system which has been optimized with genetic algorithm integrated into a marine Diesel power plant is investigated by applying improvement decision criteria together with conventional and advanced exergy analyses. The results indicated that the highest exergy destruction occurs in economizer and with

a small difference in condenser. However, condenser has the highest amount of avoidable exergy destruction potential.

Keywords*:* Marine thermal energy systems, Organic Rankine cycle, Advanced exergy analysis, Improvement decision criteria, System modelling and optimization.

1. Introduction

Economic and environmental constraints are urging the technological improvements of the marine power systems in a way to more efficient operation with less harmful emissions generated. In environmental point of view, due to the strict regulations of Maritime Environmental Protection Committee (MEPC) of International Maritime Organization (IMO) through an International Convention for the Prevention of Pollution from Ships annex VI, the requirements for improvements in maritime transport sector must be fulfilled [1]. Moreover, IMO has set the emission limits to lower values and also introduced a couple of indexes to classify the vessel with respect to their efficiency [2]. On the other hand, in the era of financial difficulties, costs are more worrying for the operators and the ship-owners [3]. As it is stated by researchers, reducing fuel consumption is the key for most of the problems faced and different approaches such as slow steaming, voyage optimization, weather routing as well as waste heat recovery (WHR) are suggested and applied [2-5]. Considering that almost quarter of the total fuel energy is lost within exhaust [6], WHR systems gain more attention and it is the mostly applied technique such as turbo-charge, turbo-generator and domestic water heating system among others for two-stroke Diesel engines [3, 4].

Organic Rankine cycle is a common application not only for low grade energy utilization but also high density energy with relatively small temperature interval of heat source [7, 8]. In this respect, it is suitable for recovering the remnant fuel energy of a marine vessel, which remains after turbocharging, turbo-generator and domestic hot water, at the end of the exhaust stack. Moreover, it could also utilize other heat sources of the waste heat vessels as lubricating oil cooler, scavenge air cooler, high temperature fresh water cooler [2, 9, 10]. Hence, ORC technology for WHR gains more and more attention by the researchers in the last two decades [11]. Mondejar et al. [2] analysed ORC systems for three different vessels and compared to a dual pressure steam Rankine cycle while they reviewed the recent studies of application of ORC WHR systems and working fluids with legalisations for marine systems in detail. They concluded with valuable information on

system design and operation to achieve %15 percent fuel savings. Chintala et al. not only gathered information about the different waste heat sources and application of ORC systems for compression ignition engine waste heat recovery systems but also working fluids and selection criteria, component selection, and evaluation methods as energy, exergy and exergoeconomic analyses [12]. Shi et al. reviewed different types of ORCS for internal combustion engine (ICE) WHR systems, starting from ideal cycle to more complex systems to approach the ideal, which are named as modified ORCs to make a good match between heat source and the system [13]. Hoang [14] stated that Diesel engines are widely used and responsible for the environmental pollution and reviewed state of the art technology to lower the emissions and potential utilization of ORC systems with investigating different layouts and working fluids. He also reviewed selection of different components with thermodynamic, economic, exergy and exergoeconomic analyses. Mahmoudi et al. reviewed recent studies on WHR ORC systems with a variety of types and working fluids and concluded where the WHR ORC stands with highly important statistics [7].

Genetic algorithm is a method to achieve optimal solutions for engineering problems, which is based on genetic processes of the biological organisms [15]. It has been applied by different researchers to determine optimum design points of ORC systems. Pierobon et al. proposed a multi objective optimization technique that includes thermal efficiency, density and net present values and utilizes genetic algorithm to design ORC systems and applied to an offshore system [16]. Larsen et al. studied design and optimization of different configurations of ORC systems for marine applications by employing genetic algorithm to discover the net power potentials of working fluids [17]. Hærvig et al. investigated 26 different working fluids for ORC systems and they used genetic algorithm to maximize net power to determine optimum working fluids [18].

Exergy analysis is a method to evaluate the energy conversion systems where, why and how much irreversibility occur within. As mentioned before, it has been widely applied to ORC systems [4]. Nevertheless, it is doubtful whether the exergy analysis gives adequate information about what is the real source of the exergy destruction and how much of it

could be regained [3]. Hence the method is taken a step further with the so-called advanced exergy analysis method. It is based on splitting exergy destruction into parts namely avoidable, unavoidable, endogenous, exogenous and their combinations as avoidable endogenous, avoidable exogenous, unavoidable endogenous and unavoidable exogenous exergy destruction [19]. More insight could be derived from this approach to optimally design and renovate the systems via the improvement potential, and the cause of the irreversibility knowledge. Galindo et al. evaluated an experimental ORC system after a 2-liter turbo-charged engine with ethanol as working fluid and revealed that 36.5% of the exergy destruction could be avoided [20]. Nami et al. applied advanced exergy analysis to a geothermal driven dual pressure dual fluid ORC system with isopentane and isobutene as working fluids and results showed that vapour generators are the most important components with respect to the avoidable exergy destruction [21]. Koroglu and Sogut investigated a superheated ORC system for marine power plant with a recuperator and four different working fluids at the four different load of the main engine by applying advanced exergy analysis and revealed that there is a potential to produce approximately 300 kW power from exhaust and jacket water waste heat with R113 at full load [22]. Moreover, they utilized five different organic fluids and compared the exergetic and economic performances of two different ORC systems namely saturated and superheated ORCs by applying conventional and advanced exergy based analyses [4]. Recently, Khosravi et al selected ORC system, working fluids for WHR from a gas turbine and not only optimized the system with two objective functions of cost and exergy efficiency by using genetic algorithm but also applied conventional and advanced exergy based analyses [23].

In this paper an optimized ORC system by genetic algorithm to maximize the net power production for the exhaust system of a 17 MW marine Diesel power plant is investigated. Isohexane is selected as working fluid. Advanced exergy analysis and recently introduced decision criteria are applied to reveal the true potential for improvement of the system as well as effects of the components on the exergy efficiency of the overall system.

2. Theoretical Analysis

In this section the theoretical approach to investigate the system will be given with the decision criteria.

2.1 Conventional Exergy Analysis

Exergy is the available energy at the ambient state conditions [24]. To apply the exergy analysis, exergy balance of a system must be ensured. In general approach, it can be said that desired output of an investigated system could be named as exergy of product and the required input could be named as the exergy of fuel while balancing exergy changes for a component as well as overall system [25, 26]. And the balances could be written as follows:

$$\dot{E}x_{D,k} = \dot{E}x_{F,k} - \dot{E}x_{P,k} \tag{1}$$

$$\dot{E}x_{F,tot} = \dot{E}x_{P,tot} + \dot{E}x_{D,tot} + \dot{E}x_{L,tot} \tag{2}$$

Where $\dot{E}x_D$, $\dot{E}x_F$, $\dot{E}x_P$ and $\dot{E}x_L$ represent the exergy destruction, exergy of fuel, exergy of product and exergy loss, respectively. Subscript k and tot denote the investigated kth component and overall system respectively. It is assumed that individual components have boundaries of environmental conditions while exergy loss only occurs at overall system level [26]. Overall exergy destruction, exergy destruction share of the components and exergy efficiency is calculated as [15, 19, 27]:

$$\dot{E}x_{D,tot} = \sum \dot{E}x_{D,k} \tag{3}$$

$$y = \frac{\dot{E}x_{D,k}}{\dot{E}x_{D,tot}} \tag{4}$$

$$\varepsilon = \frac{\dot{E}x_P}{\dot{E}x_F} \tag{5}$$

2.2 Advanced Exergy Analysis

Limits and constraints of a component indicates the maximum efficiency or minimum irreversibility that can be attained by the component, but it is impossible to eliminate all

of the irreversibilities to match the theoretical conditions. Hence, a part of exergy destruction will always occur within the investigated component, that is called unavoidable exergy destruction. It is calculated by the equation as follows [3]:

$$\dot{E}x_{D,k}^{UN} = \dot{E}x_{P,k}\left(\frac{\dot{E}x_{D,k}}{\dot{E}x_P}\right)_k^{UN} \tag{6}$$

Where superscript *UN* denotes unavoidable conditions of exergy destruction. Moreover, reaching the best possible operating conditions of the investigated component can be seen as the proof of potential to avoid some of the exergy destruction which is called avoidable exergy destruction. In other words, avoidable part, represented as superscript *AV*, is the difference between actual exergy destruction and the unavoidable exergy destruction [28]:

$$\dot{E}x_{D,k}^{AV} = \dot{E}x_{D,k} - \dot{E}x_{D,k}^{UN} \tag{7}$$

Endogenous exergy destruction is the part that occurs in the investigated component due to its own irreversibilities while exogenous exergy destruction occurs because of the irreversibilities of the remaining components in the system [27, 29]. Determination of the endogenous part requires the investigated component operating at its design condition while all other components in their theoretical or minimum exergy destruction conditions [30]. Hence, exogenous exergy destruction could be calculated as:

$$\dot{E}x_{D,k}^{EX} = \dot{E}x_{D,k} - \dot{E}x_{D,k}^{EN} \tag{8}$$

Where superscripts *EN* and *EX* represent endogenous and exogenous, respectively.

The combinations are utilized to show whether avoidable/unavoidable exergy destruction of the investigated component caused by its own irreversibilities or the influence of the other components [19]. They are calculated as follows [29]:

$$\dot{E}x_{D,k}^{UN,EN} = \dot{E}x_{P,k}^{EN}\left(\frac{\dot{E}x_D}{\dot{E}x_P}\right)_k^{UN} \tag{9}$$

$$\dot{E}x_{D,k}^{AV,EN} = \dot{E}x_{D,k}^{EN} - \dot{E}x_{D,k}^{UN,EN} \tag{10}$$

$$\dot{E}x_{D,k}^{UN,EX} = \dot{E}x_{D,k}^{UN} - \dot{E}x_{D,k}^{UN,EN} \tag{11}$$

$$\dot{E}x_{D,k}^{AV,EX} = \dot{E}x_{D,k}^{EX} - \dot{E}x_{D,k}^{UN,EX} \tag{12}$$

Lastly, modified exergy efficiency of the investigated kth component to reveal the highest achievable efficiency under limitations and constraints, ε_k^*, can be given as [5, 22, 31]:

$$\varepsilon_k^* = \frac{\dot{E}x_{P,k}}{\dot{E}x_{F,k} - \dot{E}x_{D,k}^{AV}} \tag{13}$$

2.3 Decision Criteria

Based on advanced exergy analysis, new evaluation criteria have recently been developed to reveal the effects of each of the investigated component or as a whole on the exergy efficiency of the overall system [3, 15]. The maximum efficiency under the limits and constraints of the components can be expressed by the modified exergy efficiency of the overall system which could be derived from Eq. (13) as follows [3, 15]:

$$\varepsilon_{tot}^* = \frac{\dot{E}x_{P,tot}}{\dot{E}x_{F,tot} - \sum \dot{E}x_{D,k}^{AV}} \tag{14}$$

Furthermore, the effect of individual component k on the system efficiency provides crucial information to determine where improvement efforts should be focused. Thus, the new modified exergy efficiency under the influence of the investigated component can be calculated as [3, 15]:

$$\varepsilon_{tot}^{*,k} = \frac{\dot{E}x_{P,tot}}{\dot{E}x_{F,tot} - \dot{E}x_{D,k}^{AV}} \tag{15}$$

Lastly, efficiency improvement percentage, *EI*, can be calculated to show the potential of improvement due to the investigated component as [3, 15]:

$$EI = \frac{\varepsilon_{tot}^{*,k} - \varepsilon_{tot}}{\varepsilon_{tot}} \tag{16}$$

3. System Description

The system is modelled as a saturated vapour ORC for exhaust stack of a 17 MW two-stroke marine Diesel engine. The exhaust gases of the main engine leave their energy to other systems namely turbocharger, turbo-generator and hot water utility [4, 15, 22]. Hence ORC is located at the end of the exhaust stack to evaluate the remains of exergy of the gases, which still carry a considerable amount. The layout of the system is show in Fig. 1.

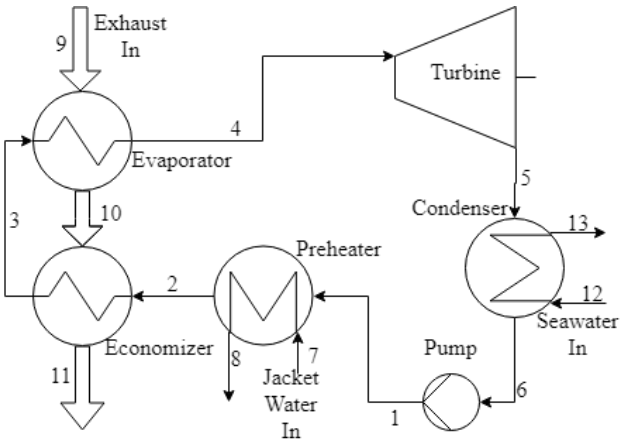

Figure 1: General Layout of the ORC system.

Working fluid is pumped to gain heat from the jacket water of the main engine, and it reaches saturated liquid phase after economizer by utilizing exhaust gas heat energy. Saturated vapour is produced in the evaporator with exhaust gas energy and expanded in the ORC turbine. The working fluid passes through condenser to reject its heat into seawater and returns to the pump to complete the cycle.

Isohexane is selected as working fluid with respect to the specifications such as critical temperature of the working fluid and condenser cooling water inlet temperature derived from literature [15, 18, 32]. Basic information about isohexane is given in Table 1 [33]. The system is modelled on Ebsilon Professional Software, which is a commercial tool to simulate, evaluate and optimize the energy systems [34].

Table 1: Basic Information About Working Fluid.

Fluid	Type	NBT (°C)	Tc (°C)	Pc (bar)
Isohexane	Dry	60.36	224.7	30.4

With the software's genetic algorithm optimization tool, boiling temperature, pump exit pressure and the mass flow rate of the working fluid are optimized to maximize the net power output of the investigated ORC. Restrictions were the dew point temperature in the exhaust to prevent acid formation at 160 °C [35], seawater inlet and outlet temperature of the marine power plant, inlet and outlet temperature and the mass flow rate of the jacket cooling water, as well as component constraints are given in Table 2 [15].

Table 2: Real, Unavoidable And Theoretical Conditions Of The Components.

Component	Working Conditions		
	Real	Unavoidable	Theoretical
Pump	$\eta = 0.8$	$\eta = 0.9$	$\eta = 1$
PREH	$\Delta P_{12} = 0.2\ bar$	$\Delta P_{12} = 0.1\ bar$	$\Delta P_{12} = 0\ bar$
	$\Delta P_{78} = 0.2\ bar$	$\Delta P_{78} = 0.1\ bar$	$\Delta P_{78} = 0\ bar$
	$\Delta T_{Min} = 8$ °C	$\Delta T_{Min} = 2.5$ °C	$\Delta T_{Min} = 0.1$ °C
ECON	$\Delta P_{32} = 0.15\ bar$	$\Delta P_{32} = 0.1\ bar$	$\Delta P_{32} = 0\ bar$
	$x_3 = 0$	$x_3 = 0$	$x_3 = 0$
EVAP	$\Delta T_{Min} = 15$ °C	$\Delta T_{Min} = 5$ °C	$\Delta T_{Min} = 0{,}1$ °C
	$x_4 = 1$	$x_4 = 1$	$x_4 = 1$
TURB	$\eta_T = 0.87$	$\eta_T = 0.92$	$\eta_T = 1$
COND	$\Delta T_{Min} = 4$ °C	$\Delta T_{Min} = 2$ °C	$\Delta T_{Min} = 0.1$ °C
	$\Delta P_{1213} = 0.3\ bar$	$\Delta P_{1213} = 0.1\ bar$	$\Delta P_{1213} = 0\ bar$

As a result of the optimization of ORC by the genetic algorithm, optimum working conditions of the ORC system are given in Table 3.

Table 3: Thermodynamic Data Of The Optimized ORC.

Stream	$\dot{m}$	P	T	*ex*
	kg/s	bar	°C	kJ/kg
1	2.90	11.20	27.98	2.1826
2	2.90	11.00	66.34	11.1370
3	2.90	10.85	160.00	75.8450
4	2.90	10.85	160.00	151.2070
5	2.90	0.31	92.20	30.7466
6	2.90	0.31	27.48	0.4804
7	10.00	3.08	74.34	22.7198
8	10.00	2.88	67.87	18.2857
9	47.69	1.00	188.40	38.2051
10	47.69	1.00	175.00	33.1849
11	47.69	1.00	159.79	27.8192
12	95.22	4.29	20.00	0.5062
13	95.22	2.29	23.48	0.6368

4. Analysis

After determination of the cycle data, conventional exergy analysis could be easily applied by using the exergy balance equations given in Table 4. By keeping turbine power output constant [29], the predetermined unavoidable and the theoretical conditions are applied to the investigated ORC system for the purpose of determining the unavoidable and endogenous exergy destruction parts. The point that should be taken into account here is

to create a hybrid cycle for each component to determine the endogenous part of the related component.

Table 4: Conventional Exergy Analysis Balance Equations.

Component	Exergy Analysis	
	$\dot{E}x_F$	$\dot{E}x_P$
Pump	$\dot{W}_{Pump}$	$\dot{E}x_1 - \dot{E}x_6$
PREH	$\dot{E}x_7 - \dot{E}x_8$	$\dot{E}x_2 - \dot{E}x_1$
ECON	$\dot{E}x_{10} - \dot{E}x_{11}$	$\dot{E}x_3 - \dot{E}x_2$
EVAP	$\dot{E}x_9 - \dot{E}x_{10}$	$\dot{E}x_4 - \dot{E}x_3$
TURB	$\dot{E}x_4 - \dot{E}x_5$	$\dot{W}_{TURB}$
COND	$\dot{E}x_5 - \dot{E}x_6$	$\dot{E}x_{13} - \dot{E}x_{12}$

Decision criteria can easily be utilized for gathering further information after the application of advanced exergy analysis.

It should be noted that, pressure loss for the exhaust gases is neglected. Due to energy balance of the marine power plant, only 10 kg/s of the jacket cooling water is utilized. Due to the fact that the main purpose of the economizer is to supply saturated fluid to evaporator, pinch temperature is the same with the evaporator for all cases. Lastly, pressure drop in evaporator and condenser on the working fluid side are neglected.

5. Results and Discussion

In this section, results related to the conventional and advanced exergy analysis as well as the decision criteria are presented.

5.1 Conventional Exergy Analysis

Table 5 shows the results of conventional exergy analysis of the investigated ORC system with isohexane working fluid. It can be observed that the maximum net power, after optimizing the ORC system using genetic algorithm, is calculated as 306 kW while the power produced by turbine is 312 kW. Almost 220 kW of exergy, which is provided by

both exhaust gases and the jacket cooling water is destroyed due to irreversibilities of the components.

Table 5: Results For The Conventional Exergy Analysis [kW].

Component	$\dot{E}x_F$	$\dot{E}x_P$	$\dot{E}x_D$	y	ε
Pump	6.1091	4.9396	1.1695	0.53%	80.86%
PREH	42.7007	25.9843	16.7163	7.62%	60.85%
ECON	255.8667	187.7719	68.0948	31.04%	73.39%
EVAP	239.3936	218.6881	20.7054	9.44%	91.35%
TURB	349.5564	312.33	37.2264	16.97%	89.35%
COND	87.8276	12.3393	75.4883	34.41%	14.05%
Total	537.961	312.33	219.4008		58.06%

Exergy destruction shares of the components are shown in Fig. 2. Condenser has slightly higher exergy destruction ratio than economizer due to its higher temperature difference level. Since the lowest exergy of fuel and product belong to pump, the lowest exergy destruction and the lowest share belong to pump as well. Preheater and economizer show similar exergy destruction rate with a difference of 4 kW.

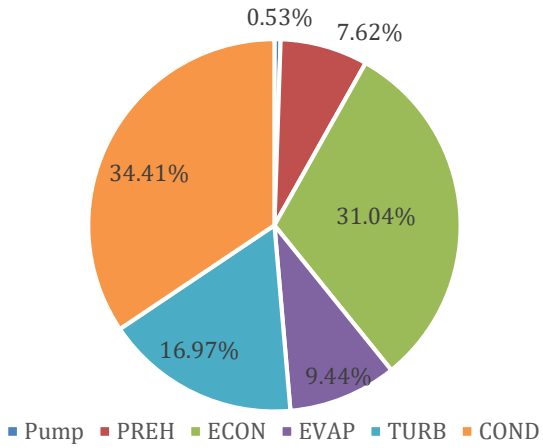

Figure 2: Exergy Destruction Shares Of The Components.

System components except condenser have an exergy efficiency above 60%. Even showing similar exergy destruction with economizer, exergy efficiency of the condenser is 14%. This is because of transferring relatively high quality heat at 92 °C to the seawater at 20 – 23 °C temperature range, which is around environmental condition. Similar evaluation could be mentioned about preheater, however, the slight difference originates from the fact that the exit temperature of the working fluid is close to the inlet temperature of the jacket cooling water. Evaporator shows the highest performance with 91% exergy efficiency due to the similar reason with the condenser, which is because of temperature levels of the two sides of the evaporator are close to each other. Hence, the quality of the heat is well preserved. For the pump and the turbine, the exergy efficiency is directly related to their isentropic efficiency.

Conventional exergy analysis with respect to the results of exergy destruction rates and the exergy destruction ratios suggest that the improvement efforts should focus on the condenser first due to highest share of exergy destruction. Afterwards, economizer is the second component to be improved. The improvement could focus on the aforementioned situations on their working conditions such as decreasing the temperature differences. Exergy efficiency of the condenser is the lowest, thus the improvement focus suggestion in agreement with the exergy destruction. On the other hand, economizer has a higher exergy efficiency and therefore room for improvement seems to be lower in comparison with the condenser. Pump is the last in the list of improvement effort focus due to lowest share of the exergy destruction and relatively high efficiency.

Overall exergy efficiency of the ORC system is 58%, hence it can be concluded that, there is a room for improvement for each component as well as the overall system.

5.2 Advanced Exergy Analysis

Results of the advanced exergy analysis for the ORC WHR system with isohexane as working fluid is given on Table 6.

Table 6: Results Of The Advanced Exergy Analysis [kW].

Component	$\dot{E}x_{D,k}^{UN}$	$\dot{E}x_{D,k}^{AV}$	$\dot{E}x_{D,k}^{EN}$	$\dot{E}x_{D,k}^{EX}$	$\dot{E}x_{D,k}^{UNEN}$	$\dot{E}x_{D,k}^{UNEX}$	$\dot{E}x_{D,k}^{AVEN}$	$\dot{E}x_{D,k}^{AVEX}$
Pump	0.5228	0.6467	1.2433	-0.0738	0.5561	-0.0333	0.6872	-0.0404
PREH	13.5403	3.1761	13.4871	3.2293	10.5964	2.9439	2.8907	0.2853
ECON	54.6081	13.4867	49.5276	18.5671	54.6684	-0.0603	-5.1407	18.6275
EVAP	9.097	11.6084	16.6334	4.0721	7.7896	1.3075	8.8438	2.7646
TURB	21.4073	15.8191	36.396	0.8304	21.4073	0	14.9888	0.8304
COND	25.537	49.9513	59.4165	16.0718	20.0167	5.5203	39.3998	10.5515
Total	124.7125	94.6883	176.7039	42.6969	115.0344	9.6781	61.6695	33.0188

Advanced exergy analysis revealed that the avoidable exergy destruction for the half of the components are higher than their unavoidable part. Moreover, endogenous parts of the components are higher than the exogenous parts. Hence it can be said that the interactions among components have a weak effect on the exergy destruction of the component in general. In the engineer's perspective, it is important to know the source of the exergy destruction that can be avoided. For five out six components, avoidable endogenous exergy destruction is higher. Hence, considering the improvement of the component conditions will lead better reduction of irreversibilities.

For detailed discussion, Fig. 3 shows the avoidable exergy destruction shares of the system components out of total avoidable exergy destruction of the overall system. The highest amount of the exergy destruction could be avoided in the condenser with the share more than half of overall avoidable exergy destruction, 53%. On the other hand, economizer, the component suggested as the second to improve by the conventional exergy analysis is coming after turbine with the share of 14%. The exergy destructions of the evaporator and the preheater were close to each other, but advanced exergy analysis revealed that the potential for improvement of the evaporator is similar with the economizer while preheater has a small room for improvement with 3% share. Pump is the least of concern.

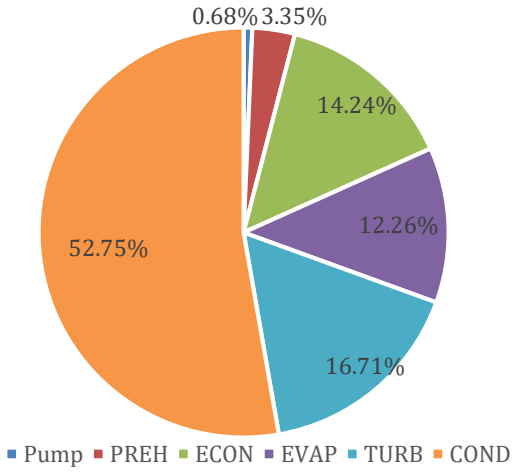

Figure 3: Avoidable Exergy Destruction Shares Of The Components.

Splitting exergy destructions into avoidable and unavoidable parts revealed that avoidable exergy destruction of the overall system is slightly lower than half of total exergy destruction with the value of 95 kW while 57% of the total exergy destruction cannot be further decreased due to limitations and the constraints.

As mentioned before, endogenous exergy destructions of the components are higher than exogenous parts. Moreover, pump has a negative exogenous exergy destruction, which is the sign of that operating conditions of the rest of the components have a negative effect on pump. While the pump is at its design working conditions, the rest of the components runs at theoretical conditions, hence the mass flow rate of the hybrid cycle decreases. But, in order to provide the same power production of the turbine with the new hybrid conditions, the outlet pressure of the pump should rise. Thus, the endogenous exergy destruction rises accordingly.

Secondary splitting of exergy destruction into combinations reveal further information about the strategies to improve the components and overall system. Particularly, splitting the avoidable exergy destruction into endogenous and exogenous parts could be utilized to determine whether the improvement efforts should be on the investigated component, the system structure and/or rest of the components. Avoidable endogenous exergy destruction of the components is higher than avoidable exogenous part, this situation

shows that improvements on the investigated components and their working conditions will help to improve the overall system. Only exception for that case is the economizer, where avoidable endogenous exergy destruction has a negative value. It is because of the fact that economizer supplies saturated fluid to evaporator at every condition and its heat load depends heavily on the working condition of the evaporator. Thus, its avoidable part is utmost affected by the evaporator and it is reflected as high amount of avoidable exogenous exergy destruction. On the other hand, improvements on the system topology and the interactions among components are less important for the better design of the overall system. It has been seen, however, improvement on the system topology could help to improve the exergy destructions of the system components except the pump. It has a negative value of the avoidable exogenous exergy destruction, which can be explained that improvements on the system topology and/or other components will cause exergy destruction rise on the pump instead of avoiding some.

5.3 Decision Criteria

Results for the new modified exergy efficiency of the overall system under the influence of the investigated components and the exergy efficiency improvement potentials are given on Table 7. Pump has the lowest effect on exergy efficiency of the overall system. Improving pump will only cause 0.12% of efficiency improvement. Similarly, preheater only increases overall exergy efficiency of the system to 58.40%. Compared to the real efficiency, there is only a small room for improvement. On the other hand, condenser has the highest effect on the efficiency of the overall system. It has an ability to rise the efficiency to the 64% on its own. Hence, improving the condenser will lead a phenomenal increase in the overall efficiency by 10%. Thus, an engineer should focus on improvement techniques for condenser, to get closer to the theoretical limit of the system. Turbine is the second important component, which has a potential of one third of the condenser, 3%.

Table 7: Results Of Decision Criteria.

Component	$\varepsilon_{tot}^{*,k}$	EI

Pump	58.13%	0.12%
PREH	58.40%	0.59%
ECON	59.55%	2.57%
EVAP	59.34%	2.21%
TURB	59.82%	3.03%
COND	64.00%	10.24%
Total	70.46%	21.36%

Simultaneously improving all components in the system will lead an overall exergy efficiency of 70%. Considering that the real efficiency is 58.06%, efficiency improvement potential is 21% for simultaneous improvement.

6. Conclusion

In this study, an ORC WHR system with isohexane working fluid for a marine Diesel power plant is investigated by conventional and advanced exergy analyses. Results of the advanced exergy analyses are evaluated with the criteria to enhance the information further.

Conventional exergy analysis revealed that condenser and economizer have the highest share of the exergy destruction among all components. Moreover, exergy efficiency of the condenser is the lowest, which means that there might be a huge room for improvement. The results also suggested that improvement efforts should be focused on condenser, economizer, turbine, evaporator, preheater and pump, respectively.

On the other hand, advanced exergy analysis has shown that condenser has a potential to decrease its exergy destruction by 50 kW via improving operating conditions such as pinch temperature and the pressure drop within the technological, metallurgical and economical limits and constraints. Moreover, it has an ability of avoiding 53% of exergy destruction of the overall system by itself, while rest of the components have potential to recover approximately 45 kW all together. The second highest share belongs to turbine,

instead of economizer as suggested by conventional exergy analysis. Pump has the lowest share of the avoidable exergy destruction rate due to utilizing small amount of exergy. Splitting avoidable exergy destructions into endogenous and exogenous parts provided more insight that economizer is under the influence of the other components positively, while pump has been affected negatively by the improvements of the remaining components. The results suggested that improvement efforts should be focused on condenser, turbine, economizer, evaporator, preheater and pump, respectively.

Finally, it has been shown that only improving the condenser will raise the overall exergy efficiency of the ORC WHR system to 64%, which is an efficiency improvement potential of 10%. If all components are simultaneously improved, the maximum achievable exergy efficiency of the ORC WHR system will be 70% under defined limit and restriction conditions. This value corresponds to an efficiency improvement potential more than one fifth, 21%.

7. Nomenclature

Abbreviations

COND Condenser

ECON Economizer

EI Efficiency Improvement (%)

EVAP Evaporator

ICE Internal Combustion Engine

IMO International Maritime Organization

MEPC Maritime Environmental Protection Committee

ORC Organic Rankine Cycle

PREH Preheater

TURB Turbine

WHR Waste Heat Recovery

Symbols

ex specific exergy, kJ/kg

$\dot{E}x$ exergy flow rate, kW

$\dot{m}$ mass flow rate, kg/s

P Pressure, bar

T Temperature, °C

$\dot{W}$ Power, kW

Greek symbols

ε exergy efficiency

Subscripts and superscripts

D destruction

F Fuel

k any kth component

L loss

P Product

tot overall system

AV Avoidable

AVEN Avoidable Endogenous

AVEX Avoidable Exogenous

EN Endogenous

EX Exogenous

UN Unavoidable

UNEN Unavoidable Endogenous

UNEX Unavoidable Exogenous

* new, modified

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Evaluation of The Maritime 4.0 Using The AHP Method

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ABSTRACT

In the world trade, almost $4 trillion worth of cargo is transported annually. Approximately 80 per cent of these shipments are carried out by ocean transport. On the other hand, removing barriers to world trade will allow global trade to expand by about 15 per cent and will provide new employment opportunities. The regulation of trade documents constitutes one-fifth of total expenses. At this point, the digital projections of the Industry 4.0 on the maritime sector suggest that the software and shipping companies should collaborate to remove this cost item. Similarly, within the scope of Maritime 4.0, commercial vessel transformation is also proposed. The issues such that human factors in marine accidents, negative impacts of long voyages on the social life of seafarers, and the idea of reducing carbon emissions from ships, espouse the idea of transforming existing vessels to autonomous ones. Due to the nature of trade, any development or change in ships initiates the adaptation process for ports. Maritime 4.0 defends that semi-automated and fully automated ports where unmanned handling equipment are used in, should become widespread in order to increase operational speed in ports. While referring the advantages that Industry 4.0 can provide to almost every sector, within the maritime sector, potentiality and challenge debate on variables such as some occupational groups' disappearance as well as emergence of new expertise areas, decrease of accident risk as well as rising of cyber-attack risk, drop of transaction cost as well as being high investment cost risk etc., is proceeding. When reviewing the literature on the Maritime 4.0 or digitalization in maritime, most of the articles approached on only one of the topics such as employment, cost, logistics, safety, and technology. Aim of this

study is to evaluate the whole effects of the Industry 4.0 on maritime sector in the SWOT Analysis template and to prioritize elements of each topic in the SWOT Analysis. In this study, the SWOT Analysis was conducted to compare the possible effects of Industry 4.0 on maritime sector. Afterwards, elements of the SWOT Analysis were compared each other and prioritized by the AHP method.

Keywords: Industry 4.0, Future of Maritime Transport, AHP Method, SWOT Analysis.

1. Introduction

In maritime industry, there are different components of the Industry 4.0 which describe this new technology. Many different topics such as autonomous ships, digitalization in shipping, smart ports, big data analytics, block chain technology etc. are examined in this area and are being studied on. Autonomous ships are referred to as self-navigating ships. As with every innovation, positive and negative situations arise with these ships. It should be noted that unmanned ships provide cost advantage to the ship owner and can be used as a safer transportation vehicle [1]. Considering the role of the human factor in marine accidents, unmanned vessels are expected to significantly reduce the risk of accidents. it is known that the long voyages have a negative impact on the social lives of the seafarers. Together with autonomous vessels it is expected that the efficiency of the seafarers will increase. It is foreseen that the ships operating companies will be more advantageous in terms of safety than other types of transportation by controlling their ships with a main centre [2]. Together with autonomous ships, new business areas and subsidiary sectors will be formed. When unmanned ships are produced, all sectors connected to it will have to renew and change themselves. Software problems in unmanned ships can cause the ship to leave the route and thus cause marine accidents. It is thought that unmanned ships will be exposed to electronic and cyber-attacks. In case of any malfunction in the ship, the main centre may sometimes be insufficient [3].

Smart ports have a place in literature with different names which are intelligent ports, robotic ports and autonomous ports, etc. Contrary to popular belief, Port 4.0 term is utilized by leading port authorities instead of academicians. For instance, Hamburg Port Authority (HPA) characterised their port as Port 4.0, while introducing its facts and figures in its [4]. The smart ports represent optimum level of port productivity thereby using some processes such as the Internet of Things (IoT), Information and Communication Technology (ICT), Big Data and environmentally-friendly technology while operating [5;6;7;8]. Sakty [9] and Buiza-Camacho et al. [5], had especially emphasized elements of ports which are operation, energy and environment, as the

special areas of the smart ports. Operation department in smart ports always strive to enhance total throughput capacity of the port with using shared data efficiently in terminal area. Energy consumption is vital component of the whole process from anchorage to gate. Smart port activities should be coherent with its environment what is composed of hinterland clients, society, public infrastructure, etc. Thus, sustainability could be provided in an easy way with smart ports.

Under the thought of digitalization in shipping, some significant processes lie such as the spread of global trade to new areas, providing cost and time efficiency and motivation for reaching optimum with transparency, etc. [10]. In an interview in 2017, Dr. Martin Stopford suggested that digitalization would be the best solution to achieve the optimum operations for the maritime sector. He pointed out that having the technology is the first step to access digitalization, but data sharing is also necessary to improve efficiency [11]. Digitalization provides an important opportunity for other stakeholders of maritime environment, as well as providing efficiency for terminal operators or lines. Digitization will help importers and exporters to monitor the status, location and movements of goods instantly and thus help them to make more informed decisions in areas such as sales, marketing and logistics [10]. The new big data analytics and the IoT applications are rapidly evolving and the most of them are targeting land-side applications of shipping [12]. Nowadays, still negotiable instruments for shipping such as the Bill of Lading, Certificate of Origin, Customs Declaration are filled manually and are carried physically. This can lead that time is wasted for clearing the container from the port as far as the time en route due to the problem of document lag which is frequently experienced. In order to avoid these costly time-sinks, the idea of digitizing negotiable instruments such as bill of lading has come up of old. Since 1986, the idea of digitizing the bills of lading has always been on the agenda, but it is created a security weakness due to closed system structure of each established platform which is guided from a centre [13]. Nowadays, emerged Block Chain technology is a digital platform that does not require registration but is a network between users rather than a single centre network. Block chain technology was first developed for bitcoin money transfer. Block chain technology, where each block in

the chain is added to the previous block, provides all stakeholders a copy of the chain, allowing all stakeholders to access the chain and store records without a central database [14]. This technology, which is already used in many sectors such as banking and finance, is seen as a very important step in inhibiting the time-sinks safely in shipping. However, a legal foundation that provides appropriate support to the block chain technology is required according as every electronic bill of lading needs [13].

Hofmann and Rüsch [15] evaluated the role and priorities of industry 4.0 in logistics management. Tran [16] mentioned the industry 4.0 and its requirements and has made extensive studies on maritime education from this point of view. Bilal et al. [17] examined the automating port operations and proposed the detailed framework for safety transportation. Stanić et al. [18] evaluated the Shipbuilding 4.0 and examined the challenges in the shipbuilding industry. Ahvenjärvi [1] stated that autonomous ship technology is more environmentally friendly and safer in terms of sea transportation. Also, Czachorowski et al. [11] forecasted environmentally friendly effects of the block chain technology especially in the maritime sector. Burmeister et al. [2] revealed the fact that a separate control algorithm will be used for each system on board for autonomous ships and also a conflict is mentioned which is incurred from that software which operate autonomous ships, are manmade and human-driven. In other respects, Van Den Boogaard et al. [3] emphasized that control algorithms to be applied on autonomous ships are sometimes insufficient especially in port operations and that human factor is still very effective in critical situations. Wang et al. [12], revealed opportunities and challenges to improve the big data analytics and IoT for a Norwegian maritime company, and also proposed a model to harmonize big data and IoT with Offshore Support Vessels (OSVs). Shirani [8] found block chain technology encouraging for shipping industry, after he evaluated applicability of this technology. Loklindt et al. [19] made suggestions on transition process which is from manual documentation movement to block chain technology in container shipping.

In this study, SWOT Analysis of the Maritime 4.0 is evaluated by expert opinions and all components of the SWOT are weighted with AHP method.

2. AHP Method

AHP method was developed by Thomas L. Saaty in the mid-1970s and is a mathematical model used in measurement and decision making [20]. Saaty has defined this method as a discrete measurement theory derived from the measure of pairwise comparisons and scoring values [21]. AHP method has been used as an analysis method in many studies and almost all of these studies focus on decision making process [22]. Especially in recent years, weighting or prioritize criteria by AHP method have a common usage in academic literature [23]. The application steps of the AHP method that allows quantitative analysis of qualitative expressions are shown in Table 1.

Table 1: Application Steps of the AHP Method [24]

Step	Equation	Definition
A1	$\mathbf{B}=\begin{bmatrix} 1 & a_{12} & \cdots & a_{1j} \\ 1/a_{12} & 1 & \cdots & a_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ 1/a_{1j} & 1/a_{2j} & \cdots & 1 \end{bmatrix}$ $\begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1j} \end{bmatrix}$	According to expert opinion, B = [bij] matrix is created as a result of pairwise comparisons.
A2	$c_{ij}=\frac{b_{ij}}{\sum_{i=1}^{n} b_{ij}}$	[Cij] matrix is generated by normalizing matrix B.
A3	$w_i=\frac{\sum_{j=1}^{n} c_{ij}}{n}$	W matrix is calculated by taking the arithmetic mean of the row values of the C matrix. Total weight is always 1.
A4	$\lambda=\frac{\sum \frac{d_i}{w_i}}{n}$ **D=B*W**	The D matrix is generated by multiplying the B matrix with the W matrix. The D matrix is solved by the formula in the leftward and thus the eigenvector (λ) of each criterion is found.

A5	$CR = \frac{(\lambda - n)/(n-1)}{RI}$ RI: Random Index	The Consistency Rate (CR) of the pairwise comparisons in the B matrix is calculated. According to Saaty, consistency rate should be less than 0.10. n : 3 4 5 6 7 8 9 ... RI: 0,58 0,90 1,12 1,24 1,32 1,41 1,45

3. SWOT Analysis of the Maritime 4.0

Maritime 4.0 which reflects effects of Industry 4.0 on shipping, has a potential to change the whole sector. SWOT Analysis of the Maritime 4.0 was carried out in this study. And strengths, weaknesses, opportunities and threats of the new approach according to perception of the authors, are shown in SWOT Analysis Scheme which is named in Table 2.

Table 2: SWOT Analysis Scheme

Strength	**Weakness**	**Opportunities**	**Threats**
• Operational Speed	• Investment Cost	• New Professions	• Unemployment
• Integration of Processes	• Lack of qualified staff	• Unit Cost Advantage	• Cyber Attack Risk
• Route Optimization	• Robotized Initiative	• Accident Minimization	• Risk of Shortening the Distance between Market and Production Centres
• Minimization of Human Errors	• Lack of Legal Infrastructure	• High Throughput in Ports	• Risk of Inter-Company Data Sharing
• Reduction of Carbon Emission from Ship			
• Load Tracking			

Positive effects of this process are noted below. Initially, data privacy regarded as one of the competitive advantages, has been on the shelf in order to reach optimum along with the 4th Industrial Revolution. Instead, data sharing has gained importance, especially when the big data can be processed. Therefore, data sharing between companies brings together the integration of processes. Due to these integrations, transactions are monitored by adding end-to-end, route optimization and operational speed are ensured. Due to the nature of digitalization, the need for manpower decreases day by day and thus the risk of human error is minimized. It is planned that autonomous ships will be operated at low speed (slow steaming). And this implies a reduction in carbon emissions of ships. Cargo trackers such as shippers, forwarders, brokers, agents etc. will be able to do online tracking all the transactions related with cargo by means of digital revolution.

Besides the positive effects of the Maritime 4.0, it has also negative impacts on some elements of shipping. As in every initiative, the investment for the technologies required by the 4th Industrial Revolution carries risk potential. This risk potential may discourage the ocean carriers. Besides, in today's digital world, the number of staff which qualified to the order of the day may be inadequate. Especially when it comes to manage robots, very limited staff has know-how. On the other hand, when possible problems occur, which require immediate intervention, whether on a ship en route or at a port that is carrying on operations, the robotization of the initiative will prolong the overcome process. Within the context of digitalization, block chain applications and coin-type payment systems take place between the buyer and the seller or the buyer and the sender in the current structure and make the monitoring and control opportunities of the states limited or impossible. Also, this improvement invalidates swift transactions. In this case, block chain technology is found objectionable by several state authorities. While the nature of the system is based on security and confidentiality on the one hand, on the other hand the request of the states exists to prevent loss of income and audit.

Maritime 4.0 presents new opportunities for new market entries, horizontal and vertical integrations, new solutions to safety and security etc. As in the previous industrial revolutions, some occupational groups have disappeared, and new business fields

emerge. Since the technologies introduced by Industry 4.0 are digitally based, the labour cost in the unit cost of the throughput is very low. In addition, by reason of the fact that the energy consumption of these new technologies is much more advantageous than in the past, it is provided unit energy cost saving. In the case of autonomous vessels against high human errors in marine accidents, the management of the process from a single centre provides the opportunity to the sector for minimizing the risk of accidents. In the land side, ports would be affected positively due to new digital developments. Automation in terminal area and increase in operational speed and decrease in waiting times based on knowledge tracking that are provided to ports by Industry 4.0, covenant the potential that high throughput figures would be experienced in the mid-term.

The maritime sector needs to protect its competitive advantage from threats that may arise with Industry 4.0. Every new technology requires qualified manpower to use it. The loss of jobs for the staff who are unable to adapt to this situation, is inevitable. Apart from that, 4th Industrial Revolution leads to the erosion of some occupational groups or to the substitution of manpower to the robotics. Accordingly, business processes related to shipping have been transferred to visual platform. So, within the scope of Industry 4.0, maritime sector may be in great danger if the cyber-attacks are realized due to the dependence of autonomous ships and fully or semi-automated ports on software. Additionally, big data analytics which is based on the principal of data share can cause some problems. The establishment of a common data pool for the follow-up of transactions and traffic will cause the business secrets to be more transparent and accessible than before. In this case, it will put forward the companies with high financial power to reach and use the information and put the small enterprises in a more difficult situation. Production designs will be customer-specific due to the processes such as the three-dimensional printers, the internet of things, self-learning mechanisms, entering into our lives with Industry 4.0. This will shorten product life cycle and make it much more significant to reach the customer as soon as possible. As a consequence of this, production centres will be located close to the consumer market, less but customer specific production will be preferred instead of high capacity production. Within the

framework of all these developments, shipping with a structure that is suitable for economies of scale and less flexible, has become disadvantageous compared to other modes of transport.

4. Application

In this study, the effects of the Industry 4.0 on Maritime affairs from all aspects were evaluated. In the context of the related literature, SWOT Analysis of the Maritime 4.0 was carried out. And then, it is wondered about which SWOT Analysis components come into prominence. In line with this purpose, data collection tool (survey form) was generated in order to prioritize the topics and each criterion of the topics of the SWOT Analysis. It is received the expert opinions of the 5 academicians worked in the Maritime Faculties of the Turkish Universities via this pairwise comparison based survey form. One of experts is Professor and the others are Assistant Professor. As a result of the survey application, AHP method is employed on the collected data and the pairwise matrices are solved. Results of this study when all these application steps are completed, is presented below.

Components of the SWOT Analysis which are strength, weakness, opportunities, threats, were prioritized by AHP method. Components' ranking table with their score according to perception of the experts is shown in Table 3. According to the results, potential of the Industry 4.0 on maritime industry is very big. Although this digital step leads to some threats, strengths of the process outweigh. Additionally, weaknesses of the Maritime 4.0 were overlooked by the experts.

Table 3: Weights of the Key Criteria

Rank	Key Criterion Name	Score
1	Opportunities	0,30
2	Strength	0,28
3	Threats	0,26
4	Weakness	0,15

In this study, alternatives of the key criteria were also ranked among own class members and among all. This kind of classification is shown in Table 4. Accordingly, the criteria such as 'Reduction of Carbon Emission from Ship' and 'Minimization of Human Errors' were seen as the most prominent strength, on the other hand 'Route Optimization' was seen as the least important strength of the Maritime 4.0. 'Lack of Legal Infrastructure' had the highest priority among the weaknesses of the Maritime 4.0, while 'Investment Cost' was being recognized. According to experts, the potential of the 'High Throughput in Ports' is the most important opportunity provided by Maritime 4.0. Nonetheless, issues are 'Unemployment' and 'Risk of Shortening the Distance between Market and Production Centres', were seen as leading threats against the Maritime 4.0. When we take a look at the general ranking of the sub criteria, it is seen that the sub criteria such as 'High Throughput in Ports', 'Reduction of Carbon Emission from Ship', 'Minimization of Human Errors', 'Accident Minimization' and 'Unemployment', come into prominence according to experts' perception.

Table 4: Priority Table of the Sub Criteria

Key Criterion Name		Sub Criterion Name	Weight among Group Members		General Weight	
			Score	Rank	Score	Rank
Strengths	G1	Operational Speed	0,135	5	0,231	11
	G2	Integration of the Shipping Actors	0,146	4	0,249	9
	G3	Route Optimization	0,111	6	0,190	15
	G4	Minimization of Human Errors	0,212	2	0,362	3
	G5	Reduction of Carbon Emission from Ship	0,222	1	0,379	2
	G6	Load Tracking	0,174	3	0,298	6
Weaknesses	Z1	Investment Cost	0,207	4	0,126	18

	Z2	Lack of Qualified Staff	0,229	3	0,140	17
	Z3	Robotized Initiative	0,237	2	0,144	16
	Z4	Lack of Legal Infrastructure	0,326	1	0,199	14
Opportunities	F1	New Professions	0,201	4	0,244	10
	F2	Unit Cost Advantage	0,218	3	0,265	8
	F3	Accident Minimization	0,257	2	0,313	4
	F4	High Throughput in Ports	0,325	1	0,395	1
Threats	T1	Unemployment	0,301	1	0,311	5
	T2	Cyber Attack Risk	0,221	3	0,229	12
	T3	Risk of Shortening the Distance between Market and Production Centres	0,280	2	0,290	7
	T4	Risk of Inter-Company Data Sharing	0,198	4	0,205	13

5. Conclusion

Maritime 4.0 is a multifaceted process affecting many different sub-sectors of maritime. It is seen that this process brings some handicaps and threats together with the opportunities and power to be offered to the sector. In this study, firstly SWOT Analysis of the Maritime 4.0 has been carried out. Then, it is asked experts' opinion to prioritize components of the SWOT. When viewed the results gained from AHP analysis, it is seen that opportunities and strengths of the Maritime 4.0 are considerably dominant. In contrast to some challenges which expressed as threats and weaknesses of the Maritime 4.0, submissions of the opportunities and strengths are found more attractive by the experts.

In the study, sub components of the SWOT Analysis were also prioritized. Accordingly, it is revealed that high throughput figures in ports due to operational speed achieved with the innovations of the Maritime 4.0, is vital. Besides, automated ship technology is seen vital yet. Such that, prominent issues after the analyses such as 'Minimization of Human

Errors', 'Reduction of Carbon Emission from Ship', 'Accident Minimization', are directly associated with autonomous ship technology. Also, unemployment risk is seen as prominent risk by the experts. This prominent risk stems from the fact that the number of employees per company would be decreased due to possible digital platform over the maritime industry. However, it is thought that progressive profitability would stimulate market-entry of the new companies and tolerate this unemployment risk.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

An Extensive Research into Possibility of a Human-Centered Safety System for Fatigue Detection at Sea

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ABSTRACT

Recent technological developments presented autonomous ship concept that requires less seafarers on board. However, having duty persons on board or ashore still makes human factor a significant subject for autonomous ships of the future. Many studies have conducted to detect real-time fatigue and drowsiness for mostly drivers and pilots with the aids of physiological measurements. In this paper, the authors discuss the possibilities of a human-centered safety system for fatigue detection at sea based on Human Computer Interface concept, categorizing and unifying the psychophysiological measures. Possible algorithms and related theories are stated in fatigue detection to produce cognitive state of seafarer. The system to be developed from this perspective is aimed to alert the officer and other authorized seafarers before making a critical error and this way will contribute to minimizing marine accidents and casualties.

Keywords: Fatigue detection, Seafarer, HCI, Maritime safety

1. Introduction

Human factor has a major effect on marine casualties that cause great harm to environment, economy and maritime sector. Extensive regulations and restrictions on environmental pollution and navigation safety have come into force to minimize these harms. Adding to regulations, new training requirements have been introduced into maritime industry which require better technological skills. Seafarers are naturally required to have sufficient cognitive ability and maintain it thorough period of duty to keep up their skills in technological equipment. Besides, recent technological developments presented autonomous ship concept that requires less seafarers on board. However, having duty persons on board or ashore, no matter how small in number, still makes human factor a significant subject for autonomous ships of the future.

IMO (International Maritime Organization) projected four autonomous ship categories and only one category ship, that is fully autonomous, will be operating with no seafarers on board. All the other three categories will require seafarers to be present either on board or ashore for remote controlling [1]. This implies even with autonomous ships; human element will still be a major concern though the number of seafarers on board will be significantly reduced. This is because the remaining crew on board will have to continuously monitor and if necessary, intervene the operation of the ship. This obligation will require the seafarers to maintain their high cognitive states and optimal behaviors at all times when they are on duty. This clearly reveals the need of a system for monitoring cognitive states and behaviors of seafarers and produce a warning signal when / if required. This process actually constitutes the core approach for integrating human beings into autonomous vessel systems.

On the basis of the integration, there should be a dynamic system design that can detect fatigue of the officer during seaborne operations. There have been studies focusing on valuating the cognitive states of operators in terms of their strain, drowsiness and relaxation levels through physiological measurements. With the aid of these studies, it has

become possible to integrate the human element into dynamic systems by making use of various algorithms of physiological data.

The aim of this study is presenting the possibilities of a human-centered safety system for fatigue detection at sea based on Human Computer Interface concept, categorizing and unifying the psychophysiological measures. On the other hand, the conformability of the psychophysiological measurements such as EEG (electroencephalogram), EDA (electrodermal activity), HRV (heart rate variability), PPG (photoplethysmography) and Eye Tracker for ship operations will be analyzed in this study. Possible algorithms and related theories are stated in fatigue detection to produce cognitive state of seafarer. At last, the system is illustrated and the conclusion are drawn.

2. Measuring Fatigue

The mean of fatigue is neither physical (muscular) fatigue nor emotional fatigue in this context. It is mental fatigue and it is about information processing and decision making. In literature, the words such as stress, arousal, attention, activation, physiological response, workload, behavioral activity, cognitive ability are used in similar areas. As mental workload cannot directly have measured, only be inferred, other measures such task performance, physiological response have been analyzed to infer mental workload. Common techniques for detecting fatigue, stress, arousal have been investigated in many studies.

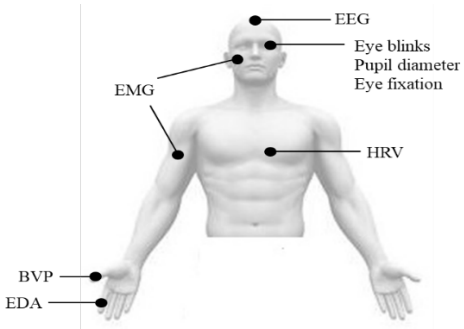


Figure 1. Common physiological measures used to detect fatigue.

O'Donnell & Eggemeier [2] specified the fatigue measures with three groups: physiological measures, subjective measures and performance measures. Physiological measures include HRV, EEG, BVP (blood volume pulse), respiration, EDA, EMG (electromyography), hormone levels, pupil diameter and eye blinks. The measure of eye fixation is hard to classify as either performance or physiological measure [3]. But that has been mostly used in fatigue detection. Figure 1 shows the skin locations of above-mentioned physiological measures.

In literature, Lee and Chung [4] developed a fatigue detection system for drivers with PPG and eye movement measurements and reported the accuracy of the system as 97%. Borghini et al. [5] have designed the system for both drivers and pilots with EEG and EOG measurements, and have achieved 89% fatigue classification accuracy with only EEG features. Moreover, Singh et al. [6] used EDA and PPG measurements in real-time fatigue detection system design for drivers. Classification accuracies of the fatigue detection systems designed with only EEG signals for drivers are over 95% [7, 8].

2.1. Measuring Fatigue on Board

In maritime studies, it has been analyzed mostly how the ship's environment, working period and other factors affect the seafarers. Maurier et al. [9] stated that fatigue negatively affects attention and awareness of seafarer in their study conducted in simulator with the aid of psychophysiological data. Yılmaz et al. [10] analyzed that increase in working hours caused fatigue and insomnia via EEG, SpO2 and ECG measurements. Tac et al. [11] examined the effects of the seafarer's cognitive performance with EEG on the operational processes in ship environment under certain stressor factors such as fatigue, insomnia, temperature and noise. Özsever and Tavacıoğlu [12] observed that when seafarer's circadian rhythm is changed more frequently, they experience more drowsiness based upon EDA and HRV measures and their reaction times decrease. Lützhöft and Sri [13] wrote a software (MARTHA) that involves working and resting hours of seafarers for fatigue detection. Culley et al. [14] revised the software with the risk index by adding shift (watchkeeping hours) alterations. However, these studies

were not able to implement real time fatigue detection based on instantaneous physiological data. Wu et al. [15] associated the EEG and the HRV data, obtained from 10 participants in engine control room simulator, with mental fatigue as task difficulty increased. Orlandi and Brooks [16] applied similar method to ship pilots and reached similar results. The last two studies include the most recent and current results for the purpose of this study.

3. The Possibilities of a Human-Centered Safety System

In this chapter, the possibilities of a human-centered safety system is presented with human-computer interface concept on board. Related algorithms about the measures and their theoretical backgrounds are stated. At last, the safety system is illustrated considering both autonomous ships and recent technological developments.

3.1. HCI (Human-Computer Interface) Concept

A human-computer interface design is required to monitor physiological states of seafarer and integrate him/her to dynamic system. Thus, it is aimed to design Cognitive Seafarer-Ship Interface (CSSI) (Figure 2). Prior to system design, the physiological data of the officer is recorded. By being correlated with the performance of the officer, the change of physiological state is analyzed in critical errors and significant performance decreases in simulator environment. The medical decision-making process, which deduces 'safe' or 'risky', is run for this change.

The algorithm with high classification accuracy will be the basis of fatigue detection system and contribute to the development of early warning system (in terms of ship safety). New design can point the way of future dynamic Seafarer-Centric Safety System for ships in parallel with the existing systems being developed for pilots and drivers in the literature.

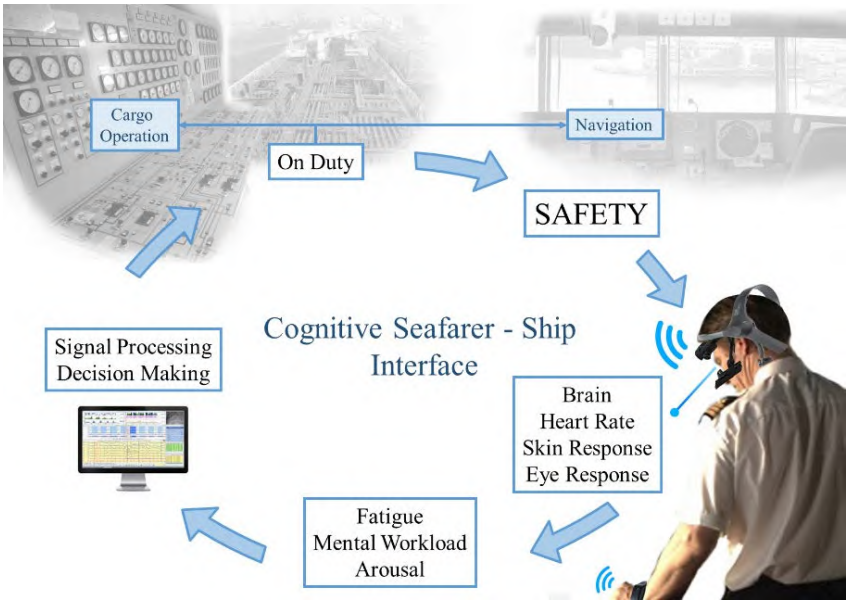


Figure 2. The Cognitive Seafarer - Ship Interface concept.

3.2. Fatigue Detection System Layout and Possible Algorithms

The system is based on processing of the physiological data of officer. As can be seen in Figure 3, inputs of the system are defined under cognition model. Brain waves can be monitored with EEG (ϕ_1), which is one of the variables of cognition model, and changes in alpha, beta, theta and delta frequency bands indicates the change of mental work. Both tonic and phasic activities can be analyzed with EDA (ϕ_2) so, either general stimulation status or instant body responses can be observed. The change in PPG (ϕ_3), which is one of the parameters of heart rate variability, indicates the change of mental work. Change in blink rate (ϕ_4) and pupil diameter (ϕ_5), which are the other indicators of mental strain, can be monitored during the tasks.

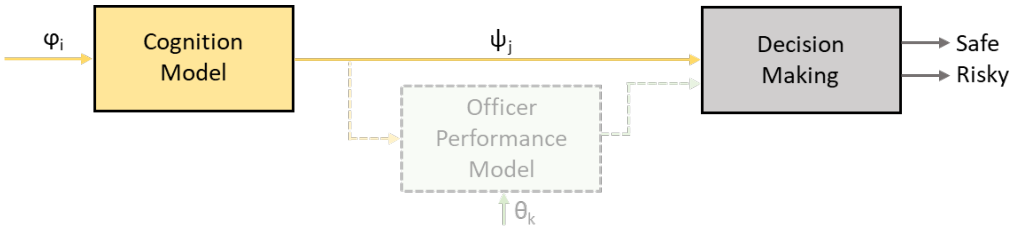
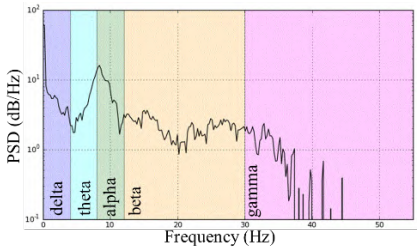
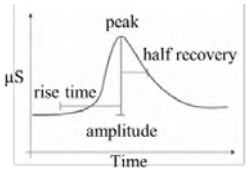
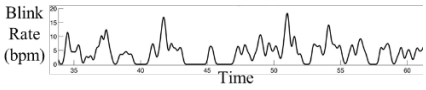


Figure 3. Fatigue detection system layout.

System requires the processable data for classification. Hence, transformation process is needed for raw physiological data. Table 1 presents the features of physiological variables of cognition model.

Table 1. The features of physiological variables.

Variables	Features	Sample signals
EEG (ϕ_1)	α PSD*	
	β PSD	
	δ PSD	
	θ PSD	
	(α+θ)/β	
	α PSD / β PSD	
EDA (ϕ_2)	Peak rise time	
	Peak amplitude	
	Peak number sum	
	Area sum	
PPG (ϕ_3)	PSD	
Blink rate (ϕ_4)	Frequency	
Pupil diameter (ϕ_5)	Diameter	

* Power Spectral Density

Cognitive states (ψ_j) (drowsy-normal-alert) of officers correspond to a set of the physiological variables (ϕ_i) of the officers, which is described as

$$\psi_{j,t} = f(\phi_{i,t}) \quad (1)$$

When the environmental demands increase, mental workload increases correspondingly and human information processing system tends to be unable to cope with large amounts of environmental demands in cognitive strain condition. On the contrary, when the environmental demand is low, an individual tends to become less vigilant and his / her attention cannot direct to needed environmental demand due to less stimulation. The relationship between performance on related task demand and mental arousal can be described with reference to Yerkes and Dodson [17]. Thus, the optimal task performance occurs at an intermediate level of mental arousal and weak performances are related to higher and lower arousal levels according to the law called Yerkes-Dodson principle. There is a linear relationship between performance and arousal in simple tasks whilst there is a curvilinear relationship in complex tasks according to Yerkes and Dodson [17].

However, there shouldn't be a linear relationship in simple tasks according to Diamond et al. [18]. High arousal cause performance degradation regardless of task difficulty. As optimum arousal level can vary in different types of tasks, physiological states of individual and environmental conditions, the intensity and direction of change in arousal should be analyzed instead of thresholds. Thus, the changes of the cognitive states at a given time can be described as

$$\psi_j = \lim_{\Delta t \to 0} \left(\frac{\psi_{jt} - \psi_{jt-1}}{\Delta t} \right) \qquad (2)$$

These changes of cognitive states are analysed in critical safety errors and sharp performance decrements. Officer performance model (stated in Figure 3) comes into play at this point. Prior to system design, performance evaluation has a critical impact for determining the thresholds of the changes of officer's physiological state.

Decision making process (stated in Figure 3) is run with cognition model data (physiological variables) in MATLAB in order to determine the current cognitive states of officers as "Safe" or "Risky". After the data in the training group are classified as "Safe" and "Risky", the data which has classified as "Drowsy" and "Alert" are considered to be classified in "Risky" category in test group. Decision making process includes the

classifiers such as Artificial Neural Networks, K – Nearest Neighbours, Bayesian Network. The success of the system depends on the accuracy rates of these classifiers.

3.2. Seafarer-Centric Safety System

It can be possible to integrate the human element into dynamic systems by making use of above-mentioned algorithms of physiological data. Such real-time detection systems can produce an output for state of officer on duty as "Safe" or "Risky" from the collected physiological data during the operation. This way has a potential of future dynamic SCSS (Seafarer-Centric Safety System) that alerts the officer and other authorized seafarers before making a critical error. Figure 4 presents SCSS as two different shipping concepts.

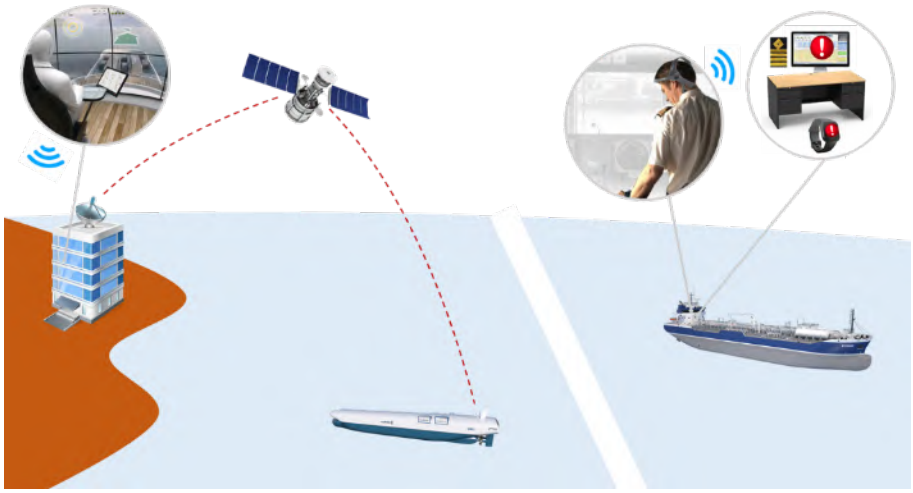


Figure 4. Seafarer-Centric Safety System with two different concepts.

The concept, which is stated in the right side of the Figure 4, figures out the integration of SCSS to recent vessels. Ship master receives the information of the state of officer on duty and early warning system is active only inboard. Hence, SCSS can be used instead of BNWAS (Bridge Navigational Watch & Alarm System) on board having more potential to detect fatigue than BNWAS. Because, the working principle of BNWAS is only based on motion of officer in Bridge.

The concept, which is stated in the left side of the Figure 4, figures out the integration of SCSS to autonomous vessels. The system can be used for Remote Maneuvering Support Officer in shore control center. Other authorized officer located in shore control center receives the information of the state of Remote Maneuvering Support Officer on duty. In this way, both the vessel and the support officer can be monitored in shore control center. Hereby, this concept actually constitutes the core approach for integrating officers into autonomous vessel systems.

4. Conclusion

The authors discussed the possibilities of a human-centered safety system for fatigue detection. The system layout presents that the physiological states of officer on watch can be monitored with the aid of electrophysiological instruments. The early warning system that is based on the classification of the physiological states of officer as "risky" and "safe", is expected to alert officer and other authorized seafarers before making a critical error. This way will contribute to minimizing marine accidents and casualties.

One of the results of this study is that the system (SCSS) can be used in both manned vessels and autonomous vessels. Having duty persons on board or ashore, no matter how small in number, it is thought that the use of such systems in every critical operation will contribute to increase maritime safety.

Future studies should include the development of measurement strategies, ensuring high classification accuracies that increase the reliability of such systems, simplifying the electrophysiological instruments to be used on board or ashore.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

A Survey for Analysing Factors that Affecting Marine Service and Seafarers' Job Satisfaction: Case Study for Turkey

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ABSTRACT

By 2017, there are 1.6 million seafarers globally. The number of Turkish seafarers is about 180 thousand. However, after China, the largest number of seafarer training in Turkey, the sea service time of seafarers is not at the desired level. For this purpose, the physical and psychological difficulties encountered by Turkish seafarers in marine services were researched through questionnaire. Totally 649 seafarers participated, 24 questions were asked on different topics such as fatigue, stress, working hours, salary, social life, piracy risk, and the effects of these subjects on their occupational life were investigated. It is aimed to contribute to the maritime industry by this study, which is important in terms of increasing marine service duration and job satisfaction level of Turkish seafarers.

Keywords: Vessel Traffic Services (VTS), Maritime Surveillance, Sea Traffic Management

1. Introduction

With the rapidly developing science and technology in recent years, maritime has gained a different structure. Nowadays, as un-man ships increase and no-man vessels are planned, as technology develops rapidly, the physical workload on vessels decreases and the internet and social media become accessible for seafarers. With the spreading of internet on ships communication has become easier and faster, that makes marine life easier for seafarers. However, shipping is still a difficult profession. Fatigue [1-2], burnout, stress [3-4], bad weather conditions [5], job satisfaction, health [6], home sickness [7], piracy and such issues continue to be a problem for seafarers.

The world maritime transport consists of 94171 vessels [8] over 100 GT, and 1647500 seafarers [9]. Turkey; as the second country to train the most seafarers in the world, with 28446 active officers, 77000 active seamen [10], seeks to increase its share in seafarer manpower on a global basis. However, officers' occupational continuity at sea has decreased to an average of 4 years [11]. For this reason, the study was carried out to examine the problems and difficulties encountered by Turkish seafarers during the maritime service and to establish the occupational profile of the Turkish seafarer. This study, which is conducted through a questionnaire with 649 seafarers in 24 questions, is important for the understanding the factors that effecting Turkish seafarers' job satisfaction and marine service.

2. Literature Review

There is a limited number of studies in the literature on maritime profile, culture and background of Turkish seafarers. Here are some examples of important publications related to this topic: In the thesis titled "Human Resources Management for Turkish Seafarers", Arslan [12] has examined the qualifications of a seaman required to have in merchant fleet, ships, maritime education institutions in Turkey. A survey was conducted with 212 seafarers in order to determine the profiles of Turkish seafarers.

Şakiroğlu [13], in the study titled "An Analysis on Career Planning Criteria of the Oceangoing Officers", investigated the causes of choosing the maritime profession, the

weight ratios of the elements affecting the maritime career duration, and the reasons of taking the decision to end sea career. The sampling group is 79 people consisting of oceangoing deck and engine officers who graduated from Istanbul Technical University Maritime School in 1987.

Solanki and Nakazawa [14] conducted a study to establish responsibility for maritime universities in order to increase the occupational continuity of seafarers. In the scope of the study, a questionnaire was applied to trainees, watchkeeping officers and seafarers working on the land from India, Philippines, Indonesia, Algeria, Egypt, Netherlands.

In his study, Kurt [15] conducted a survey with 43 people in order to determine the burnout status of seafarers on Turkish flag commercial vessels, to examine their differences such as their age, duration of stay onboard and shipboard duties.

Göksu [16] conducted a survey with 665 seafarers in the name of " Turkish Maritime Merchant Fleet of the Maritime Labour Convention (MLC) 2006 Analysis of Eligibility Conditions" for the purpose of determining the conformity of the existing conditions with the MLC in terms of seafarers.

In the article titled "Burnout Syndrome: A Descriptive Study on Masters and Deck Officers", Zorba [17] examined whether the burnout of captains and deck officers is a reason for pushing them away from the profession. Totally 67 people participated in the questionnaire prepared using Maslach Burnout Scale, personal information and evaluation form.

Yıldız et. al. [5] examined the challenges faced by deck cadets during their sea training periods. A survey was conducted with 618 people to determine the expectations and challenges regarding marine life in the study conducted with Turkish deck cadets.

3. Data and Methodology

This study aimed to determine and examine the factors that affecting marine service duration and Turkish seafarers' job satisfaction through questionnaire. For this purpose, 649 seafarers were reached between January and June of 2017. In the questionnaire,

firstly there are some questions about seafarers' competency and duration of service. As seen in Table 1, seafarers from all competencies on-board participated in the survey. Most of the participants were deck officers, cadets and masters respectively.

Information on duration of service, which is one of the information requested in the questionnaire, is presented in Table 2. In duration of service, the category between 0-4 years had the highest rate. The number of participants with more than four years of service is 42%.

Table 1. Competency of seafarers participated in the survey

Competency	f	%
Master	72	11.1
Deck Officers	215	33.1
Chief Engineer	18	2.8
Engine Officers	92	14.2
Deck Cadets	148	22.8
Deck Rating	47	7.2
Engine Rating	41	6.3
Cabin Rating	16	2.5
Total	649	100

The 24 different factors that affecting marine service duration and job satisfaction level of Turkish seafarers are presented in Table 3. While the questionnaire was being prepared, benefited from BSc thesis of Arslan [12] entitled "Human Resources Management for Turkish Seafarers" and study of Şakiroğlu [13] entitled "An Analysis on Career Planning Criteria of the Oceangoing Officers".

Table 2. Duration of service of seafarers participating in the survey

Duration of Service (Years)	f	%
0-4	373	58
4-8	102	15.6
8-12	86	13.1
>12	88	13.3
Total	649	100

Participants in the questionnaire were asked to evaluate the factors by using a Likert scale of five. The consistency and reliability of the questionnaire is extremely important in the studies conducted by using the survey method [5, 18-21].

In this study, Cronbach Alpha (α) test was used which is one of the most preferred tests to assess the reliability of the questionnaire's scale. An α value can be calculated for each individual questions and/or an average α value can be calculated for the questionnaire. The most important point to be considered in the test is that the scale of the questions being tested is identical and the consistency of the answers is expected. The α value for all questions indicates the total reliability of the questionnaire. The Cronbach Alpha value is expected to be greater than 0.7 (Table 4).

Table 3. Factors Affecting the Marine Service of Turkish Seafarers

No	Factors	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
		f	%	f	%	f	%	f	%	f	%
1	Sleeplessness (Insomnia)	55	8.5	81	12.5	185	28.5	154	23.7	174	26.8
2	Fatigue	34	5.2	88	13.6	162	25.0	196	30.2	169	26.0
3	Stress	42	6.5	87	13.4	124	19.1	168	25.9	228	35.1
4	Working Hours	56	8.6	100	15.4	178	27.4	151	23.3	164	25.3

5	Duration of Voyage	210	32.4	160	24.7	125	19.3	83	12.8	71	10.9
6	Pressure (Mobbing)	89	13.7	128	19.7	147	22.7	134	20.6	151	23.3
7	Homesickness	84	12.9	97	14.9	117	18.0	119	18.3	232	35.7
8	Family Issues	186	28.7	143	22.0	117	18.0	91	14.0	112	17.3
9	Craving of Social Environment	91	14.0	92	14.2	128	19.7	135	20.8	203	31.3
10	Social Impossibilities	139	21.4	121	18.6	142	21.9	113	17.4	134	20.6
11	Communication	113	17.4	112	17.3	147	22.7	141	21.7	136	21.0
12	Working Environment	126	19.4	132	20.3	126	19.4	113	17.4	152	23.4
13	Responsibilities	115	17.7	99	15.3	145	22.3	132	20.3	158	24.3
14	Noise. Vibration. etc.	122	18.8	114	17.6	152	23.4	118	18.2	143	22.0
15	Customs and Traditions	232	35.7	138	21.3	123	19.0	84	12.9	72	11.1
16	Hierarchy	197	30.4	151	23.3	135	20.8	84	12.9	82	12.6
17	Adequate Salary	150	23.1	83	12.8	156	24.0	111	17.1	149	23.0
18	Job Satisfaction	120	18.5	132	20.3	194	29.9	108	16.6	95	14.6
19	Heavy Weather Conditions	123	19.0	115	17.7	167	25.7	119	18.3	125	19.3
20	Piracy Possibility	246	37.9	99	15.3	119	18.3	72	11.1	113	17.4
21	Accidents	141	21.7	121	18.6	158	24.3	107	16.5	122	18.8
22	Nutrition	156	24.0	136	21.0	156	24.0	105	16.2	96	14.8
23	Health	136	21.0	124	19.1	150	23.1	125	19.3	114	17.6
24	Hygiene	141	21.7	148	22.8	162	25.0	104	16.0	94	14.5

The Cronbach's Alpha (α) test was applied to 24 questions (Table 3) which had a five-point Likert scale and closely related with the job satisfaction of the participants. In this study, all statistical tests were implemented by using IBM SPSS Statistics 23 software. As a result of the α test applied to twenty-four questions, the reliability of the questionnaire was determined as "Excellent" (α = 0.919).

Table 4. Interpretation of α value [22]

Cronbach Alpha (α)	Reliability

α≥0.9	Excellent
0.9>α≥0.8	Good
0.8>α≥0.7	Acceptable
0.7>α≥0.6	Questionable
0.6>α≥0.5	Poor
0.5>α	Unacceptable

In order to evaluate and interpret the results of the survey, frequency analysis and chi-square independence test were used. The chi-square independence test is a mathematical approach that is frequently used in statistical studies [23-26] and has proven its reliability. It is utilising to determine the existence and level of statistical relationship between two categorical variables. One of the important advantages of the chi-square independence test is that it is applicable to numerical data as well as nominal (i.e. non-numeric) data [24, 26]. The basic principle of the chi-square independence test is to examine whether the distributions of the two variables are interdependent. For this, the chi-square ($\chi 2$) values of the variables must be calculated. If the distribution of a variable is not dependent on the distribution of the other, it means there is no relationship between these two variables. In such a data set, it is not possible to interpret other variables by knowing the value of a variable [24-25]. The chi-square value can be calculated by following the steps described in the example below.

Example: It will be examined whether there is a relationship between the stress level and the job satisfaction of the people working on board. In this case, test hypotheses should be established first.

$\chi 2$ test hypotheses:

H0: There is no relationship between job satisfaction and stress level (these variables are independent).

H1: There is a significant relationship between the stress level and job satisfaction (these variables are dependent.)

Once hypotheses are established, a table is created in the mxn form, which includes the number of responses to the relevant questions, by using the survey responses (Table 5).

Table 5. Questionnaire results for stress level and job satisfaction

Satisfaction	Stress level					
	Very low	Low	Medium	High	Very high	Total
Very low	24	20	16	24	32	116
Low	5	30	32	40	27	134
Medium	4	24	50	52	66	196
High	3	7	16	38	44	108
Very high	3	6	11	15	60	95
Total	39	87	125	169	229	649

When the stress level of 649 people is not taken into account, the probability of "satisfaction level very low" is calculated as 116/649. Because a total of 116 people answered the satisfaction level question very low. With this approach, if it is calculated for 39 people who responded the "stress level" question "very low"; 39*(116/649) = 6.9 people is expected to give the answer "very low" to the "job satisfaction level" question. So, the value of 6.9 is the expected value of this cell. However, in reality 24 people responded "very low" (observed value). There is a difference between the observed and the expected value. It is necessary to evaluate whether this difference is random or not and if there is a relationship between these two variables, by applying "$\chi 2$ independence test".

According to the $\chi 2$ independence test; if P(Satisfaction very low/Stress very low)= P(Satisfaction very low) equality is achieved, it can be said that "satisfaction level" and

"stress level" are independent of each other. Therefore, for the variables examined, it should be checked whether all row and column combinations (cells) meet this requirement by calculating all of the values. In order to test whether it meets the independence requirement, the expected frequencies need to be calculated. In our case 6.97 is the expected frequency for $Satisfaction_{very\ low}/Stress_{very\ low}$. Table 6 shows the expected frequency values calculated for each cells using the same equation.

Table 6. Expected values and observed values for each cell

Satisfaction level	Stress level										
	Very low		Low		Medium		High		Very high		Total
	Obs.	Exp.	Obs.	Expected	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.
Very low	24	6.97	20	15.55	16	22.34	24	30.20	32	40.93	116
Low	5	8.05	30	17.96	32	25.81	40	34.89	27	47.28	134
Medium	4	11.78	24	26.27	50	37.75	52	51.04	66	69.16	196
High	3	6.49	7	14.48	16	20.80	38	28.12	44	38.11	108
Very high	3	5.71	6	12.74	11	18.30	15	24.74	60	33.52	95
Total	39	39	87	87	125	125	169	169	229	229	649

Obs: Observed Exp: Expected

In order to be able to test the hypotheses established in the beginning, χ2 values should be calculated. First of all, as with any statistical test, it is necessary to determine the level of significance of the test. This value depends on the practitioner. The significance level for this sample was 95% (α = 0.05). The χ2 value for each cell will be calculated based on the differences between the observation values and the expected frequencies. Total of all calculated χ2 values will be the test statistic χ_h^2. For our example calculated Chi-square value is $\chi_h^2 = 121.260$. After calculation of the χ_h^2 value, in order to use the standard chi-square table, it is necessary to determine the degrees of freedom (df). In our case the degrees of freedom is 16.

In order to make a statistical decision, the calculated χ_h^2 value should be compared with the standard $\chi_{0.05;16}^2$ value obtained from the chi-square table [25]. In our case Table $\chi_{0.05;16}^2$ is 26.296.

Statistical decision: Since the $\chi_h^2 = 121.260 > 26.296$, H_0 hypothesis rejected and the contrary hypothesis (H_1) assumed accepted. Thus, it can be concluded that there is a significant relationship between stress level and job satisfaction level (these variables are dependent). The differences between the expected values and observed values for these two categorical variables did not occur coincidentally. Participants' responses to these two questions are dependent on each other. For each hypothesis established, calculations can be made as described above. However, in this study, calculations were made using IBM SPSS Statistics 23 software.

In this study, frequency analysis results and results of similar studies in the literature were taken into consideration in determining the variables to be subjected to chi-square independence test. Thus, Chi-square independence test hypotheses were established for the purpose of the study (Table 7).

4. Results

The purpose of the study is to determine the factors affecting the marine service duration and job satisfaction of Turkish seafarers. The factors were tried to be diversified as much as possible, but it was decided that 24 factors were sufficient to enable the profile to be revealed. Based on the answers given to the questionnaire, Chi-Square test was applied to 6 different questions related to service duration and job satisfaction level. The hypothesis validity (Sig.) values and Acceptance/Rejection results were presented in Table 7. Cross tabulations for all Chi-square tests were presented in Appendix Tables. According to Chi-Square test results, the most important factor related to service duration of seafarers has been identified as homesickness. The most important factors affecting Turkish seafarers' job satisfaction were determined as stress, fatigue, homesickness, craving of social environment, sleeplessness (insomnia) and working hours. It has been observed that 61.5% of seafarers in the stressful working environment have a negative

impact on their job satisfaction and marine service duration. This result is similar to many studies in the literature.

Table 7. Results of the Chi-Square test

Hypothesis of the study	Sig.	Result
H0: There is no relationship between duration of service and sleeplessness	0.458	Accepted
H1: There is a significant relationship between duration of service and sleeplessness		Rejected
H2: There is no relationship between duration of service and fatigue	0.735	Accepted
H3: There is a significant relationship between duration of service and fatigue		Rejected
H4: There is no relationship between duration of service and stress	0.321	Accepted
H5: There is a significant relationship between duration of service and stress		Rejected
H6: There is no relationship between duration of service and working hour	0.767	Accepted
H7: There is a significant relationship between duration of service and working hour		Rejected
H8: There is no relationship between duration of service and home sickness	0.032	Rejected
H9: There is a significant relationship between duration of service and home sickness		Accepted
H10: There is no relationship between duration of service and craving of social life	0.623	Accepted
H11: There is a significant relationship between duration of service and craving of social life		Rejected
H12: There is no relationship between job satisfaction and sleeplessness	<0.001	Rejected
H13: There is a significant relationship between job satisfaction and sleeplessness		Accepted
H14: There is no relationship between job satisfaction and fatigue		Rejected

H15: There is a significant relationship between job satisfaction and fatigue	<0.001	Accepted
H16: There is no relationship between job satisfaction and stress	<0.001	Rejected
H17: There is a significant relationship between job satisfaction and stress		Accepted
H18: There is no relationship between job satisfaction and working hour	<0.001	Rejected
H19: There is a significant relationship between job satisfaction and working hour		Accepted
H20: There is no relationship between job satisfaction and home sickness	<0.001	Rejected
H21: There is a significant relationship between job satisfaction and home sickness		Accepted
H22: There is no relationship between job satisfaction and craving of social life	<0.001	Rejected
H23: There is a significant relationship between job satisfaction and craving of social life		Accepted

For example; Arslan [12] and Elo [7] found that in their studies, stress of seafarers was mostly associated with work-related issues. Homesickness is one of the most important factors in many studies [13, 17] relating to the shortening of maritime service duration. Elo [7], determined that the other important factors are noise, unfair task distribution, intense working hours, uniformity, and curiosity and concern about close relatives on land. In his work Arslan [12] found that most of the seafarers were away from social life and family life while on board, and that they were suffering from difficulties when they could not reach the things they needed. In the study, it has been seen that communication and social environment are very important for long marine career. Similarly, it is suggested that internet and social facilities should be developed on ships for the occupational continuity of Turkish deck trainees [5], seafarers [16].

Fernandez-Gonzalez et al. [27] in a survey conducted by 219 students from the maritime school in Riga, Latvia; They emphasized that family, social environment, salary and

working conditions are crucial factors in moving the young population towards the maritime sector.

Solanki, and Nakazawa [14], emphasized that mariners focus on short-term motivating factors when choosing their job, such as adventure, travel to foreign countries and salary; however, in long term they have to face with social factors such as family and professional flexibility. The study emphasizes that maritime service duration of seafarers is short.

Many of the above-mentioned substances cause burnout problems for seafarers. Because there is a direct relationship between burnout, workload and work stress. The most important reason for burnout is to staying away from family and land [17]. Reducing the anxiety and longing for the family with accessible and inexpensive communication resources will have a negative impact on burnout [15]. The least important factors are the duration of ship's voyage, tradition and customs, hierarchy on-board, risk of pirate attack, family issues and nutrition.

5. Conclusion

The study was conducted in order to understand the point of view of the Turkish seafarers to the problems and difficulties they encountered during their maritime services and to lay out the general profile of Turkish seafarers. Questionnaire prepared by 24 questions, 649 seafarers were participated to the survey. When the survey results are examined, the homesickness problem, which was first in 10 years ago, fell to the second rank with the development of communication facilities of today. On the other hand, important issues such as stress, fatigue, professional stability, salary, and craving of social environment remain among the major challenging factors of the profession today. The results of this study are parallel with studies in the literature which conducted with seafarers from different countries. This proves that the problems of seafarers are common though they come from different societies. The study shows that the occupational problems of seafarers are global. For the development, safety and efficiency of maritime trade; it is necessary to work on both national and international authorities to take steps to shorten contract periods, to increase social facilities at sea, to make living spaces more

comfortable and liveable, to develop business standards related to safety culture, and to solve such problems.

Future studies will also be useful for maritime transport, where the review is planned in two chapters, as officers and rating, and compared with other countries.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

A Compliance Analysis of Marine Engineering Cadets' Practices on Maintenance and Repair of Shipboard Machinery/Equipment Tasks & Duties Within On-Board Training Book Records

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ABSTRACT

Marine engineering cadets' on-board training process has significant contribution to enable required level of knowledge, understanding and proficiencies of undergraduate students. This paper conducts a compliance analysis through performed practices along with the on-board training book records. The study particularly focuses on the training book chapter involving maintenance and repair of shipboard machinery/equipment. The numbers of 25 marine engineering students, completed the long term sea training in 2017-2018 spring semester, are invented to join a basic compliance survey. The survey determines whether the cadets find an opportunity to involve into the tasks in procedural/operational several times, particularly or not. The results are classified based on procedural tasks, operational tasks, ship type, ship flag, etc. For instance, the cadets' responses reveal that they find good opportunities to involve survey of turning gear, overhaul of fuel oil filters, and spare part storing while there are some difficulties to get familiar with operations especially for crosshead guides, deck machineries, top end bearings, tie bolts, and main bearings. Consequently, the findings might contribute to program compliance studies in maritime education and training institutions. Furthermore, a study might be extended to think about supporting the relatively low compliance items of on-board training book via distance marine engineering class, labs and advance virtual arrangements.

Keywords: marine engineering cadets, maintenance operations tasks; compliance analysis

1. Introduction

In merchant ships, marine engineers are responsible for propulsion, electrical power generation, and various maintenance & repair operations of ships [1]. Minimum standards of competence for such duties are described in the Table AIII/1 and AIII/2 of the international convention on STCW (Standards of Training, Certification, and Watchkeeping in Seafarers) which has been updated in 2010 by Manila amendments [2]. For instance, in the AIII/1, the descriptions of minimum requirements of "competencies", "knowledge, understanding and proficiencies", "methods for demonstrating the competencies" and "criteria for evaluating competency" are shown with detailed explanations [3]. Today, the global maritime education and training (MET) system for marine engineering has been established upon these standards.

Since the MET activities are crucial for a seafarer's occupational lifetime; competence standards, teaching methods, training tools, learning environment, and other aspects often come under scrutiny by the experts, when appropriate. For instance, Lu & Liu (2015) [4] integrated augmented reality technology into marine education environment with the intent of enhancing marine engineer student's learning activity. Likewise, Shen et al (2019) [5] have conducted a study via integrating virtual reality training system into a marine engine room environment. In that study, the comparison between students' pre-test and post-test results show that this learning environment has a positive impact on the training progress of the seafarers. Besides, Kandemir et al (2018) [6] proposed a problem-based learning approach for operation & maintenance course in marine engineering programme. According to this study, all marine engineering students have increased their success rate by approximately %16 with this new learning technique. Balaji & Venkadasalam (2017) [7] presented a training center idea via AHP (Analytic Hierarchy Process) approach through a liquefied natural gas tanker for the purpose of choosing the most suitable learning modes and environment.

Khan & Zubaidy, (2016) [8] have revealed gaps in a specific learning curriculum and have made suggestions in order to enhance training efficiency. Similarly, Kandemir et al (2018) [9] identified crew training needs through analyzing PSC inspection records for maintenance actions in the engine room. According to the results, the study proposed improvements for the current MET activities. Zapalska et al. (2015) [10] have also made comprehensive research via presenting a framework for leadership skills development through experimental learning for coast guard engineers.

Despite the fact that such studies have made important contributions to the global MET concept, the internship phase of marine engineering students has not been judged with a large spectrum by the researchers. However, there are also some valuable studies which cannot be ignored such as Sevilla & Arceno (2017) [11]. They utilized a comprehensive survey for both deck & engine cadets in order to assess shipboard training profile and cadet performances in the Philippines. They discussed and analyzed the cadet performances with different aspects and have made suggestions for their MET activities. Likewise, Demirel & Ziarati (2010) [12] have assessed the English language skills of the maritime cadets through a similar survey-based approach. As another approach to the matter, Yilmaz et al (2018) [13] have measured sleep and working hours of the cadets during their long term sea training. They identified that the effect of the long term sea training has a significantly negative effect over seafarers and they proposed several suggestions for this issue. In addition to this, Zhao et al (2017) [14] and Guo & Liang (2012) [15] have indicated another problem and have discussed specific difficulties for female seafarers. Both of these studies have consulted cadet opinions and subsequently emphasize inequalities which sourced only by gender difference for occupational carrier including arranging an internship. As seen, the internship phase of seafarers has some sector related, characteristic problems. Even so, the scarce literature for this subject associates that these revealed matters are just the tip of the iceberg. Thus, internship of maritime students should be studied more frequently by academic and industrial experts from different aspects.

Not only identifying the problems of the cadets are important but also the opportunities which are given to them from ship companies, supervisors and crewmates. Moreover, the operational variety throughout their sea training is another aspect to be justified. At this regard, this study interrogates the involvement level of marine engineering cadets towards operational and procedural levels in the engine room which are expected to interact with a set of machinery or equipment. Hence, a compliance analysis based approach is conducted for engine cadets in order to identify if they have founded sufficient opportunities for specific tasks or have not through individual basis.

2. Compliance Analysis

The ship engine room often contains complex, narrow, warm, noisy and enclosed atmosphere which makes it difficult to operate [16]. Working in such environment is required additional competencies, however; competency gaining requires plenty of time in MET activities. The proof of that is the long term sea training which is compulsive for seafarers obliged from IMO (International Maritime Organization). According to the STCW based minimum standards, marine engineering students must complete at least 6 months on-board a ship as cadets. Besides, the total internship time cannot be less than 12 months [2].

Despite the total required time to complete an internship is equal for all marine engineering students, working conditions may not be equal. On-board a ship, engine room operations, organizational culture, task involvements, and other elements can be various. Additionally, some of the operations could be less likely outperformed in proportion to a ship's type, age, size and etc. So, training efficiency of a cadet could remain unfamiliar towards some specific duties in the engine room. Moreover, such training ambiguities may lead to serious human error based incidents or accidents which have the potential to result with injuries, deaths, total losses and etc. Consequently, this study directly investigates the involvement level of engine cadets in order to obtain clear findings. For each marine engineering student who disembarked a short time ago, a set of procedural and operational tasks have been introduced in order to obtain responses. The specific

tasks which have been selected for this study (See: Table 1 and Table 2, respectively) is derived from Istanbul Technical University (ITU) Marine Engineering Department, Onboard Training Book for Engineer Cadets [17]. Earlier on, these checklists were prepared as they were in comply with the most updated STCW Table AIII/1 and AIII/2 by the department lecturers.

Table 1: Procedural tasks list in the compliance analysis.

Cod	Task & Duties
1	Learn about the ship's PMS
2	Learn about manufacturer's instructions and drawings
3	Assist with input to the ship's PMS
4	Learn how items of spare gear are stored and maintained good condition
5	Learn about special precautions to be taken for repair and maintenance work in
6	**Learn about safe working practices and procedures for:**
6a	Use of portable power operated tools
6b	Entry into enclosed spaces
6c	Work beneath floor plates
6d	Use of lifting gear
6e	Moving heavy machinery
6f	Disposal of oily waste materials
6g	Use of appropriate protective clothing
6h	Working at height
6i	Manual lifting and carrying

The "Code" section is given for compact and understanding demonstration in the next sections of the study. "Tasks & Duties" is the description of a task which is expected to be practiced by a cadet during the sea training.

Table 2: Operational tasks list in the compliance analysis.

Co	Task & Duties
7	Learn to take and log readings of crankshaft deflections of main and auxiliary engines
8	**Learn to change, inspect, check condition, wear and clearance, overhaul and test of following components of main and auxiliary engines:**
8a	Inlet valves
8b	Fuel Injection valves
8c	Air start valves
8d	Relief valves
8e	Exhaust valves
8f	Fuel Pumps
8g	Camshafts
8h	Crosshead bearings
8i	Fuel oil filters
8j	Lube oil filters
8k	Air filters
9	Learn to use turning gear
10	**Learn to change and/or overhaul the following main and auxiliary engine components:**
10a	Pistons
10b	Cylinder heads
10c	Turbochargers
10d	Top end bearings
10e	Bottom end bearings
10f	Indıcator cocks
10g	Main bearings
10h	Piston-rod scraper box/stuffing box
10i	Crosshead guides
10j	Tie bolts
10k	Holding-down bolts and chocks
11	**Learn to inspect scavenge trunk and exhaust**

11a	Scavenge drains
11b	Scavenge valves
12	Learn to carry out crankcase inspection
13	Learn to take a boiler out of service
14	Learn to isolate boiler
15	Learn to blow a boiler down
16	Learn to open up a boiler
17	**Learn to open up and inspect the following**
17a	Safety valves
17b	Feed check valves
17c	Ancillary valves
18	Learn to overhaul and test water gauge glass and check that passages, cocks and valves
19	Learn to change and overhaul burner
20	Learn to open up and reassemble purifiers/separators for cleaning maintenance
21	Learn to carry out routine maintenance on a main compressor and its system components
22	Learn to carry out routine maintenance on a
23	Learn to carry out routine maintenance on fresh
24	Learn to open up and overhaul different types of
25	Learn to overhaul and test different types of valves
26	Learn to carry out routine maintenance on deck
27	**Learn to carry out routine maintenance on following emergency equipment:**
27a	Fire flaps
27b	ER fire extinguishing system and equipment
27c	Remote stops for pumps with overboard
27d	Fuel valve trips
27e	Breathing apparatus sets and recharging breathing
27f	Survival crafts

Besides, some main tasks contain several tasks such as 6, 8, 10, 11, 17 and 27 which are indicated with bold letters. Therefore, there are a total of 63 tasks involved to be judged by students and 14 of them belong to the procedural tasks whilst 49 belong to the operational ones. The assessment criteria in the survey are also shown in Table 3. The total number of respondents is 25; they are all marine engineering students who returned from a long term sea training.

Table 3: The assessment criteria in compliance analysis.

SCORE	DESCRIPTION
1	This operation has not been performed during my sea training
2	This operation has been performed during my sea training, however, I could never find an opportunity to get involved in it.
3	This operation has been conducted a few times during my sea training, and I could find some opportunity to get involved in it.
4	This operation has been conducted several times during my sea training, and I could find sufficient opportunity to get involved in it.
5	This operation has been conducted several times during my sea training, and I could find too much opportunity to get involved in it.

3. Results

The 25 respondents of this survey have completed their internship (long term shipboard training period) on different ships. Type, built date, length overall and flag of ships are shown in Table 4. Hence, the majority of them have trained in oil/chemical tanker while the rest of them operated in container, dry cargo, bulk, and Ro-Ro ships. The most aged ship has been built in 2001, whilst the youngest ship has been built in 2017. The flags of ships commonly belong to Turkey and Marshall Islands, however there are also Malta,

Panama and Valetta flags. The smallest ship length is 123 meters, on the other BUhand, Suezmax class ships are also hosted engine cadets.

As things stand, responses have significant differences from each other. Majority of cadets get involved several times in some tasks such as turning gear (#9), fuel oil filters (#8i), spare gear storing & maintaining (#4), lubricating oil filters (#8j), air filters(#8k) and purifier maintenance (#20).

Table 4: Characteristics of the engine cadets' ships.

Cadets	Ship Type	Built Year	Length (m) or Size	Flag
C1	Container	2012	177	Turkey
C2	Bulk	2008	172	Malta
C3	Oil / Chemical Tanker	2014	183	Marshall Islands
C4	Dry Cargo	2008	172	Panama
C5	Oil / Chemical Tanker	2010	179	Panama
C6	Oil / Chemical Tanker	2017	183	Marshall Islands
C7	Oil / Chemical Tanker	2004	270	Turkey
C8	Container	2004	184	Turkey
C9	Container	2001	146	Turkey
C10	Bulk	2014	N/A	Marshall Islands
C11	Oil / Chemical Tanker	2006	144	Malta
C12	Crude Oil	2015	278	Malta
C13	Dry Cargo	2008	174	Turkey
C14	Dry Cargo	2006	183	Turkey
C15	Oil / Chemical Tanker	2010	184	Panama
C16	Oil / Chemical Tanker	2008	N/A	Marshall Islands
C17	Oil / Chemical Tanker	2014	N/A	Marshall Islands

C18	Oil / Chemical Tanker	2001	274	Turkey
C19	Oil / Chemical Tanker	2009	123	Marshall Islands
C20	Oil / Chemical Tanker	2014	N/A	Marshall Islands
C21	Oil / Chemical Tanker	2013	180	Marshall Islands
C22	Ro-Ro	2007	198	Turkey
C23	Oil / Chemical Tanker	2012	182	Turkey
C24	Crude Oil	2017	Suezmax	Turkey
C25	Oil / Chemical Tanker	2015	Suezmax	Valetta

Nonetheless, the cadets have experienced some difficulties to get involved in crosshead guides (#10i), deck machinery maintenance (#26), top end bearings(#10d), tie bolts(#10j) and main bearings (#10g) related tasks. In Figure 1, the average scores of all operational and procedural tasks are illustrated.

The involvement level of the operations is can also be seen in the Figure 2 with more details. The green cells in the figure indicate the highest scores given by respondents, on the other hand the red cells signal the lowest scores. Accent colors refer in a similar manner thus strong green tonnes for higher values and strong red tonnes for lower ones.

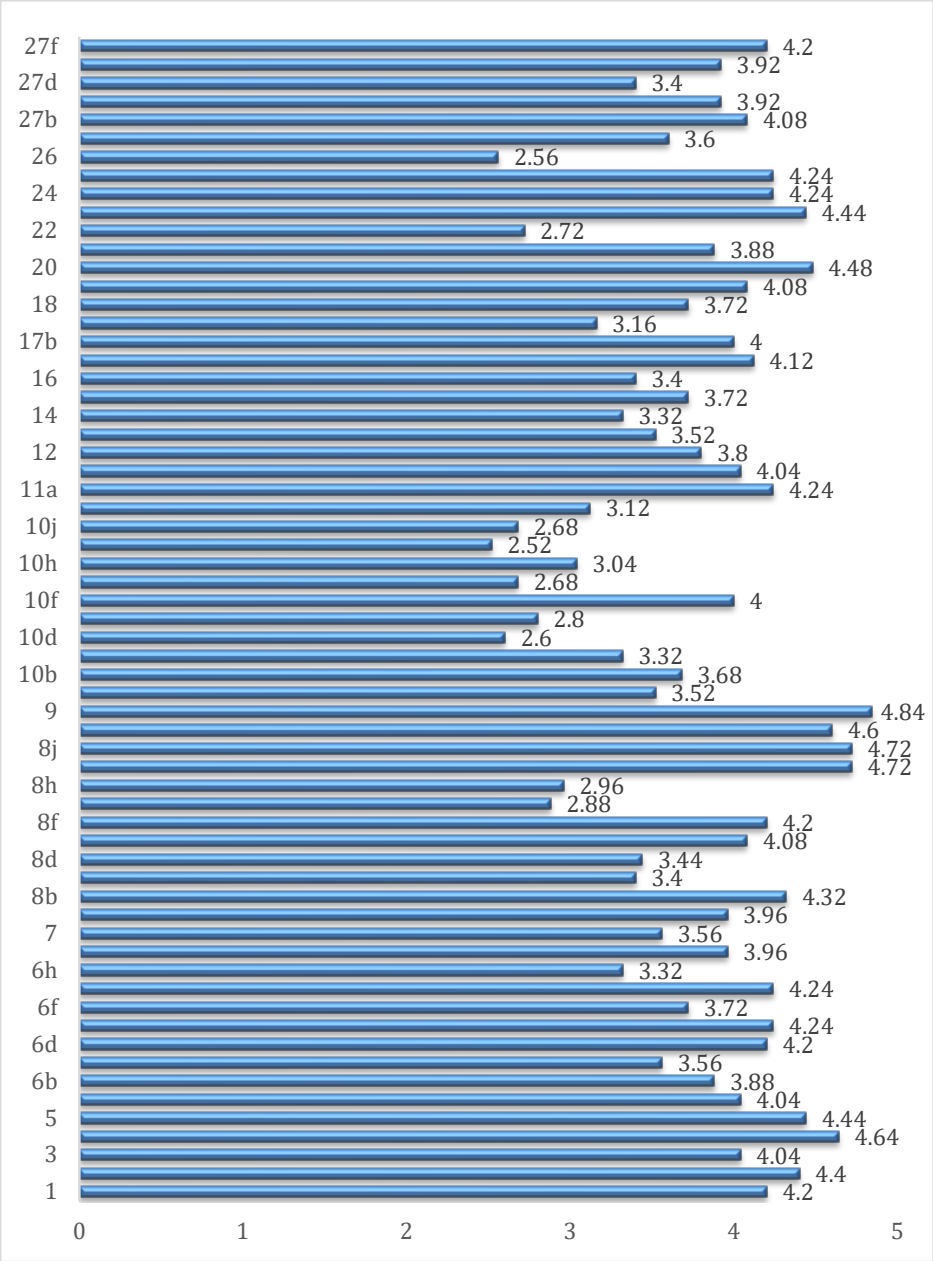
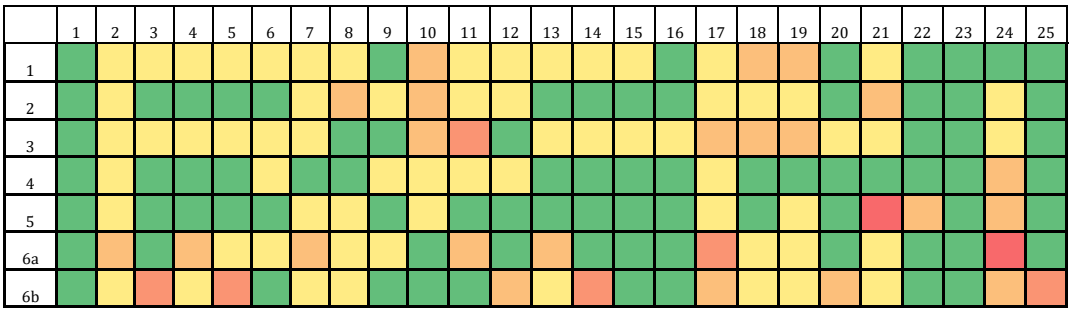


Figure 1: Average scores of all tasks.



6c
6d
6e
6f
6g
6h
6i
7
8a
8b
8c
8d
8e
8f
8g
8h
8i
8j
8k
9
10a
10b
10c
10d
10e
10f
10g
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17c
18
19
20

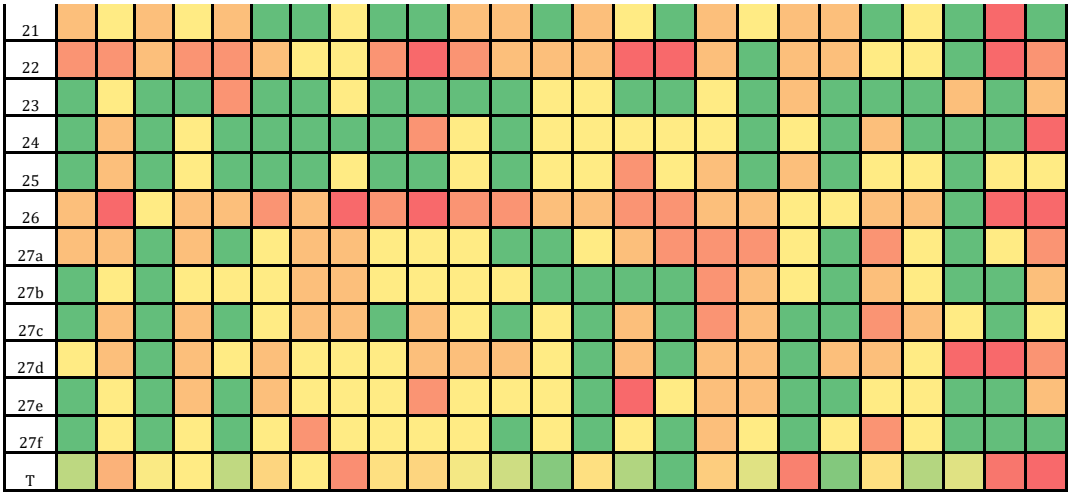

Figure 2: Results for all operations and respondents.

So, the higher and lower values can easily be seen from this demonstration as a lot of green cells are cumulated on the #8i, #8j, #8k rows, whilst the red ones are usually seen on the #10d, #10g, #10i rows.

The last raw at the bottom reflects total scores for each cadet. As seen in the figure, the cadet who had the best internship experience is #C16 with 289 total score points. Following, #C20 (278), #C13 (277), #C15 (262), #C22 (261), #C1 (258) and #C5 (257) are other considerably high values. On the other hand, in ascending order; #C25 (187), #C24 (192), #C19 (196), #C8 (201), #C2 (214), #C17 (224), #C10 (227) and #C6 (227) are far from an effective sea training in terms of the relevant operations. The difference between the highest and the lowest values is 102, and the average value of all cadets is 237. Considering the maximum score can be 315 for the given scale, the highest score of the cadets (#C16 with 289) complies with the 92% of the ideal internship. On the other hand, the lowest score (#C25 with 187) complies with only 59%. The average value of 25 cadets comply with 75% of the ideal internship.

The compliance analysis results show that there could be considerable difference between the cadets' long term sea training experiences in the sense of finding opportunity to get involved with the operational tasks. However, there is no considerable correlation

can be seen regarding ship characteristics with the obtained data. That is to say, more comprehensive study should be executed by a large amount of cadets, and various compliance monitoring criteria. Since the internship phase is critical for seafarers, specific opportunities should be provided in more balanced way. In order to establish this, many suggestions can be proposed. Nevertheless, the awareness of maritime sector's shareholders should be arisen at the first stage.

4. Results

Since long term shipboard training periods are very crucial for the career of seafarers, the existing challenges and difficulties should be unveiled. For this reason, this study has interrogated the involvement level of marine engineering students to pre-described operational and procedural tasks through a compliance analysis based approach. In this way, the experimental availability level of the various tasks for engine cadets was identified. The 25 engine cadets were selected among the marine engineering students who have just returned from their sea training. The students have completed their internship on different vessels, which means in different working conditions. In the survey process, a total of 63 tasks are involved. Each operation can have 1 to 5 scores from respondents thus the maximum value for involvement level of an ideal internship could be 315. According to the results, the efficiency of sea training can be varied significantly. There is a big margin between the highest value (#C16 with 289) and the lowest (#C25 with 187). Besides, some tasks such as main and auxiliary machinery overhaul & maintenance could remain unfamiliar for the engine cadets.

Since therefore, the internship phase of seafarers should be researched more studiously by the academia, industrial experts, international authorities and etc. As the sea training is an inseparable part of the whole MET activity, further studies should examine this issue in more comprehensive way. For instance, the number of cadets can be dramatically increased. In addition to this, various elements of learning process can be utilized as a compliance monitoring criteria. Hence, well-settled suggestions can be made by researchers.

5. Acknowledgement

This article is partially produced from initial studies of Design Project "An investigation through marine engineering cadets' training and task duties on maintenance and repair of shipboard machinery/equipment items" which is conducted in ITU-SUNY DDP in Marine Engineering at 2018-2019 Spring Semester. The authors would like to acknowledge to marine engineering students who join a basic compliance survey.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

The Effect of Stress' on Seafarers' Job Performance

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ABSTRACT

Stress, which is a concept that emerges when the physical and mental limits of the organism are forced and threatened, is defined as the veil of the 21st century. In various discussions, whether it is media or academically based, on conferences, congress or panels, there is no consensus on whether it is possible to completely eliminate the concept or not. However, stress, also defined as the opposing response of individuals in the case of extreme oppression, which positively or negatively affects individuals and organizations, is supported by the relevant literature. From this point of view, it is aimed to examine the positive or negative effects of the stress levels of the employees of the maritime industry on their job performances, which are among the most stressful sectors in this study. In the study, the data gathered from the sector workers were analyzed through simple linear regression method. The findings of the study were concluded with recommendations for the sector practitioners and guidelines for future researchers.

Keywords: Stress, Maritime Industry, Job Performance

1. Introduction

Maritime transportation plays a vital role for the world economy. More than 80% of the world trade is transported by sea and it is by far the most cost-effective method to transport the best products and raw materials in the world [1] [2]. And seafarers play a crucial role in maritime transportation process in ensuring that ships and cargo are delivered safely and efficiently from origin to destination. It is a profession that draws on physical effort, skill and intellectual power in a variety of disciplines [3] [4]. Being a seafarer requires strong mental stability and a solid physical foundation along with an adaptable and flexible attitude. However, stress prevents the maritime profession from working onboard effectively [5]. Stress defined as; "a mental and physical condition that results from a perceived threat or demand that cannot be dealt with readily" [6] Seafaring is qualified with mental, psychosocial and physical stress sources that cannot be compared with jobs onshore. There is amount of risks and challenges to face for seafarers that can cause stress, such as long working hours, lack of support, away from home, loneliness, exposure to dangerous substances, communication problems, sleep disturbance, work related stressors, danger related with piracy, fatal accidents, limited influence on quality and quantity of food [7] [8] [9] [10] [11] [12]. According to current literature, there is a serious shortage of experienced and well-trained senior seafarers in globally because of the high turn-over rate of seafarers, in this line the research question of this specific study is, it can be possible to reduce this high turn-over rate of seafarers by pointed out stress-induced problems in job performance. From this point of view, it is aimed to determine stress and job performance levels of seafarers and to investigate the effect of stress on job performance.

2. Literature Review

2.1 Seafarers' Stress

According to the International Labor Office [13], stress has become a growing global phenomenon that affects all countries, all workplaces, workers, family and community categories. Stress is a widely accepted problem in the maritime industry too and has a

great impact on the occurrence of accidents [11] [14] [15]. Work-related stress between seafarers is strongly linked to the specific physical and psychosocial conditions of working on board [7]. As a human resource issue, seafaring is one of the most important maritime policies used in maritime industries in many developed countries to confront the problems of qualified and skilled seafarers. Although, earlier research has attempted to solve the scarce seafarers' dilemma, there are few studies to discuss stress-related factors that affect the intention of working on the ship or the maritime profession in the current literature.

For example; Oldenburg et al. (2010) pointed out that the most dangerous situations onboard are determined as unsafe practices, toxic substances, psychological stress and lifestyle risks [10]. Another study investigating seafarers and work-related stress is [7] stated that the most common psychosocial stress factors are; monotony, loss of attention, biorhythmic disorders, excessive or inadequate responsibility, family distraction, continuous change of environment and conflict, responsibility arising from the safety of personnel and difficult decisions are taken. Working under these conditions may cause extreme stress and negative performance, including the health and safety of seafarers. Stress can adversely affect seafarers' performance at work, reduce their alertness, and influence their problem-solving and decision-making abilities [17].

2.2. Seafarers' Job Performance

The job performance concept defined in several sources for some long decades. In 1990, Campbell related the job performance to the act of doing a job, defined it to reach a goal or set of goals inside of a job, role or organization [18]. Motowidlo and Kell (2013) defined the concept as; "the total expected value to the organization of the discrete behavioral episodes that an individual carries out over a standard period of time [19]". When measuring and analyzing organizational performance as a whole, individual performance metrics are particularly important to understand the impact of various factors on occupational functioning [20], for why, organizational performance is ultimately guided by job performance [21]. When it comes to the seafarers, because of the extraordinary

nature of their job, they supposed to receive standard training to be a qualified crew, according to the Seafarers' Training, Certification and Watchkeeping (STCW) code and its amendments [22]. However, competency of seafarers especially related with their job performance is not just about having a knowledge and certificates, it requires the skills and experiences that can only be gathered year by year [22].

To understand the job performance metrics and its relations with various variables of seafarers, several studies were conducted. Yuen et. al (2018) aimed to analyze main determinants of job performance and job satisfaction of seafarers and the results show that job satisfaction is significantly associated with seafarers' job performance [21]. Another study that aimed to discover the existing problems of seafarer recruitment process and to find out an efficient recruitment system for shipping companies was carried out by [22]. They found four primary dimension that effect the seafarers job performance namely; work attitude, loyalty, payment and welfare and opportunity. Performance improvements in seafarers have significant outputs, such as improving the return time of ships, meeting shipbuilders' productivity demands, and improving the safety performance of ship operations [23]. Thus, measuring and improving the performance of seafarers' means significant cost savings and service improvement for shipping companies [21]. Therefore, it is considered by the authors that analyzing seafarers' stress-induced performance losses and revealing possible problems will contribute significantly to both existing literature and shipping companies.

3. Methodology

The objectives to be covered in this study are as follows:

- To examine the stress and job performance levels of seafarers onboard.
- To determine the effect of the relationship between the stress of seafarers and job performance onboard.

In order to carry out the objectives, the data gathered from Turkish seafarers were analyzed through simple linear regression method with applying statistically analyses of SPSS 21.0. version.

The data used in the study were collected by means of questionnaires via internet and face-to-face from seafarers on board in Turkey. Questionnaire that used in this study consists of three divisions; questions related demographic characteristics of the participants, questions developed from Perceived Stress Scale (PSS) [24] [25] [26] and lastly questions developed from Job Performance Scale (JPS) [27].

The survey was conducted during the period from January to February in 2019. In total, 58 questionnaires were gained, 6 of them was obtained through face to face and 55 of them was obtained via the internet. 8 questionnaires that obtained through internet were found unreliable and authors decided to discard them. Remaining 53 questionnaires used as primary data source in the study.

4. Findings and Discussion

Reliability analysis results of indicators that are used in the study given below Table 1 detailed.

Table 1: Reliability Analysis Results

Questionnaire Determinants	Cronbach Alpha Value
Stress Variables	0,845
Job Performance Variables	0,817
Total Reliability	0,741

The alpha coefficient, which is a value between 0 and 1, is used to define the reliability of the factors and the higher the score means that the more reliable the scale is. In the current literature, 0.7 is considered to be an acceptable reliability coefficient [28]. As all reliability results obtained in this study is higher than 0,7 as given in Table 1, the reliability of the study is considered as provided.

Regression analysis also conducted in the study to analyze the effect of stress level on job performance levels of seafarers. Results indicate that there is no direct effect of stress levels on job performance levels of seafarers for this specific sample. However, both stress levels and job performance levels of the sample calculated as moderate. So, it is thought that duplicate the study with increased sample number could be change the results and contribute the literature. In addition, another possible cause of obtained results can be the hierarchical structure of seafarer's nature. As, stress is the part of their educational and in some cases social lives of seafarers, they are considered as quite familiar with the stress on their lives. Even, it is an unstructured hypothesis in this phase of the study, to attach questions that aimed to answer this issue is suggested by the authors for future studies.

Time limitation is seen as the major limitation of this study. Also, because of the nature of their working conditions, encountered several geographical obstructions while reaching them. Lastly, the study is structured as the pilot study. After collecting several expert opinions, study will be duplicated with wider sample with the aim to contribute the literature.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

The Components of the Port Hinterland Performance: A Literature Review Study

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ABSTRACT

Especially with the emergence of Industry 4.0, some instruments such as internet of things, 3d printers, self-learning structures etc., have come into play. Thus, the duration of product life cycle will be shortened, products will be designed by each of customers individually, etc. These reasons have shown that reaching consumer fast has become much more significant. So, already existing cutthroat competition on operational speed among ports is also experienced in arriving hinterland as soon as possible. Considering the efficiency of hinterland transport by ports will bring the need for measuring hinterland performance. In the study, the studies conducted by reviewing the literature in terms of hinterland performance as one of the components of the port performance, have been investigated. The aim of the study is to identify the components of the port hinterland performance, identify the characteristics of the related studies and identify the methods that are employed in these studies. In this context, related academic studies are investigated and the keywords of these studies, the methods they used, their findings, the indicators they used, are analysed in detail.

Keywords: Hinterland Performance, Literature Review, Intermodal Transport, Port Accessibility.

1. Introduction

Notteboom and Rodrigue [1] defended that the connotation of port hinterland has shifted and they divided the hinterland into three types: physical, logistic and macroeconomic hinterlands [2]. Macroeconomic hinterland refers to economic activities such as production and consumption level that affect transport demand, while physical hinterland refers to supply which is infrastructure and superstructure provided by port. As for logistics hinterland is the balanced management of the process against the fluctuations of the demand and supply. As a result of the developments in the hinterland networks, port innovations, port privatization policies and changing service demands [3], the port hinterlands have expanded and the restricted hinterlands have been transformed into joint or competitive hinterlands and the port markets have become competitive markets rather than monopolistic or oligopoly markets [4]. The port's service quality and port usage fees are the main success factors of the ports in the competitive hinterland [5], because there is no dominant advantage of any port in the competitive hinterland in respect of any issue such as access to the customer, infrastructure capabilities, etc. However, considering that such a market cannot exist, the factors affecting the competition of hinterlands are becoming more diversified. For the first time, a comprehensive port performance measure has been proposed by ESPO in the project named PPRISM and the intermodal linkage level is used as a performance indicator and so it is referred to the inseparable link between the ports and the hinterlands [6]. Maybe the effect of this, nowadays, hinterland efficiency is seen as important as port operations [7; 8]. Thus, the hinterland is not only the area that connects the customers to the port but also becomes an environment where spatial instability and clustering prevail. The ports have begun to regionalize and this regionalization imposes an important obligation on ports to provide integration to the hinterland and safe access [1]. In fact, safety and security for hinterland transport are prerequisites and many natural or man-made disasters can affect hinterland transport flow [8].

When we look at hinterland from the point of view of the port users on the land side, it is seen that the hinterland connection and the costs come into prominence in terms of the port choice. Although hinterland transportation covers only 10% of the total transport distance, hinterland transport costs account for 80% of the cost of intermodal shipping [9]. Beyond this economic reason, many indicators have emphasized the port-hinterland connection as one of the most important factors in terms of shippers' port preference [10]. In other words, in order to be competitive along the international logistics corridor, ports need to be able to convince international operators on that their connections are as effective as other ports located the same region to reach potential users and private ports [11]. The three most important factors that make the port hinterland attractive to its customers are location, accessibility and infrastructure [5].

We frequently mentioned the importance of the hinterland's role in maintaining the operations of the ports and providing effective services to maritime transport. At this point, many strategies are proposed for the hinterland to keep up with the logistic conditions of the era and to provide an effective performance to port users. In general, improving the performance of the supply chain can be achieved by extending the connection of the seaside and the land side of the ports towards the hinterland. At this point, the focus could be an environmentally friendly link development between the port and its hinterland, and with the appropriate infrastructure expansion, the strategies to improve the level of service for the hinterland, could provide a wider port area to create added value and employment [12]. On the other hand, besides increasing the existing effectiveness, it is also an important performance item to protect either financial assets such as infrastructure, superstructure, equipment or intangible assets such as information technology, organizational memory, operational capabilities from external factors or to repair them quickly if they are destroyed. [8] defend that the immediate reaction to any disasters that may occur in any port-hinterland line is a very important attitude that increases the competitiveness level of the ports. Initiatives on corridors connecting ports and hinterlands generally focus on expanding the loading gauge, extending the length of the train and increasing the route capacity [13]. There is also a

general consensus on the fact that cargo transportation by train is more sustainable in comparison to road transport and its utilization should be supported [13]. Recent developments in shipbuilding technology have resulted in a considerable increase in cargo handling in a single port at one time and that the hinterland traffic has being congested as never before. This demonstrates that the efficient use of the railway would not only be enough to remove the congestion in the hinterland. The worldwide steady increase in international container traffic is putting a lot of pressure on ports and port-hinterland connections, especially in land-connected cities [14]. At this point, in order to establish a sustainable port-hinterland connection and a healthy container flow on this connection, rail and inland waterway transportation should be included in the hinterland connection by train and barges instead of directing exclusively the traffic to the road. In addition, the 'extended gateway' regime in which the dry ports are accepted as part of the seaport and exemption of customs procedures in the transfer of cargo between the port and the dry port, should be incorporated in the hinterland strategy to provide effectiveness [14].

In this study, the literature about hinterland transport has been reviewed and it is revealed that hinterland transport concept transitivized and had comprehensive meanings in time. It is also revealed the criteria related to the performance of the hinterland transport according to authors of the reviewed studies. Besides, statistical analyses related to methods employed in reviewed studies and keywords of these studies have been carried out in this study.

2. Literature Review

Several different studies evaluated hinterland performance or efficiency from various viewpoints in the literature. Some of them built a model to optimize hinterland connections of the ports, some of them examined innovations or developments through the hinterland, some proposed solutions against several negativities taking into account different scenarios etc. The connection between hinterland and port issue has been studied several times. Haezendonck et al. [12], developed Port Hinterland Impact (PHI)

to assess hinterland impact on ports and focused on especially logistic network and accessibility issues as Ferrari et al. [4] did. Woodburn in his studies referenced as [15] and [13], emphasized the utilization of rail transport for connecting port and hinterland through the example of the UK. Optimization issue in hinterland literature has been studied many times as the whole study issues in logistics. Halim et al. [10], developed a model to assess port connectivity to its hinterland and to choose optimum cost – distance combination. Feng et al. [16] proposed a model to optimize turnaround time of the port-hinterland transport by barges. Akbayırlı et al. [3], developed a model to determine what port choice criteria of the port users exist and road connection level has been a prominent criterion in consequence of the analysis. In other respects, Nguyen and Notteboom [17] unveiled the importance of having trimodal (road, rail, barge) or at least bimodal connection for seaports through the hinterland when it comes to throughput performance. Comparisons of hinterlands and expanding strategies for hinterlands of the ports also are popular issues for the hinterland studies. Acciaro et al. [11], evaluated how Adriatic ports gain Southern German ports' cargo flow. With this case study, it is aimed to explain many factors to expand ports' hinterland network. Jafari and Khosheghbal [5] studied the reasons that comprise why local ports cannot compete with regional ports and proposed solution recommendations for expansion to policymakers. In response to existing optimization, expansion or efficiency problems, protecting or sustaining existing system against manmade or natural disasters is crucial yet. While Chen et al. [8], were evaluating resilience level of the ports' hinterlands against natural or manmade disasters, Chen et al. [18] concentrated on how the actions of the port users affect resilience level. Accordingly, Ubogu et al. [19] disclosed the challenges of hinterland transport in Nigeria. A number of studies take into account not only throughput efficiency but also social, logistics, macroeconomic efficiencies when it comes to assessing hinterland performance. Iannone [14] submitted a solution for efficient flow between the port and its hinterland by the model which evaluates the process from either optimization oriented or social perspectives. In the study of Shi and Li [2], hinterland activity is evaluated from shippers'

viewpoint within different aspects such as from physical, logistics, and macroeconomic perspectives.

3. Implications

In this study, a literature review of hinterland transportation performance has been made. At this stage, the articles related to 'hinterland transport performance', 'hinterland transport efficiency' and 'hinterland transport productivity' have been investigated. As a result of the study, produced literature table which contains information about the articles such as authors and keywords of these studies, year info, methods they employed and criteria seemed by the authors as indicators of the hinterland transport performance, showed in Table 1.

Table 1. Literature Table

Authors	Year	Keywords	Method	Criteria	Conclusion
Haezendonck, E., Dooms, M., and Verbeke, A.	2014	Governance; Transaction cost economics; Economic impact; Port hinterland; Geographic reach; Dedicated traffic.	Matrix is developed	Intermodal Capacity, Value-Added Logistics.	In this study a matrix which is named Port Hinterland Impact (PHI), was developed to assess hinterland impact on ports. This matrix focuses on the logistics network and accessibility issues.
Halim, R. A., Kwakkel, J. H., and Tavasszy, L. A.	2016	Port-hinterland network; Distribution network; Freight model; Port connectivity; Policy analysis; Facility location model.	Model is developed	Service Distance, Cost, Flow.	Authors have developed a model to assess port connectivity to its hinterland and to choose optimum cost – distance combination.
Woodburn, A.	2017	Port-hinterland; Rail freight; Container flows; Transport efficiency; United Kingdom.	Statistical calculation	TEU per train, Train capacity utilization (%), Service distance	This study focused on the utilization of rail transport for connecting port and hinterland. It is seen that in the period from the year of 2007 to 2015 in GB, railway usage of the port users to reach hinterland, has visibly increased. Hence, some key items such as TEU per train by port,

					train capacity utilization has also been increased in GB ports.
Acciaro, M., Bardi, A., Cusano, M. I., Ferrari, C., and Tei, A.	2017	Contestable hinterlands; North Adriatic ports; Port competition.	SWOT Analysis	Cost, Responsive-ness to customer, Timing, knowledge level.	In this study it is evaluated how Adriatic ports gain Southern German ports' cargo flow. With this case study, it is aimed to explain many factors to expand ports' hinterland network.
Chen, H., Cullinane, K., and Liu, N.	2017	Resilience; Port; Hinterland; Container; Shippers; Measurement model.	Integer Program-ming Model is proposed.	Resilience.	An integer programming model is built to evaluate resilience level of the ports' hinterlands against natural or manmade disasters. This pilot model is applied to Port of Gothenburg and its hinterland.
Shi, X. and Li, H.	2016	Port hinterland; Multi-perspective; Shenzhen Port.	Tradition al Network Analysis	Cost, Accessibilit y, Time, Service (Value-added) Quality,	In this study, Shenzen ports' hinterland activity is evaluated from shippers' viewpoint within different aspects such as from physical, logistics, and macroeconomic perspectives.
Woodbur n, A.	2013	Intermodal transport; Rail freight; Port hinterland connections; Rail network enhancement; Transport efficiency.	'Before and After' Analysis	Train capacity, Load factor.	This study revealed that gauge enhancement in the UK showed a substantially positive effect on hinterland efficiency of this country.
Feng, F., Pang, Y., and Lodewijks , G.	2015	Hinterland transport; Bi-level optimization; Multi-agent system; Integrate planning.	A Bi-level Model is proposed.	Turnaroun d time	This study proposed a model to optimise turnaround time of the port-hinterland transport by barges.
De Langen, P. W. and Sharypov a, K.	2013	Intermodal connectivity indicator; Port performance indicator.	Mathema tical calculatio n.	Headway frequency of trains or barges	Voyage frequencies of the trains or the barges through the hinterland of the European ports were calculated in way to change due to different scenarios.
Ferrari, C., Parola, F., and	2011	Container port hinterland; Competitiveness; Spatial interaction;	Gravity Model	Accessibilit y	This research executed a model to examine the accessibility of the Ligurian ports' hinterlands.

Gattorna, E.		Gravity model; Traffic diversion.			
Ubogu, A. E., Ariyo, J. A., and Mamman, M.	2011	Nigeria; Constraints; Trucking; Harassment; Rank-order; Magnitude.	Kruskal-Wallis	Security, Traffic regulation	In this study limitations of the Nigerian hinterland transportation were prioritized.
Akbayırlı, K., Deveci, D. A., Balcı, G., and Kurtuluş, E.	2016	Container Port; Competitiveness; Port Selection; Contestable Hinterland.	Factor Analysis	Port Distance, Accessibility	This study sought what port choice criteria of the port users are. Their model also involves hinterland connection issue and thus road connection level has been a prominent criterion in consequence of the analysis.
Ye, C. and Chen, S.	2018	Xiamen port; Sea-rail combined transportation; Economic hinterland; The Kohonen neural network model.	Artificial neural network	Railway connection	In this study the artificial neural network based model is employed for Xiamen port to subdivide its hinterland regions.
Meersman, H., Sys, C., de Voorde, E. V., and Vanelslander, T.	2016	Cost structure; Port competitiveness; Road pricing; Sustainable transport choice.	Cost Calculation Method	Cost	This study revealed the clear effect of the road pricing on the Flemish ports and its hinterlands.
Chen, H., Lam, J. S. L., and Liu, N.	2018	Port–hinterland container transportation network; Resilience; Vulnerability; Investment; Network game theory.	Network Game Theory	Resilience	This study sought how the actions of the users of the port affect resilience through port–hinterland container transportation network against disasters, strikes or terrorist attacks by its own-developed model.
Jafari, H. and Khoshegh bal, B.	2013	Hinterland; Foreland; Main hinterland: Comparative hinterland; Transportation; Ports.	Delphi	Railway access	Authors studied the reasons that comprise why local ports cannot compete with regional ports and proposed solution recommendations to policy makers.
Iannone, F.	2012	Green freight logistics systems; Transport external	Network Program-	Cost, Air emissions, customs	The author submitted a solution for efficient flow between a port and its hinterland by the model

		costs; Modal shift policies; Port hinterland container connections; Interport model; Total social generalized logistic cost.	ming Model	control, Dwell time,	which evaluates the process from either optimization oriented or social perspectives.
Nguyen, L. C. and Notteboom, T.	2019	Dry port; Seaport; Inland terminal; Sample analysis; Hinterland	Chi-square, Correlation, Wilcoxon Mann–Whitney U Test, Kruskal Wallis H Test.	Throughput, Utilization, Connectivity, Distance.	This study revealed that characteristics of the seaports and dry ports affect each other in terms of performance. Also, the importance of having trimodal (road, rail, barge) or at least bimodal connection for seaports through the hinterland is unveiled when it comes to throughput performance.

According to the table, we can derive some statistical implications. Accordingly, when we look over the methods employed in these studies, the usage frequency of basic statistical tests (factor analysis, chi-square, mann-whitney u, kruskal wallis h tests etc.) and model building effort to reach optimization, attract the attention. As we can see in Figure 1, several methods have been employed but especially model building and basic statistical tests are prominent.

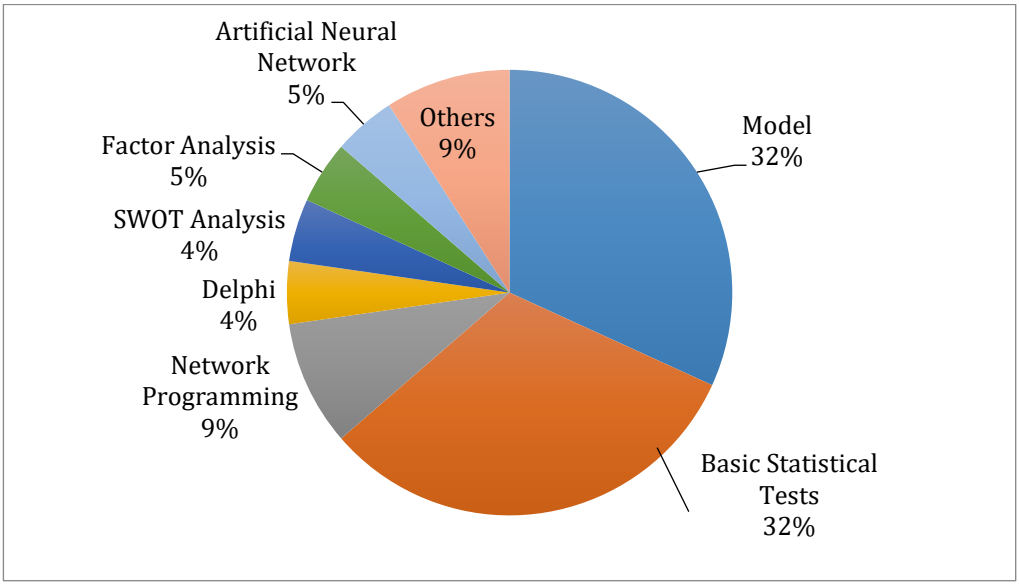

Figure 1. Percentage Distribution of the Methods.

In Figure 2 and Figure 3, it is shown that are prominent keywords of these studies and the percentage distribution of the criteria which seemed by the authors as indicators of the hinterland transport performance. In Figure 2, it is seen that the word 'port' has been used in reviewed studies 17 times as a keyword and 'container' word chased it with 6 times. And also, 'model', 'rail', 'network', and 'connectivity' words has been used several times as a keyword in these studies. In Figure 3, we can see that many factors have been used as criteria affecting hinterland transport performance of the ports. Especially, the factors 'connectivity', 'railway connection', 'service distance', and 'time', have been seen as the prominent criteria contribute hinterland transport performance if they are deployed effectively.

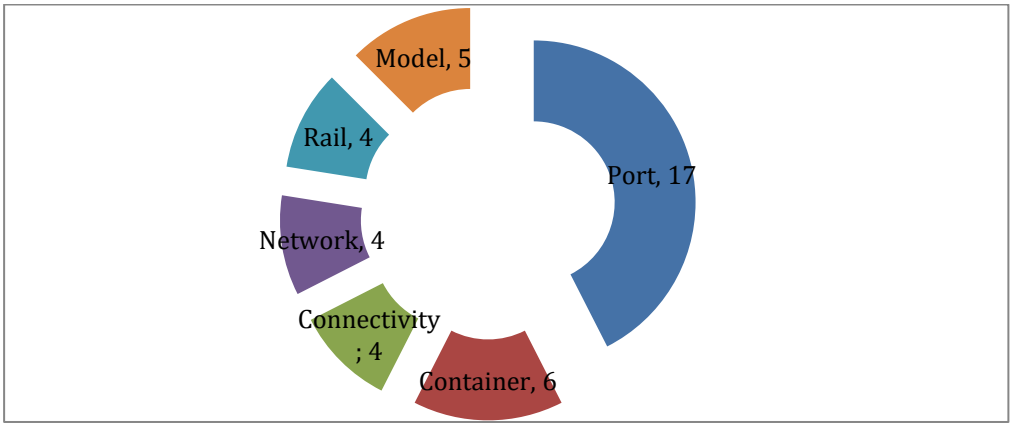

Figure 2. Usage Frequency of the Prominent Keywords.

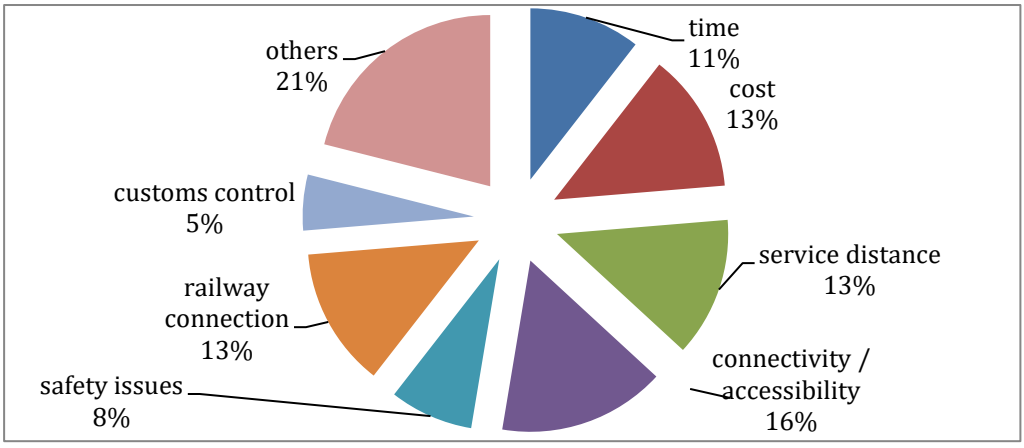

Figure 3. Percentage Distribution of the Hinterland Performance Criteria.

4. Conclusion

Mega vessels are preferred in maritime transport due to the rapid development of shipbuilding industry and the filling of large capacity vessels with container line alliances. Megaships concept and its high cargo volume transported in a lump put pressure on the ports and their hinterlands. Accordingly, port-hinterland traffic has been congested due to fast and high amount of cargo flow from sea to land or from land to sea. All these developments showed that 'hinterland' or 'port-hinterland connection' terms have

shifted and become a comprehensive and multilateral notion. In this study, against the traffic congestion risks towards port-hinterland connection, 'extended gateway' regime in which the dry ports are accepted as part of the seaport and exemption of customs procedures in the transfer of cargo between the port and the dry port, has been proposed. It would not be right to attribute the changes in the notions related to hinterland transport to only mega ships. Port innovations, port privatization policies and changing service demands have also affected port-hinterland network. That's why the indicators such as service distance, time, accessibility etc. come into prominence when hinterland performance has been mentioned.

This study revealed a literature review on hinterland performance and performance indicators approached by the authors of these reviewed studies. Especially, the factors 'connectivity', 'railway connection', 'service distance', and 'time', have been used more frequently as a performance indicator in these studies. When the studies are reviewed, it attracts the attention that model building to reach optimization for hinterland transport generally has been used as a methodology. It is showed that there is no single way when reaching optimization in terms of route planning, traffic regulation or transport mode utilization share, is considered. These clear indicators show that hinterland transport is a comprehensive, multifaceted and occasionally complicated process.

In this study, it is seen that model building has been the most applied method while optimizing hinterland transport. With these models, authors have assessed ports' hinterland performance as an optimum or not. Besides, lack of study which comprises the whole performance aspects of hinterland transport altogether, is also seen explicitly. As a further research suggestion, maybe a scientific study which combines more performance items together such as waiting time considerations, service network wideness, environmental concerns, capacity utilization, etc., could be done.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Statistical Analysis of Tanker Inspection Reports

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ABSTRACT

Maritime transportation has been growing as a result of increasing globalization and industrialization. The increase in the number of ships operating at seas may naturally cause a proportional increase in maritime accidents and hence hazards caused by those accidents. In order to make sure that ships are operated and managed safely, their compliance with international standards is continuously being inspected both by flag state and port state authorities for. As tankers ships are prominently important for seaborne transportation, they are also vessels which can expose major dangers due to cargoes they carry. Any fault made or any inattentive conduct during transportation and handling of these goods may cause great risks for human life and irreversible damage to environment as well as marine pollution. For this reason, tanker companies, in addition to these inspections are subjected to inspections conducted by oil and chemical industries that ship the goods. In this study, effort is made to investigate the (common) defects by evaluating the inspection reports of SIRE (Ship Inspection Report Programme) and CDI (Chemical Distribution Institute) inspections conducted by Turkish Tanker Companies. The deficiencies detected from SIRE and CDI inspections are analyzed statistically and the contributing factors of these deficiencies are discussed.

Keywords: Maritime Safety, Oil/Chemical Tanker, Tanker Inspections

1. Introduction

Over 80 percent of global trade is transported seaborne and approximately 70 percent of the total value is carried by ships and handled by ports around the world. This fact requires emphasis on the importance of maritime trade and focus on the development [1].

Estimations by UNCTAD suggested that seaborne trade around the globe would increase by 2.8 per cent in 2017, which in turn would reach a total of 10.6 billion tons. In parallel to this increase, the shipping industry expands worldwide shipping traffic becomes even dense [2, 3]. Hence increasing number of vessels is likely to cause a proportional rise in marine hazards and accidents [4]. Akten (2006) states that marine shipping will be full of risks in the future as it is at the present irrespective of the increase in safety standards and improvements in the technology [5].

Flag state and port state authorities performs periodic inspections to make sure that ships are operated in compliance with national and international requirements. Actually, it is those periodic inspections which help ensuring that the ships are operated and managed safely.

As chemical tankers carry massive amounts of oil and chemical substances, any possible accident caused by them may result in dangerous spills and hence catastrophic consequences both for human life and environment. For this reason, tanker companies, as well as tanker ships are inspected by oil and chemical industries that ship the goods.

SIRE and CDI audits are the two main inspections through which tanker ships are assessed for any nonconformities. This study firstly aims to analyse the results of those audits to find out what areas in tanker shipping receives the most attention in terms of audits. The goal is made concrete by evaluating the number of remarks and the reasons for deficiencies causing those remarks. By doing so the study also aims to contribute to raising awareness on the risks and deficiencies in tanker shipping industry.

Within the course of the study, SIRE/CDI audit reports received from Turkish tanker companies are analyzed. For analysis purposes, the focus is set on the Vessel Inspection Questionnaires (VIQ 6, Edition 2014 Rev1.2) for Oil Tankers, Combination Carriers, Shuttle Tankers, Chemical Tankers and Gas Tanks. Likewise, for CDI analyses, Ship Inspection Report (SIR), Chemical Tanker Edition 2015 (8th Edition, Version 8.6) is used [6].

2. General Information about OCIMF, SIRE and CDI

OCIMF (Oil Companies International Marine Forum) is a voluntary association of oil companies. Following the 1967 Torrey Canyon incident, OCIMF was established in response to growing public concern about marine pollution. Since its establishment, the forum has been playing a great role in ensuring that tanker vessels and terminals comply with environmental and safety rules.

This forum contributes to safe management of the tanker shipping operations. Main goal of the forum is, first of all, to identify the problems related to tanker ships and terminals. Developing corrective standards as well as making them public through publications is the main way the forum uses for solving the problems encountered. It also contributes to construction of tankers and operation of the ships and terminals by contributing to contracts. One other important input by the forum is coordinating the efforts with IMO, regional and national institutions and organizations. Helping and promoting implementation of international agreements and regulations as well as organizing industry activities and forums to raise better awareness is another supportive ground OCIMF is working on. It also contributes to positively influencing industry stakeholders and helps sharing the experiences of the members [7].

In parallel to the aims and objectives set forth, OCIMF has produced many utilities and programs. One of the most important programs developed by OCIMF is the Ship Inspection Report Program (SIRE). OCIMF SIRE (2014) is composed of 13 chapters as can be seen below [8]:

Chapter 1 General Information

Chapter 2 Certification and Documentation

Chapter 3 Crew Management

Chapter 4 Navigation

Chapter 5 Safety Management

Chapter 6 Pollution Prevention

Chapter 7 Structural Condition

Chapter 8 Cargo and Ballast Systems

Chapter 9 Mooring

Chapter 10 Communications

Chapter 11 Engine and Steering Compartments

Chapter 12 General Appearance and Condition

Chapter 13 Ice Operations

Chemical Distribution Institute was established by the chemical industry in 1994 to improve the safety and quality performance of bulk liquid transport. The institute serves the chemical company members of CDI by providing their inspection and audit needs. For this purpose, CDI controls and inspects ports and terminals around the world. The institute, in order to provide the chemical industry with an independent audit system, performs training, qualification and accreditation of inspectors. Through the inspectors, CDI produces inspection and risk assessment reports required in chemical industry.

As one of the recent utilities of the institute, CDI Programme (3) consists of two parts. In part A, general information together with the basic instructions as to conduct of the audit is presented. Part B is mainly for declaring the inspection summary to include observations and remarks. Part B consists of 14 sections [6]:

A. General Information

B. Inspection Summary

1 Certification, Manning Etc.

2 Management and Personnel

3 Bridge

4 Mooring

5 Cargo Operations

6 Engine Department

7 Operational Safety

8 Health, Safety and Personnel Protection

9 Firefighting

10 Lifesaving

11 Environmental Protection

12 Security

13 Hull and Superstructure

14 Accommodation.

3. Analysis Results of Tanker Inspections

3.1. Results of SIRE Inspections

For companies, undergoing a SIRE inspection is important to exhibit their quality and compliance with the rules in force. Main concern of those companies, through good practices, is to keep the findings as minimum as possible and throughout the years progressively reduce the number of the findings of the inspections. Because each remark received during an inspection may create a problem that needs to be solved in the operation of a particular area.

In this section, the number of remarks received during SIRE inspections along the years are analysed and results are presented. Analysis focuses on the inclination of the number of remarks to check if they display either an increasing or decreasing manner along the

years. Figure 1 shows the average numbers of remarks obtained through SIRE inspections along the years.

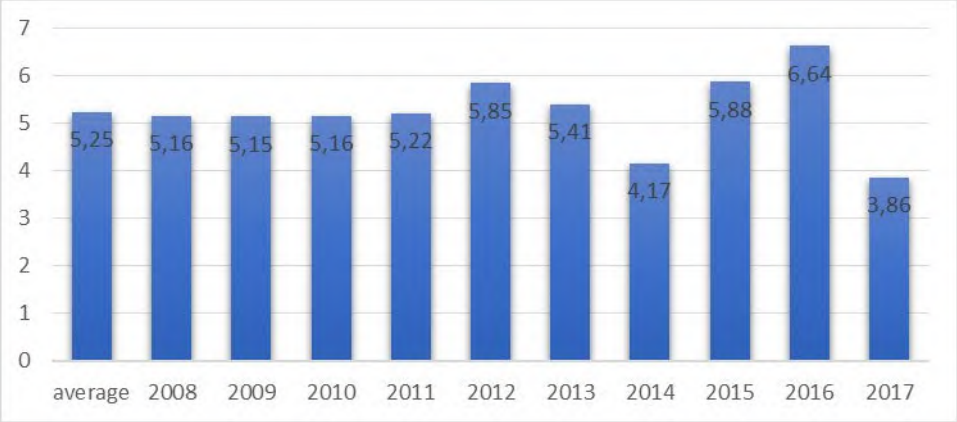

Figure 1. The average annual number of remarks between 2008 and 2017.

In Figure-1 the first column, with the value of 5.25, indicates the average remark rate of the last ten years. As the figures suggests, the ten-year-lowest-figure for findings of audits in the last decade is 3,86 in the year 2017 which is well below the ten-year-average. The highest value experienced in the last decade is found to be 6.64 in the year 2016. Between 2008 and 2011 average remark figures show a steady and almost equal values. Although the values seem to converge on almost equal figures, still the comments per each item of an inspection may differ from the others. The findings also indicate that the year 2015 has the second highest remark figure following 2016 by 0.63 difference above the ten-year-average figure. One other eye-catching issue is that, the year 2012 ranks as the third place with an average remark rate of 5.85 making the highest rate following four consecutive respectively low-rated years. Excluding the figures for the mentioned three specific years, it can be seen that there has been a general tendency of decreasing in the number of remarks along the years.

From the above figures, it can be deduced that SIRE inspections in general help reducing the non-conformities and deficiencies on board tanker ships. Especially after the ten-year-

highest remark figure in 2016, almost a fifty percent decrease in 2017 is a good evidence of this deduction.

As mentioned above, SIRE (2) reports have 13 chapters to cover. Table-1 below shows the remarks concerning those chapters as listed in VIQ (Vessel Inspection Questionnaire).

Table 1. Number of remarks according to VIQ chapters.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	1	0	2	8	2	3	0	1	0	0
2	5	19	12	11	15	5	5	8	5	3
3	5	11	7	11	11	8	8	4	8	5
4	4	4	7	11	7	10	8	9	5	10
5	9	20	20	10	18	16	22	12	16	9
6	4	5	3	4	8	6	4	6	9	6
7	0	0	0	0	0	0	0	0	0	0
8	8	8	13	5	6	9	9	10	13	5
9	7	9	7	16	11	13	10	11	9	6
10	1	2	2	0	2	3	1	1	0	2
11	30	19	26	10	21	12	9	19	21	9
12	8	7	2	13	11	7	5	7	5	2
13	0	0	0	1	14	1	2	5	0	1

Figures below are evaluated to show the percentages of the remarks for ease of preview. As understood from the chart in figure-2 below majority of remarks issued after SIRE inspections are related to chapter 11 (Engine and Steering Compartments) with 19 % and chapter 5 (Safety Management) with 16 %. Those issues serve as a guideline for the tanker companies to get them as the top priority to solve. Figure-2 below shows the percentages of cumulative remarks issued through SIRE inspections.

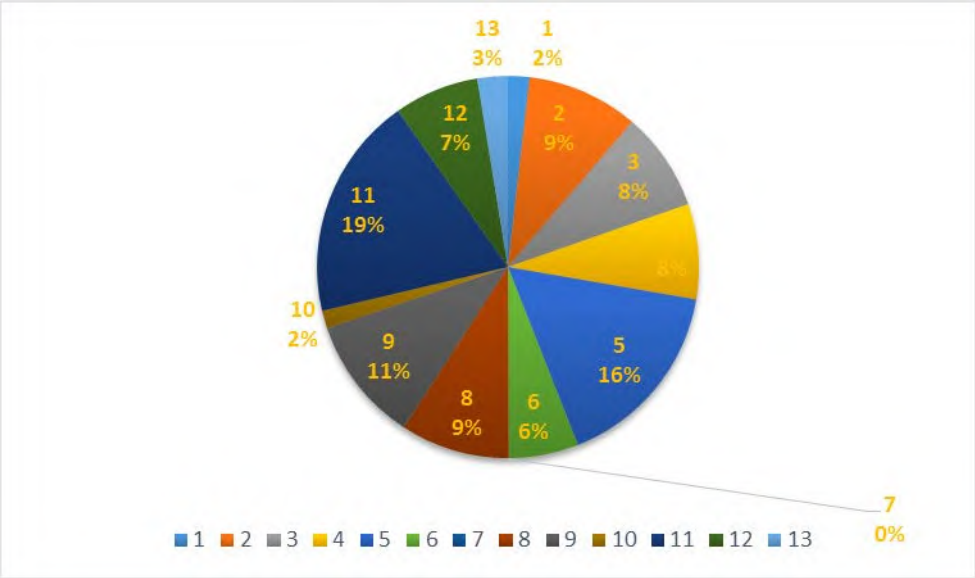

Figure 2. Percentages of remarks according to SIRE chapters.

Figure 3 below is another presentation of SIRE remarks to show numeric values. From the inspection reports inference is made to show that chapter 11 (Engine and Steering Compartments) and chapter 5 (Safety Management) are the sections which gets the first and second highest number of remarks respectively. From this perspective, it is evident that the tanker companies take the content of highly criticized chapters to sort out any shortages, non-conformities and deficiencies as soon as they can. This way they will have a valid and consolidated reference for their corrective actions till the upcoming SIRE inspections.

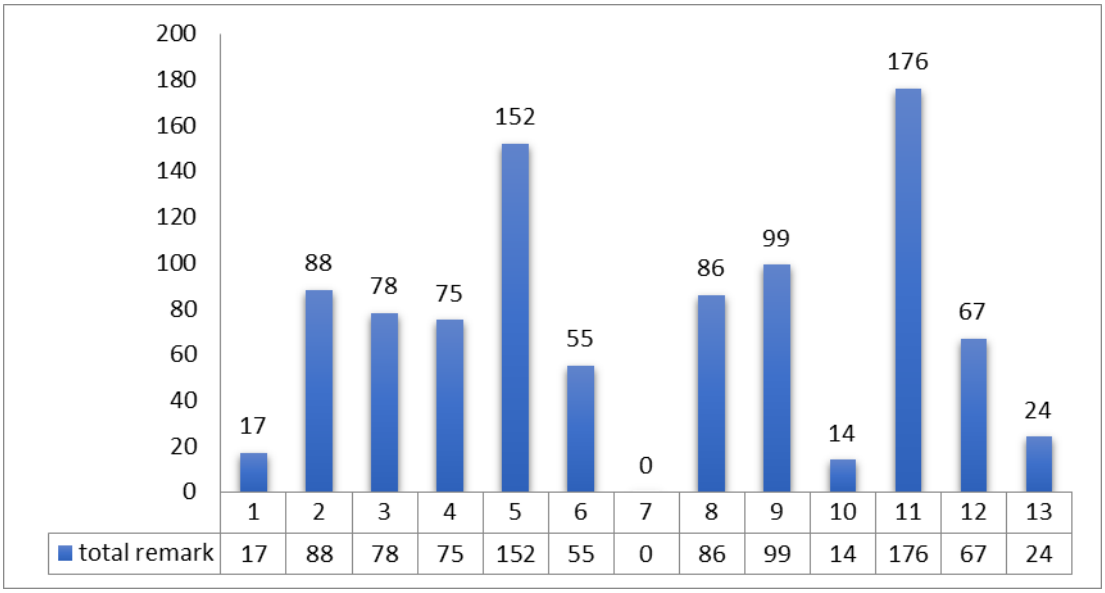

Figure 3. Total number of remarks with respect to SIRE chapters.

3.2. Results of CDI Inspections

Tanker companies, like SIRE inspections, make use of CDI inspections for assuring and raising their quality and compliance levels. Main aim for companies to seek for CDI inspection is to minimize the findings of the audits along the years. As it is the case with SIRE inspections, any remark received through CDI inspections may pose a problem for the company in that specific area of operation. This may even cause the tankers of a company to be assumed not eligible for carrying cargo it is designed to carry. This section focuses on brief numerical analysis of CDI inspections the same way it is done for SIRE inspections. The average numbers of remarks written through audits are analyzed along the years to assess the inclination as to decreasing or increasing in number. Figure 4 shows average number of remarks given to ships entering CDI inspections in the last ten years.

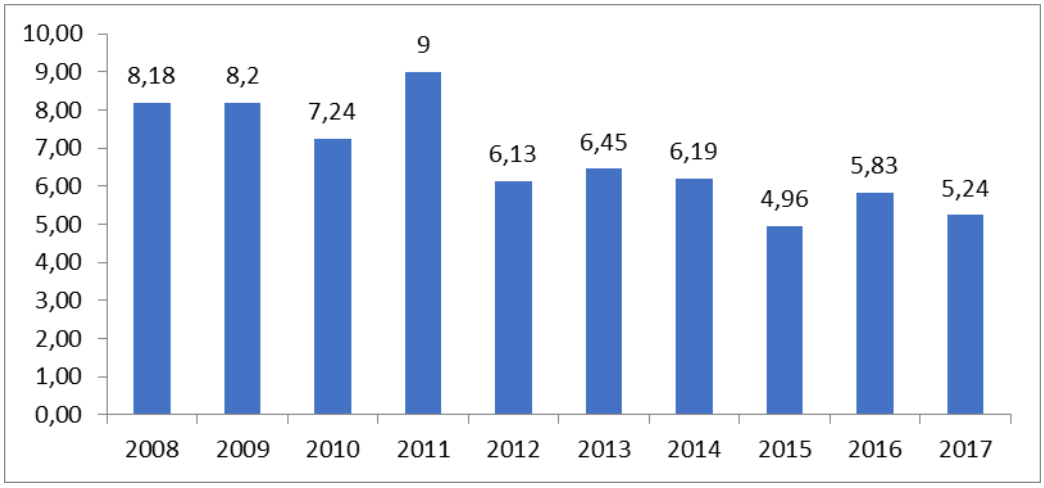

Figure 4. The average annual number of remark between 2008 and 2017.

The figure above shows brief summary of the results of the study performed. As average remark number in the last ten years is 6.74, the year 2015, with an average of 4.96, has the lowest remark figure of the audits done in the last decade. The decade highest figure is 9 in the year 2011. During the period from 2012 to 2014, remark figures are steady in the vicinity of 6.15 remaining below the ten-year-average. When compared to ten-year-average figure, the number of remarks has a tendency of decreasing after the year 2011which had the highest remark figure of the last decade.

This decreasing inclination is a good indication of how the CDI system helps companies to correct the deficiencies through years. Leaving the 2011 peak aside, the figures went from 8.18 average in the year 2008 down to 5.24 in 2017. This indicates almost a forty-five percent decrease in the number of remarks in the last ten years, which can be considered a satisfactory progress.

When remarks received during CDI inspections are compared to the remarks of SIRE inspections, the number of remarks received through CDI audits, although declining over the years, CDI remarks prove to be higher in quantity. Through the comparison, with forty-five percent improvement in CDI remarks, it can be deduced that CDI audits have a

better effect on the companies to rectify the deficiencies and to correct the non-conformities on board their ships.

In the CDI audit reports, the Part B, Inspection Summary is divided into 14 sub sections. The bar-chart figure below shows the number of remarks received in those sections. As the figures suggest, the highest quantities of remarks are in chapter 5 (cargo operations) with a figure of 277. Chapter 1 (certification, manning etc.) follows in the second place with 246 remarks. Comparing these figures with that of chapter 12 (security), which adds up to only 3 remarks, it can be understood how high the figures for the chapters 5 and 1 are.

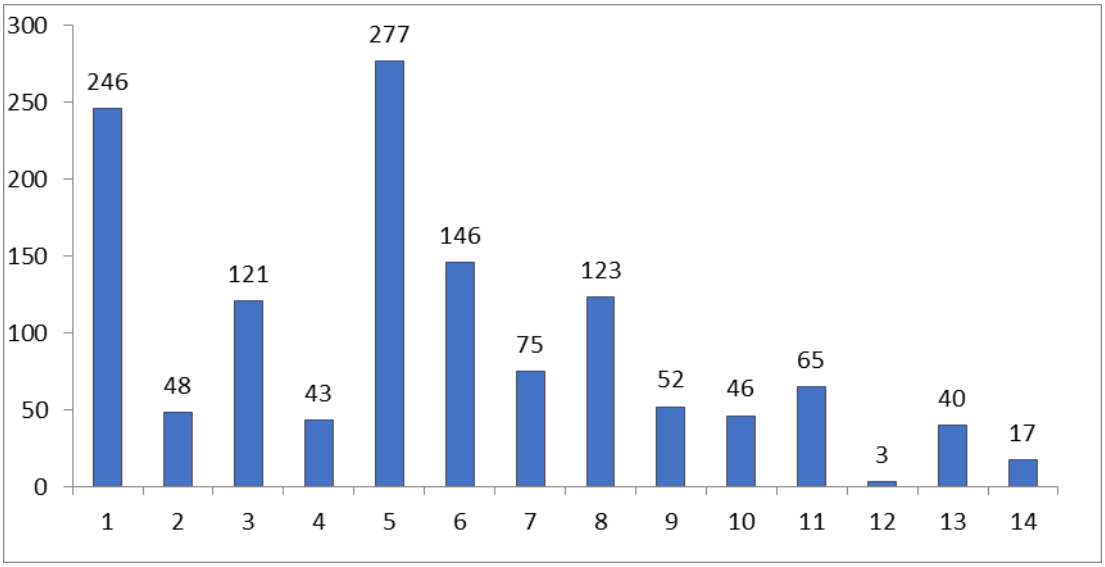

Figure 5. Number of remarks according to CDI chapters.

The lowest figure for Chapter 12 (security) with only 3 remarks indicates that companies pay sufficient attention for making their tankers comply with requirements of ISPS Code. However, chapter 1 (Certification), covering areas like bridge, engine department, health, safety and personnel protection with the second highest remark figure, still needs more attention of the companies on the respective issues.

4. Conclusion

In order for the tanker companies to take corrective actions for deficiencies and non-conformities CDI and SIRE inspection reports can be used as resourceful guidelines. After a careful analysis of inspection reports the content of remarks can be assessed to find and use respective remedies. This process, besides making companies and their vessels even more ready for operation, can also be used for pinpointing the issues which may lead to possible future accidents. So that necessary measures can be taken to eliminate the possible risks in the future. Hence statistically analyzing the results of inspection reports by classifying and quantifying the deficiencies and other shortcomings is deemed a valid method to contribute to safety of maritime tanker operations.

This study, through statistical analysis, quantitatively investigated deficiencies found in SIRE and CDI inspections conducted in tanker companies in Turkey. The data in hand is statistically evaluated in accordance with SIRE and CDI inspection booklets by separately classifying them in line with the items listed in those booklets.

Results of this study has shown that deficiencies found in tanker inspections have gradually decreased over the last 10 years. Actually SIRE and CDI inspections, in a sense, function as remedial closed loops for tanker companies. Oil and chemical tanker companies strive for keeping their ships in compliance with international regulations as well as keeping their commercial shipping privileges, surely helps reducing the deficiencies by time. Hence deficiencies and shortages are promptly rectified and as a consequence they will be able to pass those inspections with less number of remarks.

In the last decade, the greatest number of deficiencies fall under engine and steering areas in SIRE inspections and safety management comes in the second place. As to CDI inspections, the greatest number of deficiencies is about cargo operations. All though there is still way to cover for full success, still a reassuring point is that all of the remark figures have a tendency to decrease over the years, making the ships safer and companies better. This way, all the shortages and non-conformities will be minimized and corrective

measures either directly or indirectly will help minimizing the hazards and damages to human life and environment.

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The Proceedings *of GMC '19*

A Study on Turkish Maritime Trade Statistics

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ABSTRACT

In relation to maritime trade, the Turkish Ministry of Transport and Infrastructure keeps different types of statistical data regarding Turkish maritime trade. Although these data show a number of values on their own, it is not possible to understand the changes in maritime trade without being subjected to statistical analysis with a holistic approach. In this study, the maritime trade data with a large number of different variables are analyzed and significant changes in recent years are presented.

Keywords*:* Maritime, Maritime Trade, Data Analysis.

Türk Deniz Ticareti Verileri Üzerine Bir İnceleme

ÖZET

Deniz ticareti ile ilgili olarak T.C. Ulaştırma ve Altyapı Bakanlığı tarafından, deniz ticaretine konu olan farklı türde veriler tutulmaktadır. Bu veriler kendi başlarına birtakım değerler gösterseler de bütüncül bir yaklaşımla istatistik analizlere tabi tutulmadan deniz ticaretindeki değişimlerin anlaşılması mümkün değildir. Bu çalışmada, çok sayıda farklı değişkene sahip deniz ticareti verileri bütünsel olarak analiz edilerek, ülkemiz deniz ticaretinin son yıllardaki önemli sayılabilecek değişimleri ortaya konmuştur.

Anahtar Kelimeler*:* Denizcilik, Deniz Ticareti, Veri Analizi.

1. Giriş

Deniz taşımacılığı zinciri, taşıyıcıların ve limanların bu ağ üzerinden kargonun (nakliyeciler tarafından sağlanan) taşınması için hizmet sağladığı bir ağdır. Deniz taşımacılığı zincirinin var olması için üç tarafın (taşıyıcılar, limanlar ve nakliyeciler) bu zincirin seçimi ile uyumlu olması gerekmektedir [1].

Yüklerin hareketine taşıyıcılar, limanlar ve nakliyeciler dahil edildiğinde, bir deniz taşımacılığı ağı ya da zinciri oluşturmaktadır [2].

Küresel deniz ticaretine etki eden faktörler arasında küreselleşme, dış ticaret, petrol fiyatları, finansman, navlun giderleri ve mali krizler sayılabilir. Bunların içinde denizcilik sektörünü en çok etkileyen 2008 küresel mali krizidir [3].

Tedarik zincirinin küreselleşmesiyle birlikte kıtalararası taşımacılık önemli bir bileşen haline gelmiştir. Lloyd' s Marine Intelligent Unit tarafından 2009 yılında kapsamlı bir araştırmaya göre dünya ticaretinin çoğunluğunun deniz yoluyla taşındığı (hacmen %75 ve değer olarak %60); deniz taşımacılığı sektöründe (tanker, kuru yük, konteyner ve genel kargo dahil), yüklerin değerinin %52' sinin konteyner gemileri tarafından taşındığı belirtilmiştir [4].

İlk olarak devlet bilimi anlamında ortaya çıkan istatistik uygulamaları sayesinde bir konu ile ilgili elde edilen ham veri işlenerek anlamlı bilgiye dönüştürülmektedir. İstatistik işlemler sonucunda elde edilen bilgi ve çıkarımlar, karar vericilerin kullandığı çok değerli araçlardır.

İstatistik verinin oluşturulması için anketler, ölçüm araçları, kayıt altına alma, deneyler kullanılabilir. Kendi oluşturduğumuz verinin yanı sıra, belli başlı kurumlar tarafından oluşturulup yayınlanan ve ikincil veri olarak adlandırılan veriler de istatistik analizlerde sıkça kullanılmaktadır.

Elde edilen verilerin hepsi aynı özelliğe sahip olmayıp, verinin işlenebilirliği açısından farklı türlere sahiptir. Veri türlerine bağlı olarak ta yapılabilecek istatistik analizlerin türleri değişmektedir. İstatistik yöntemlerle betimleyici ve çıkarımsal olmak üzere

temelde iki türlü analizler yapılarak, çoğu zaman bilinmeyen bağımsız değişkenlerin karmaşık etkileriyle bir sonuç olarak elde edilen verinin arkasında yatan işleyiş gün yüzüne çıkarılmaya çalışılmaktadır.

TC Ulaştırma ve Altyapı Bakanlığı, Deniz Ticareti Genel Müdürlüğü bünyesinde, deniz ticareti ile ilgili olarak, acente istatistikleri, geçmiş yıllarda tutulmuş ancak şu an devam etmeyen verilere ait arşiv, deniz kazaları verileri, deniz ticaret filosu istatistikleri, liman devleti denetimleri kapsamındaki gemi denetim istatistikleri, yeni inşa, tersane ve gemi söküm ile ilgili gemi inşa sanayine ait istatistikler, limanlara uğrayan gemi sayı ve tonajına ait istatistikler, kabotaj hattı yük ve yolcu taşımacılığına ait veriler, konteyner taşımacılığına ilişkin veriler, kruvaziyer turizmi verileri, deniz taşımacılığını teşvik amaçlı uygulanan Özel Tüketim Vergisi (ÖTV) sıfırlanmış deniz yakıtı istatistikleri, Ro-Ro araç taşıma istatistikleri, Çanakkale ve İstanbul Boğazı' ndan geçen gemi sayıları ile limanlarımızda işlem görmüş yük türü ve miktarına bağlı istatistikler bulunmaktadır. Bu verilerden bazıları her yıl için tutulurken, örneğin gemi acenteleri gibi bazı konularda belli bir tarih için veri bulunmaktadır. Arşiv verileri ise, bölgeler ve liman başkanlıkları bazında yük elleçleme miktarları, Türk deniz ticaret filosunun yıllara göre değişimi, ülkemiz deniz ticaret filosunun dünya sıralamasındaki konumu ile ilgili 1997-2010 yılları arasındaki istatistikleri içermektedir [5].

Bu çalışmanın amacı T.C. Ulaştırma ve Altyapı Bakanlığı tarafından 2000' li yılların başından itibaren tutulan kapsamlı deniz ticareti verilerini inceleyerek, günümüze gelinceye değin ülkemiz deniz taşımacılığında meydana gelen önemli değişimleri ortaya koymaktır.

2. Deniz Ticareti Verilerinin Analizi

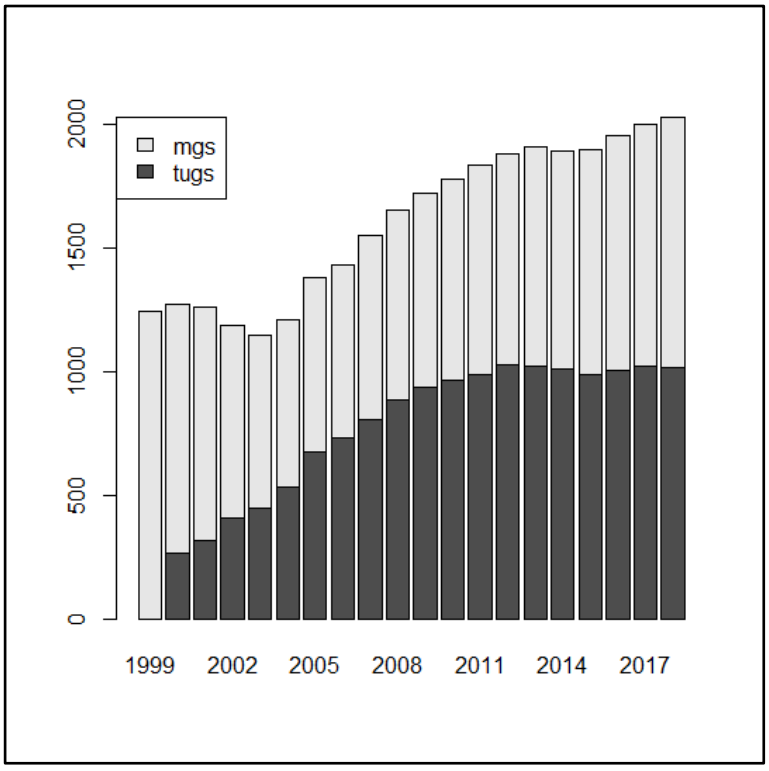
Deniz ticareti verilerinin analizinde, Deniz Ticareti Genel Müdürlüğü tarafından, geçmişten günümüze tutulan veriler değerlendirilerek, deniz ticaretinin gidişatı hakkında bilgi oluşturulmaya çalışılacaktır.

2.1. Türk Deniz Ticaret Filosu

Deniz ticareti filosuna ait istatistikler 150 grt ve 300 grt üzerindeki gemilere ait istatistikler tutulmaktadır. Doğal olarak, 150 grt ve üzerindeki gemilerin istatistikleri 300 grt ve üzerindeki gemi istatistiklerini kapsamaktadır. Her iki tür istatistikte gemi türleri 10' lu ve 30' lu gruplar olarak verilmektedir. Gemi türleri 30' lu grupta daha ayrıntılı olarak gruplandırılmıştır.

Deniz ticaret filosuna ait güncel istatistiklerde 150 grt ve üzerindeki gemiler için 2010 yılı sonrasında gemi türüne göre gemi adedi ve tonajı, 1999 yılı sonrasında TUGS ve Milli Gemi Sicili' ne kayıtlı gemilerin adedi, tonajı ve dwt' si ile gemilerin yıllar itibariyle yaş ortalaması bulunmaktadır.

Tonajı 300 grt ve üzerindeki gemilerde sadece yıllara göre adet ve tonaj değişimleri bulunmaktadır. Şekil 1' de, TUGS ve Milli Gemi Sicili' ne kayıtlı gemilerin yıllara göre değişen adetleri görülmektedir.



Şekil 1. Milli Gemi Sicili ve TUGS' a kayıtlı gemi sayıları [5].

2.2. Gemi İstatistikleri

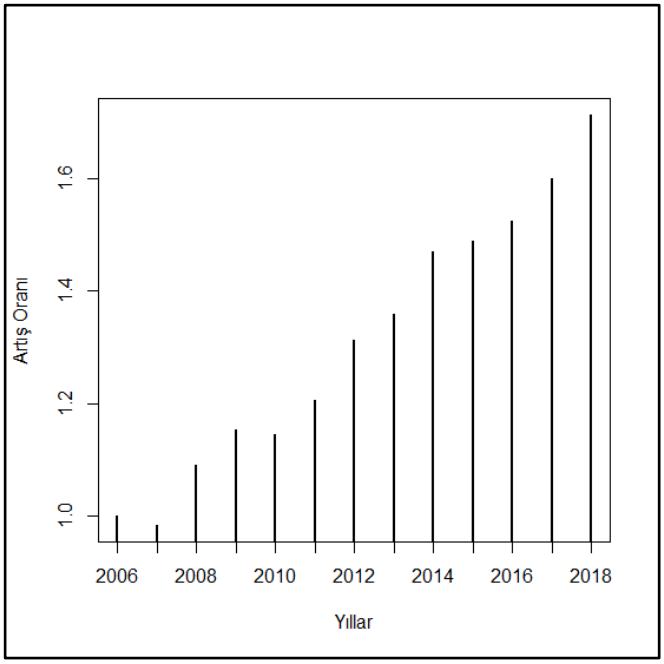
Deniz Ticareti Genel Müdürlüğü' nün gemi istatistiklerinde Türk limanlarına uğrayan gemi sayıları tutulmaktadır. 2011 yılında limanlarımıza uğrayan gemi sayısı 75.134 ve toplam tonaj 697 milyon grt iken, bu rakam 2018 yılında 72.360 ve toplam tonaj 816 milyon grt olarak gerçekleşmiştir [5]. Gelen gemi sayısının azalmasına rağmen toplam tonajın artması, gelen gemilerin yılda yıla ortalama tonajının artmakta olduğunu göstermektedir.

2.3. Türk Boğazları Gemi Geçiş İstatistikleri

Türk Boğazları; İstanbul Boğazı (17 Nm), Marmara Denizi (110 Nm) ve Çanakkale Boğazı (37 Nm)' ndan oluşan bölgedir. Asya ve Avrupa kıtalarını ayıran Türk Boğazları, dünya deniz ticaretinde önemli yeri bulunmaktadır [6].

1996-2011 yılları arasında Türk Boğazları' ndan geçen gemi sayılarında azalma görülürken, geçen gemi tonajı artmaktadır. Bu durum, Türk Boğazları' ndan yıllar itibariyle gittikçe daha büyük tonajlı gemilerin geçmekte olduğunu ve olası deniz kazalarında can, mal ve çevre açısından daha büyük riskler oluşturacağını göstermektedir [7].

Bakanlık verilerinde Türk Boğazlarında geçen gemi sayıları 2006 yılından itibaren aylara ve gemi türlerine göre tutulmaktadır. Veride gemi adedinin yanı sıra, toplam tonaj, kılavuz kaptan alan gemi sayıları, geçiş yapan tanker gemisi sayıları, uğraksız geçiş yapan gemiler hakkında kayıtlar da bulunmaktadır. Şekil 2' de 2006-2018 yıllarında İstanbul Boğazı' ndan geçen gemilerin ortalama tonajının yıllar itibariyle artış oranı gösterilmektedir.



Şekil 2. İstanbul Boğazı' ndan geçen gemilerin ortalama tonaj artışı [5].

2.4. Yük İstatistikleri

Yük limanı, yükün denize hareket ettiği alandır. Limanın kara tarafı hinterlandıdır, yani belirli bir limandan geçen trafik akışlarını oluşturan yük varış noktasının dağılımıdır [8].

Liman hizmetleri bir dizi sağlayıcı tarafından verilmektedir: (1) liman operatörü, (2) nakliyecinin yükü için liman hizmetleri sağlayan nakliyeci üçüncü taraf brokerleri (örneğin, nakliye şirketi, üçüncü taraf lojistik sağlayıcısı ve gümrük komisyoncusu) limandayken; (3) nakliye hattı acenteleri, yani, limandayken, gemilere (gemi sahiplerine ve kiraya verenlere) liman hizmetleri sunan üçüncü taraf brokerleri; (4) bir gemi ustasına, geminin limanın limanına ve rıhtımına ve limanından hareketinde yardımcı olan liman pilotları; (5) römorkörlerini, bir limanın rıhtımına (veya rıhtımına) veya rıhtıma gelen gemilerin yanaşması ve yanaşmaması için kullanan gemi şirketleri ve (6) bir limanın ülkeye giriş için ithal ettiği kargoları temizleyen devlet gelenekleri [9].

Denizcilik ile ilgili literatür, liman kullanıcılarının (taşıyıcılar ve nakliyeciler) denizcilik tedarik zinciri yerine, limanları seçtiklerini varsaymaktadır. Bununla birlikte, liman kullanıcıları bir liman seçmeyebilir, "portun kritik bir unsur olarak yerleştirildiği liman odaklı bir tedarik zinciri" seçebilir [10]. Limanlar, diğer değere dayalı zincir sistemleriyle rekabet eden, değer odaklı bir zincir sisteminin bir parçasıdır [11].

Deniz taşımacılığında kullanılan en önemli endekslerden bir tanesi, Baltık Kuru Yük Endeksi (Baltic Dry Index – BDI)' dir. Türkiye' nin 2000-2018 yılları arasındaki toplam ithalat ve ihracat rakamları ile BDI arasındaki nedensellik araştırmalarının sonucuna göre, BDI' dan ithalat ve ihracata doğru bir nedensellik tespit edilmiştir, yani BDI değiştiğinde Türkiye' nin ithalat ve ihracatı değişmektedir. Ancak tersi yönde bir nedensellik bulunmamaktadır [12].

Tablo 1' de, 2004 ve 2018 yıllarında Türkiye' nin denizyoluyla en fazla ithalat ihracat yaptığı ilk beş ülke listelenmektedir.

Tablo 1. 2004-2018 Türkiye Denizyolu Toplam İthalat İhracat Ülkeler (mton) (DTGM, 2019).

Sıra	2004	2018
1	Rusya Fed. 22,3	Rusya Fed. 46.4
2	Ukrayna 18,5	ABD 20,6
3	İtalya 16,6	Mısır 20,3
4	Mısır 14,9	Kolombiya 19,5
5	Yunanistan 9,8	İtalya 18,5

Tablodan anlaşılacağı üzere, Türkiye özellikle kendi bölgesindeki ülkelerle yoğun ticari ilişkilere sahiptir. Yıllar itibariyle değişime bakıldığında, 2004' ten 2018 yılına gelindiğinde, Rusya Federasyonu ile yapılan denizyolu yük taşımacılığının önemini koruduğu, Ukrayna' nın yerini Amerika Birleşik Devletleri' nin aldığı, 2004 yılındaki

toplam ithalat-ihracat rakamlarına göre 20. sırada bulunan Kolombiya ile ticaretin beklenmedik şekilde artarak 4. sıraya yükseldiği görülmektedir. Türkiye' nin deniz ticaretinin büyük oranda kendi bölgesindeki ülkelerle veya dünyanın gelişmiş ekonomileriyle yaptığı göz önüne alındığında, her iki kritere de uymayan Kolombiya ile deniz ticaretinin en üst sıralara yükselmesi dikkat çekicidir. Yunanistan 2018 yılında 6. sırayı 18,3 milyon ton ile korumaktadır.

2.5. Konteyner İstatistikleri

Konteyner trafiği 1990 yılında yaklaşık 85 milyon TEU' dan yıllık %9,3 büyüme oranı ile 2013 yılında 651 milyon TEU' ya yükselmiştir. Yüklerin konteyner ile taşınması, nakliye maliyetini büyük ölçüde düşürmüş ve küresel tedarik zincirine önemli ölçüde katkıda bulunmuştur. Tüketici ürünleri birimi başına nakliye maliyeti sadece raf fiyatlarının yaklaşık%1' ini oluşturmaktadır [13].

Navlun talep değişkenleri (Bayliss, 1988) tarafından tanımlanıp ölçülmesine karşın, deniz konteyner taşımacılığının talep değişkenlerinin çeşitli tanımları literatürde devam etmektedir. Bu değişkenler üç ana sınıfa ayrılabilir: verim (throughput), aktarma (transhipment) ve çıkış-varış yeri akışı (origin-destination flow) [14-15].

Türkiye' de 2012-2016 yılları arasında ticaret dengesizliği ve ticaret dengesizliği harici boş konteyner hareketlerinin miktarları incelendiğinde, 20 feet ve 40 feet konteynerlere ilişkin olarak ticaret dengesizliği, toplam dolu konteyner hareketinin sırasıyla %31 ve %17' sini oluştururken, ticaret dengesizliği harici boş konteyner hareketi dolu hareketin %20 ve %26' sına denk gelmektedir [16].

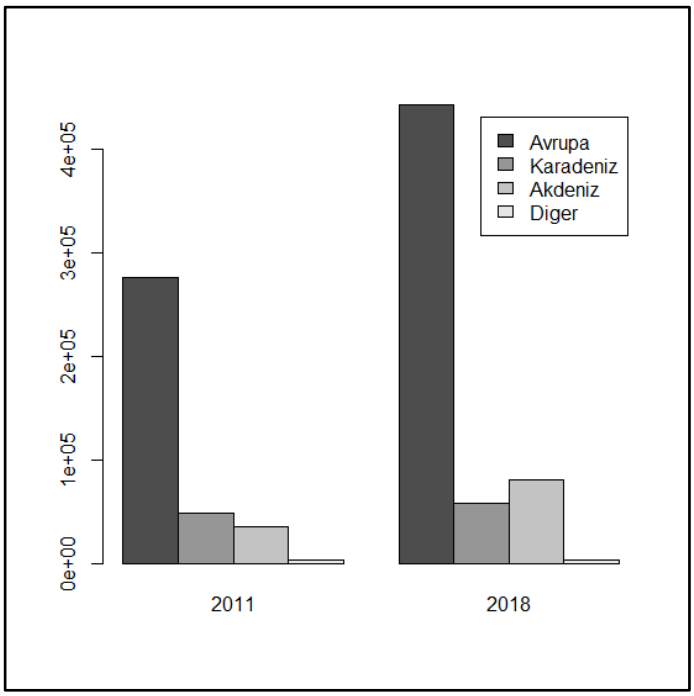
Türkiye limanlarında elleçlenen konteyner miktarı 2004 yılında toplam 3,1 milyon TEU iken, bu rakam 2018 yılında 10,8 milyon TEU' ya yükselmiştir [5].

2.6. Ro-Ro ve Araç-Otomobil İstatistikleri

Ro-Ro gemileriyle hem yük taşıyan araçlar hem de yeni araç ve otomobiller taşınmaktadır. Ro-Ro ve Araç-Otomobil istatistikleri Bakanlık tarafından 2011 yılı ve sonrası için yayınlanmıştır.

Ro-Ro taşımacılığı ülkemizde Avrupa, Karadeniz, Akdeniz ve diğer bölgelerle yapılmaktadır. Ro-Ro taşımacılığında yük taşıyan araçlar genellikle gittikleri bölgelerden dönüş yaptıklarından, aynı bölge için ülkemize gelen ve giden araç sayısı birbirine yakın olmaktadır.

Şekil 3' te, ülkemizin 2011 ve 2018 yıllarında Avrupa, Karadeniz, Akdeniz ve diğer bölgelerle yaptığı toplam Ro-Ro taşımacılığı miktarı gösterilmektedir.



Şekil 3. Ro-Ro taşımacılığı (adet) [5].

2011 yılında ülkemizden tüm bölgelere gelen ve giden Ro-Ro taşımacılığı 362.958 iken, bu rakam 2018 yılında 583.580' e yükselmiştir. Akdeniz bölgesine yapılan Ro-Ro taşımacılığı 2011 yılında 3. sırada iken, 2018 yılında 2. sıraya yükselmiştir.

Tablo 2' de, ülkemize 2011 ve 2018 yıllarında gelen ve giden araç ve otomobil sayıları gösterilmektedir.

Tablo 2. Araç-Otomobil Taşımacılığı (adet) [5].

Yıl	Gelen	Giden	Toplam
2011	594.049	798.697	1.392.746
2018	438.163	1.340.362	1.778.525

Araç ve otomobil taşımacılığına bakıldığında, 2011 yılından 2018 yılına yaklaşık %28' lik bir artış söz konusudur. 2011 yılında giden araç sayısı gelen araç sayısının 1,34 katı iken, 2018 yılında bu oran 3.06 katına ulaşmıştır.

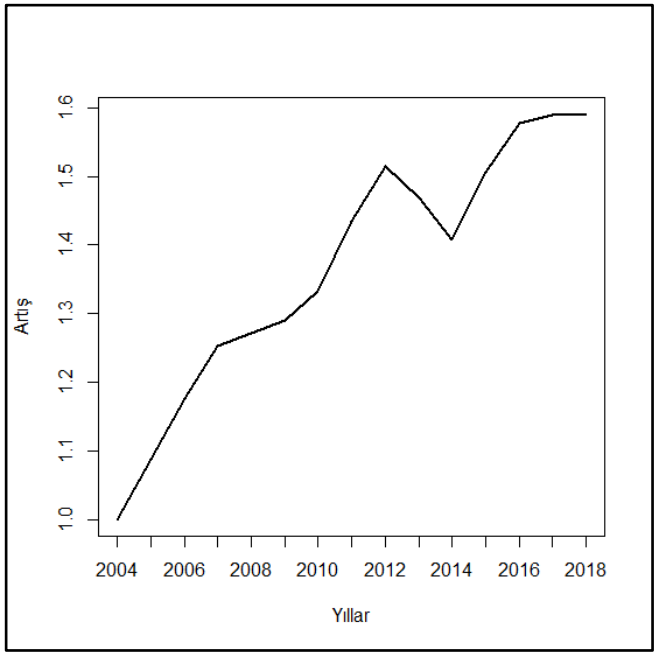
2.7. Kabotaj Hattı İstatistikleri

Kabotaj hattı istatistiklerinde Türk limanları arasında taşınan araç ve yolcu sayıları bulunmaktadır. 2003 yılında toplam taşınan araç sayısı 6,2 milyon iken, 2018 yılında 13,2 milyona çıkmıştır. Yine 2003 yılında 99,8 milyon yolcu taşınırken, 2018 yılında 139,6 milyona ulaşmıştır [5].

2.8. ÖTV' siz Yakıt İstatistikleri

01.07.2003 tarih ve 2003/5868 sayılı Bakanlar Kurulu Kararı ile; Türk Uluslararası Gemi Siciline (TUGS) ve Milli Gemi Siciline (MGS)' ye kayıtlı, kabotaj hattında yük ve yolcu taşıyan gemilere miktarı her geminin teknik özelliklerine göre tespit edilmek ve geminin jurnaline işlenmek kaydıyla verilecek akaryakıtın özel tüketim vergisi (ÖTV) tutarı sıfıra indirilmiştir [17].

2004 yılından itibaren verilen ÖTV' siz yakıt miktarındaki artış oranları Şekil 4' te verilmektedir. 2018 yılında verilen yakıt miktarı, yıllar itibariyle artarak 2014 yılının 1,6 katına ulaşmıştır.



Şekil 4. ÖTV' siz yakıt miktarındaki artış oranı [5].

2.9. Gemi İnşa Sanayi İstatistikleri

Faal tersanelerin proje kapasitelerin veride sehven 2002 yılında başladığı düşünülmektedir. Çünkü bu veri yıllık olarak tutulmakta ve ilk veri 2002'den sonra 2005 yılından itibaren düzenli olarak tersane kapasitelerin göstermektedir. Bu çalışmada verinin 2004 yılından başladığı kabul edilmiştir. 2018 yılı itibariyle faal tersane sayısının 78 olduğu belirtilmektedir. 2004 yılında 14.700 kişi olan tersane istihdamı, 2017' de 27189' a yükselmiştir. Aynı yıllar arasında tersane kapasitesi 0,55 milyon dwt/yıl' dan, 4,44 milyon dwt/yıl' a çıkmıştır. Toplam 78 tersanenin 28 tanesi İstanbul' da 26 tanesi Yalova' da 9 tanesi Zonguldak' ta, 5 tanesi İzmit' te, 3 tanesi Trabzon' da 2 tanesi Çanakkale' de ve birer tanesi de Kastamonu, Samsun, Ordu, Adana ve Hatay' da bulunmaktadır [5].

2.10. Gemi Denetimleri

Gemi denetimleri Liman Devleti Kontrolleri (Port State Control) kapsamında, Türk limanlarına gelen yabancı bayraklı gemilere yapılmaktadır. Türkiye bu denetimleri

Akdeniz MOU ve Karadeniz MOU kapsamında gerçekleştirmektedir. Aynı şekilde Türk Bayraklı ticari gemiler de gittikleri limanlarda o ülkenin tabi olduğu MOU kapsamında denetlenmektedir.

Tablo 3' te, Karadeniz ve Akdeniz MOU kapsamında yapılan gemi denetimleri sonucunda tutulan gemi sayıları görülmektedir.

Tablo 3. Karadeniz ve Akdeni MOU kapsamında tutulan gemi sayıları [5].

Yıl	Karadeniz MOU		Akdeniz MOU	
	Denetim	Tutulma	Denetim	Tutulma
2006	216	37	1.772	467
2018	401	17	1.430	51

Tablodan anlaşıldığı üzere, 2006 yılından 2018 yılına gelindiğinde Karadeniz MOU kapsamında denetim iki katına çıkarken, tutulan gemi sayısı yaklaşık olarak yarıya düşerken, Akdeniz MOU' da denetlenen gemi sayısı az bir miktar azalmasına karşın, tutulan gemi sayısı 9' da 1' e gerilemiştir. Bu durum, liman devleti denetimlerinin gemilerin performansında iyileşmeye neden olduğunu göstermektedir.

Paris MOU kapsamında denetlenen Türk gemilerinin durumuna bakıldığında, 2003 yılında 749 denetimin 131' inde tutulan gemilerimiz, 2018 yılındaki 304 denetimin sadece 7 tanesinde tutularak, 2008 yılından itibaren içinde bulunduğu Beyaz Bayrak listesindeki yerini korumuştur [5].

2.11. Deniz Kazaları

2013 yılından itibaren bulunan deniz kazaları icmal tablolarına göre, 2016 sonrası verilerde özellikle Marmara ve Ege Bölgesi' ndeki kaza olaylarında anormal artışlar görülmektedir. Bu artışın sebebi yasadışı göç olayları olması sebebiyle, 2017' de kaza verileri düzensiz göç olarak ayrıca belirtilmeye başlanmış, 2018 itibariyle de kaza verileri

köklü bir değişim göstererek bölgeler bazında değil, olay türü bazında tutulmaya başlanmıştır. Bundan başka, arama kurtarma gerektiren ve gerektirmeyen olaylar şeklinde ayrılarak yasadışı göçmen olayları ayrıca değerlendirmeye alınmıştır. 2013' ten 2018' e kadar toplam 982 deniz kazası meydana gelmiştir. Bu kazalarda 334 kişi hayatını kaybetmiş, 186 kişi kaybolmuş ve 15.925 kişi kurtarılmıştır [5].

3. Sonuçlar

Yıllar bazında tutulması gereken verilerin kendi içinde tutarlı olması ve bu sayede yıllık değişimlerin sağlıklı bir şekilde izlenebilmesi için, veri yapısının değişmeden sürdürülmesi gereklidir. Örneğin, deniz kazaları ile ilgili verilerde son yıllarda yaşanan göçmen kaçakçılığı olayları istatistikleri olağan dışı etkilemiştir. Bu sebeple deniz kazalarına ait veri yapısı birkaç yıl içinde tamamen değişmiştir. Bu gibi durumlarda sağlıklı bir analiz yapılması, verinin bilgiye dönüşmesi ve uygun kararların alınması zorlaşmaktadır. Bu sebeple konu ile ilgili meydana gelebilecek her türlü ihtimal göz önünde tutularak tutarlı bir veri yapısı ve içeriği belirlenmeli, uzun süreler boyunca bu yapı değiştirilmemelidir. Aynı şekilde, her yıl girilen bir veri kaydının kendi içinde tutarlı olması gereklidir. Örneğin bir ülke ile ilgili veri girişinde ülkenin isminin farklı yıllarda farklı şekillerde (farklı dilde ya da kısaltma olarak) girilmesi veri analizini güçleştirmektedir.

Türk deniz ticaret sektörü ile ilgili Bakanlık tarafından tutulan veriler ışığında, 2000' li yılların başlarından günümüze denizyoluyla taşınan yük miktarı başta olmak üzere tüm istatistiklerin katlanarak arttığı söylenebilir.

Bir başka önemli konu da deniz ticaretinin başta mali krizler olmak üzere küresel ve bölgesel politikalardan doğrudan etkilenmesidir. Denizyoluyla yapılan taşımacılık rakamları, ülkemizin deniz ticaretinin büyük bölümünü genellikle bölge ülkeleriyle gerçekleştirdiğini göstermektedir.

Son olarak, yıllar itibariyle ülkemiz limanlarına uğrayan ve Türk Boğazları' ndan geçen gemilerin ortalama tonajlarının yıllar itibariyle artmaktadır. Bu da önemli su yollarından biri olan Türk Boğazları' nda ve liman bölgelerimizde olası deniz kazalarının can, mal ve

çevre açısından daha fazla risk oluşturabileceği anlamına gelmektedir. Diğer taraftan gemi tonajlarının artması da denizyoluyla taşınan yüklerin birim taşıma maliyetlerinin azalmasını sağlamaktadır.

4. Teşekkür

Bu çalışma Bandırma Onyedi Eylül Üniversitesi Bilimsel Araştırma Projeleri Koordinasyon Birimi tarafından desteklenmiştir. (This work was supported by Scientific Research Projects Coordination Unit of Bandırma Onyedi Eylül University). Proje No: BAP-19-1009-027.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

The Effect of Piracy on Maritime Transportation

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ABSTRACT

The share of maritime transport in world trade is very high. This rate continues to increase today. Sea piracy, which is a threat and risk in maritime transportation, is important rather than the positive aspects it creates in the transportation sector.

Sea bandit attacks Somalia, Gulf of Aden, South East Asia. And it has become increasingly complex and violent. These attacks have negative consequences in many ways. International organizations have been established in order to eliminate these negative results and increase security measures. In addition, the legal rules were evaluated in terms of criminal sanctions. Within the scope of maritime piracy, military forces, especially the EU and NATO, have created a fighting environment.

The aim of this study is to show the effects of sea piracy attacks in maritime transport. The countries where sea bandits were seen based on the years 2013-2017 and the weapons they used were considered as a table. Suggestions for solution of these deficiencies are explained.

Keywords: Sea Freight, Naval Guard, Somalia, BMDHS

Denizyolu Taşimaciliğinda Deniz Haydutluğunun Etkileri

ÖZET

Dünya ticaretinde denizyolu taşımacılığının payı oldukça yüksektir. Bu oran günümüzde artmaya devam etmektedir.

Taşımacılık sektöründe yarattığı olumlu yanlardan ziyade denizyolu taşımacılığında tehdit ve risk içeren deniz haydutluğu önem arz etmektedir. Deniz haydutluğu saldırıları genellikle Somali, Aden Körfezi, Güney Doğu Asya da görülmektedir. Ve gittikçe daha karmaşık ve şiddetli olmaya başlamıştır. Yapılan bu saldırılar birçok yönden olumsuz sonuç doğurmaktadır. Bu olumsuz sonuçların giderilmesi ve güvenlik önlemlerin arttırılması maksadıyla uluslararası örgütler kurulmuştur. Ayrıca hukuki kurallar cezai yaptırımlar açısından değerlendirmeye alınmıştır. Deniz haydutluğu kapsamında AB ve NATO başta olmak üzere askeri güçler mücadele ortamı oluşturmuşlardır.

Bu çalışmanın amacı, denizyolu taşımacılığında deniz haydutluğu saldırılarının etkisini göstermektir. 2013-2017 yılları baz alınarak deniz haydutluğunun görüldüğü ülkeler, kullandıkları silahlar tablo halinde ele alınmıştır. Söz konusu eksikliklerin giderilmesine ilişkin çözüm önerileri açıklanmıştır.

Anahtar Kelimeler: Denizyolu Taşımacılığı, Deniz Haydutluğu, Somali, BMDHS

1. Giriş

Dünya ticaretinde denizyolu taşımacılığı, maliyetlerin diğer taşıma türlerine nazaran daha az olmasıyla aynı zamanda yük taşıma kapasitesinin fazla olmasıyla tercih edilme sebebidir. Günümüzde ticaretin %90'ı denizyolu taşımacılığı ile gerçekleşmektedir [14].

Dünya ticaretinin artmasıyla birlikte orantılı olarak denizyolu taşımacılığında taşınan malların güvenliği en önemli unsurdur. Limanlarda her geçen zaman da konteyner elleçme oranlarının artması potansiyel güvenlik tehditlerinin kaynağını oluşturur. Deniz haydutluğu, devlet ile hiçbir bağlantısı olmadan özel şahısların veya örgütlerin gemileri ile birlikte başka gemilerdeki mallara, insanlara karşı menfaat sağlamak amacıyla şiddet içeren saldıralar dahil olmak üzere hukuk dışı tüm faaliyetleri kapsamaktadır. Herhangi bir ticaret gemisine yapılmış olan saldırının yarattığı etkiler dünya ekonomisini de olumsuz etkileyecektir. Teslimatta gerçekleşen gecikmeler, gemi yüklerinin kaçırılması fiyatların ve mali kayıplarının artmasına yol açmıştır [44].

Deniz haydutluğunu önlemek ve buna karşın korunma faaliyetlerine katılan birçok örgüt bulunmaktadır. Başta Uluslararası Denizcilik Örgütü (IMO) olmak üzere Baltık ve Uluslararası Denizcilik Meclisi (BIMCO), Uluslararası Kulüp Grubu (IGP&I), Uluslararası Denizcilik Bürosu (IMB) deniz haydutluğuna karşı güvenlik önlemlerini arttırmak ve bu saldırıları azaltmak için çeşitli çözüm yollarını uygulamayı amaç edinmişlerdir [49].

Bu çalışma kapsamında, dünya ticaretinde denizyolu taşımacılığının önemi ile birlikte deniz haydutluğunun tanımı, türleri, sebepleri ve dünya da görülen bölgelerin istatistikleri belirtilmiştir. Aynı zamanda deniz haydutluğunu önlemek amacıyla düzenlenen kuruluşlar açıklanmıştır. Veriler çerçevesinde deniz haydutluğu saldırılarının önlenebilmesine ilişkin önerilerde bulunulmuştur.

2.Deniz Haydutluğunun Tanımı

Günümüzde deniz haydutluğu devlet otoritesinden bağımsız bir şekilde hareket eden kişileri ve özel imkânları kullanarak gemi kaçırma, gemilere saldırarak soygunların yapılması, mürettebatın veya yolcuların rehin alınması şeklinde meydana gelmektedir [30]. Birleşmiş Milletler Deniz Hukuku Sözleşmesi'nin 101. maddesine göre deniz haydutluğunun tanımı:

a) " Özel bir geminin ya da hava taşıtının özel amaçlı amaçlarla hareket eden mürettebatı ya da yolcuları tarafından gerçekleştirilen;

b) Eylemi gerçekleştiren kişinin, söz konusu gemi ya da hava taşıtının korsan gemi ya da hava taşıtı olduğunun bilincinde olması halinde, bir geminin ya da hava taşıtının kullanımına iradi olarak katılma eylemi." [49].

Riskli ticaret yolları arasında Batı Afrika, Aden Körfezi ve Somali açıkları, Malakka, Kızıl Deniz, Güney Çin Denizi ve Singapur yerini almaktadır. Riskli bölgelerin oluşturduğu tehditlerin artmasının başlıca sebepleri arasında siyasi istikrarsızlıklar, deniz alanlarının yeterince kontrol altına alınamaması, yolsuzluk ve rüşvet ortamı gösterilmektedir. Teknolojinin gelişmesiyle birlikte haydutlar ağır silahlar kullanmaya başlamış olup belirledikleri hedefleri bulma ve takip etme hususunda GPS gibi teknolojik imkânlar yerini almıştır. Tespit edilen seyir halindeki gemilere sürat motorları ile saldırılar düzenlenmektedir [28].

Deniz haydutluğunun sonuçlarına bakıldığında dünya ekonomisini doğrudan olumsuz etkilediği saptanmıştır. Seyrin gecikmesi veya yükün çalınması yüksek mali kayıplara neden olmaktadır. Bu durumdan gemi sahibi taşıyıcılar, imalatçılar, sigorta şirketleri, yükün sahibi de etkilenmektedir. Diğer yandan saldırıya yakalanmak istemeyen gemiler alternatif suyollarını tercih etmektedir. Ancak yakıt israfı hususu ile karşı karşıya kalınmaktadır (Ship Owners Call For UN-led Force, tarih yok). Oluşan bir farklı olumsuz sonuçlara çevre kirliliği eklenmektedir. Deniz haydutluğu seyir emniyetini tehlikeye düşürdüğü için petrol veya diğer tehlikeli yük taşıyan gemilerin kazaya uğrama olasılığı çok yüksektir [49].

3.Deniz Haydutluğunun Sebepleri ve Türleri

Uluslararası hukuka göre yapılan eylemin deniz haydutluğu şeklinde tanımlanabilmesi için 4 şart aranmaktadır [36].

Şiddet, yağma ve alıkoyma şartı;

Yapılan eylemlerin gemiyi ele geçirerek batırmak dâhil olmak üzere mürettebatı yaralama, öldürme, yüke el koyma, rehin alma hareketleri şiddet şartını karşılamaktadır. Saldırganlar genellikle taşınabilir eşyaları alıp kolayca gemiden ayrılmaktadır.

a) Özel amaçlar şartı

Bu şartta aranan amaç, saldırganların özel amaç kapsamında hareket etmeleridir. Para veya gemide yükü ele geçirmekten ziyade fidye gibi yollara başvurulmaktadır.

b) İki gemi şartı

İki gemi şartının aranmasının sağladığı dolaylı yoldan avantaj politik amaçlı gerçekleştirilen eylemlerin deniz haydutluğu kapsamında değerlendirilmemesidir. Deniz haydutluğu sayılabilecek eylemin geminin yolcuları ve mürettebatı ya da mürettebatı isyan etmiş devletin üzerinde kontrol edilmeyen bir devlet gemisi kullanılarak bir başka gemiye yapılmış olması gerekmektedir.

c) Açık deniz şartı

Açık denizler, bir devletin iç sularına, münhasır ekonomik bölgesine, takımada sularına ve karasularına dahil olmayan deniz alanlarında geçerlidir. Kıyı devletinin sahilinden başlayarak 200 millik deniz alanının dışında kalıp uluslararası sular şeklinde tanımlanmaktadır. Açık denizlerde olan ticaret gemilerde hukuki statü bayrak devleti ilkesi ile belirlenmektedir. Ancak günümüzde deniz haydutluğu genelde demir yerleri, liman sahaları gibi ülkelerin münhasır egemenlik yetkileri kapsamında gerçekleşmektedir. Bu açık deniz şartı tekrar değerlendirmeye tabi tutulmalıdır [49].

Liman sınırlarının güvenlikten yoksun olması gemilere düzenlenen saldırıların durdurulmasını önleyememektedir. Hukuk sisteminde oluşan boşluklar, siyasi iktidarsızlık haydutları cesaretlendiren hususlardır. Deniz polisi veya güvenlik güçlerinin yetersiz olması da sebeplerin arasında gösterilmektedir. Haydutların kullandığı silahlar

artık günümüzde teknolojinin de gelişmesi ile birlikte ağır makineli silahlara dönüşmüştür. Hedef bulma ve takip etme sistemlerini kolayca kullanmaktadırlar. Teknolojik cihazlarla tespit edilen gemilere sürat botlarıyla saldırı düzenlenmektedir [36].

Hem eylem tarzı hem de amaç maksadıyla farklı saldırı türlerine rastlanmaktadır. Deniz haydutluğunun türleri üç sınıfta incelenmektedir:

1) Demirleme yerlerinde bulunan gemilere veya limanlarda demir atmış gemilere karşı uygulanan saldırılardır. Genellikle mürettebat soyulmaktadır. Dünya da emniyetin yetersiz olduğu limanlarda rastlanmaktadır.
2) Karasularda ve açık deniz de yapılan saldırılardır. Mürettebatın soyulmasına ve yükün çalınmasına ilave olarak yaralama ve öldürme olayları görülmektedir.
3) Yasa dışı gerçekleştirmek üzere ticari amaçların organize edilmesidir. Gemilerin yeniden boyanması, çalınması, satılması, isminin ve bayrağının değişmesi güçlü kaynağa sahip iyi eğitimli kişilerin görev aldığı soygunlar olarak tanımlanmaktadır [30].

En ciddi saldırılar Uzak Doğu'da görülmektedir. Bu bölge de düzenlenen saldırılarda haydutlar geminin mürettebatını öldürüp denize atmaktadır. Ve saldırılan gemi boyanarak yeni kimlik kazandırılmaktadır. Gemiler hayalet gemi olarak isimlendirilmektedir. Gemi ve taşınan yükler sahte evrakla satılmaktadır [8].

4.Dünya'da Riskli Alanlar ve Saldırı İstatistikleri

Deniz haydutluğunun yaşattığı tehditler hızla büyümektedir. Günümüzde belirli bir deniz alanında veya bölgesinde olmayıp dünyanın her yerinde deniz haydutluğu ile karşı karşıya kalınmıştır [13].

Dünya da deniz haydutluğunun en yaygın biçimde hangi bölgeler de görüldüğü aşağıda verilmiştir;

1) **Malacca Boğazı:** Deniz haydutluğundan etkilenme derecesi yüksek olduğu için önemli bir bölgedir. Konumu bakımından Hint Okyanusunda yer almaktadır. Ticari kaçış oluşturmasının yanında Süveyş Kanalı, Boğaz, Avrupa ve Mısır için

en önemli Hint-Çin deniz seyir rotalarından birisidir. Bu bölgede deniz haydutluğunu azaltmak amacıyla Malezya, Singapur ve Endonezya makamları arasında doğan işbirliği çabaları atılan önemli adımlardır.

2) **Güney Çin Denizi:** Saldırı rakamları ile karşılaştırıldığında en tehlikeli ikinci bölge olmaktadır. Çoğunluğu Endonezyalı ve Malezyalı haydutlardan oluşmaktadır. Yapılan saldırıların şiddetine bakıldığında en acımasız haydutlarını bu bölge barındırır.
3) **Aden Körfezi:** Coğrafi konum sebebiyle Süveyş Kanalına giden bir rota oluşturduğu için birçok geminin uğrak noktasıdır. Haydutların milliyeti çoğunlukla Somali'dir.
4) **Gine Körfezi:** Son yıllarda deniz haydutluğunda artış gösteren bir bölgedir. Gine Körfezi, Avrupa ve Amerika kıtasına ham petrol tankerlerinin geçişi esnasında önemli konuma sahiptir. Ticaret trafiği yoğun yaşanmaktadır.
5) **Benin:** Afrika da deniz haydutluğuna maruz kalan bir diğer bölgedir. IMO tarafından bu bölge denizyolu taşımacılığı hususunda yüksek risk teşkil eden olarak ilan edilmiştir. Sonuçlar incelendiğinde deniz haydutluğu saldırılarında önlemler günümüzde başarılı sonuç verememiştir.
6) **Nijerya:** Afrika'nın batı kesiminde yer almaktadır. Haydutluk faaliyetleri sıkça görülmektedir. Denizyolu taşımacılığında haydutların ortaya çıkardığı tehditler açısından en riskli bölgelerden biri olarak ele alınmıştır. Bu durumun ortaya çıkmasında Nijerya devlet güçlerinin de etkisi vardır.
7) **Somali:** Bu bölge de yaşanan iç savaşlar, hükümet otoritesinin eksikliği ve yoksulluk deniz haydutluğu faaliyetlerinin artmasını kamçılamaktadır. Bu durumda saldırıların son bulması imkânsız hale bürünmektedir.
8) **Endonezya:** Anambas, Natuna ve Merundung adaları civarında deniz haydutluğu saldırıları en sık görülen yer arasındadır. Özellikle bu saldırılar gece gerçekleşmektedir. Ancak Endonezya da bu saldırıların artmasının bir sebebi olarak yapılan faaliyetlere karşılık yeteri kadar yaptırım uygulanmaması gösterilmektedir.

9) **Umman Denizi:** Diğer bölgeler ile kıyaslandığında saldırıların daha az yaşandığı bir bölgedir. Bu bölge de yaşanan saldırıların az olması Arap otoritelerinin güvenliği sağlamak amacıyla oluşturdukları çabalar gösterilmektedir.
10) **Hint Okyanusu:** Bu alanda gerçekleştiren saldırıları yapan haydutların milliyeti Somalilidir. Denizyolu taşımacılığı açısından Hint Okyanusu önemli bir yere sahiptir [1] .

Tablo1: 2013-2017 Yılları Arasında Korsanların Gemilere Saldırılarında Kullandıkları Silah Türleri

SİLAH TÜRÜ	2013	2014	2015	2016	2017
Ateşli Silah	71	62	33	48	52
Bıçak	81	83	97	44	44
Belirtilmeyen	109	93	108	96	80
Diğer Silahlarla	3	7	8	3	4
TOPLAM	269	245	246	191	180

Tablo 2: 2013-2017 Yıllarına Göre Saldırıya Uğrayan Gemilerin Sayısı ve Milliyetleri

BAYRAK DEVLETİ	2013	2014	2015	2016	2017
ANTİGUA BARBUDA	7	5	9		3
AVUSTRALYA			1		
BAHAMALAR	7	4	5	5	6
BANGLADEŞ				1	
BARBADOS	1				
BELÇİKA			3		
BELİZE			1	1	
BERMUDA		1			1
CAYMAN ADASI	2				

ŞİLİ	1				
ÇİN	2	1			
KOMORLAR	1		1		
COOK ADASI			1	1	
HIRVATİSTAN	1			1	
CURAÇAO			1	2	
KIBRIS	1	2	7	3	4
DANİMARKA	6	4	3	1	1
DOMİNİKLER		1			
MISIR			1		
ETİYOPYA				1	
FRANSA	1		1		
GABON	1				
GANA		1	1		
CEBELİTARIK	3	1		1	
YUNANİSTAN	3	4	3	2	
HONDURAS		2			
HONG KONG (SAR)	20	16	19	9	6
HİNDİSTAN	4	4	2	3	4
ENDONEZYA		2	2	4	1
İRAN	1		1		1
MAN ADASI	2	3	3	3	3
İTALYA	4	7			
JAPONYA				1	
KİRİBATİ	1	1			
GÜNEY KORE		1	1	1	
LİBERYA	43	20	28	17	26
LİBYA	1				
LÜKSEMBURG	2		2	1	

MADEİRA				1	
MALEZYA	10	9	12	6	4
MALTA	8	6	11	5	8
MARSHALL ADALARI	31	36	40	36	29
MAURİTİUS				1	
MOĞOLİSTAN		2			
HOLLANDA	2	7	1	2	1
NİJERYA	2	3	2	4	2
NORVEÇ	4	4	1	3	4
PANAMA	32	44	38	46	27
PAPUA YENİ GİNE			1		
FİLİPİNLER	2	3	1		2
PORTEKİZ			1		
SUDİ ARABİSTAN		2	1	2	2
SİERRA LEONE	1	1			1
SİNGAPUR	39	32	32	21	31
İSPANYA					1
SRİLANKA					1
ST. KİTTS & NEVİS		1			
ST. VİNCENT & GRENADİNES	4				
İSVİÇRE	1	1			
TAYLAND	5	6	5		3
TÜRKİYE	2			1	
TUVALU					1
BİRLEŞİK KRALLIK (U.K)	2	1		2	2
AMERİKA BİRLEŞİK DEVLETLERİ	2	2			
VANUATU	1		2	1	1
VİETNAM	1	5	1	2	3
BİLİNMEYEN		1			1

YILSONU TOPLAM SALDIRI	264	245	246	191	180

Deniz haydutluğunun riskleri ve oluşturduğu tehditler devam ettiği sürece doğrudan ve dolaylı olarak sonuçlar ortaya çıkmaktadır.

Doğrudan sonuçlar kapsamında kaçma manevraları esnasında olan gecikmeler, nakit para kaybı, kira kaybı, soruşturmada oluşan masraflar, geminin alıkonmasıyla oluşan zararlar, kaçırılan gemi adamları için istenilen fidyeler, gemideki yükün hasar görmesiyle oluşan zararlar, petrol tankeri saldırılarında oluşan çevre kirliliği ve şiddet eğilimleri sonucunda gemi adamlarında sağlık sorunlarının oluşması yer almaktadır [30].

Tablo 3: Dolaylı Sonuçlar

Güvenlik Masrafları	**Ticaret Yollarının Değişmesi**	**Sigorta Masrafları**
Güvenlik önlemlerinin arttırılması üzerine doğan masraflar	Daha uzun mesafelerin oluşması	Denizyolu taşımacılığında yükselen ücretler
Nakliye ücretlerinin yükselmesi	Seyir sürelerinin uzaması	Kaçırma sigortasına ve ek fidye durumlarına ilişkin masraflar
Deniz haydutluğuna karşı koymak amacıyla yapılan masraflar	Maliyetlerin yükselmesi	Gemilere yapılan sigortalardan yüksek prim istenmesi
	Bazı limanların seyir esnasında kullanılamaz hale gelmesi	

1. Deniz Haydutluğuna İlişkin Sözleşmeler ve Önlemler

Deniz haydutluğunun olumsuz sonuçların önüne geçebilmek amacıyla devletlerin güvenlik önlemlerini arttırması, mücadele kapasitelerini geliştirmeleri önem arz etmektedir [41]. 1988 Viyana Uyuşturucu ile Mücadele Sözleşmesi, Uluslararası Gemi ve Liman Tesisleri Güvenlik Tüzüğü (ISPS), Uluslararası Denizcilik Örgütü (IMO), Denizde Seyir Güvenliğine Karşı Yasadışı Eylemlerin Önlenmesine Dair Sözleşme (SUA), Birleşmiş Milletler Güvenlik Konseyi Kararları, Ocak 2002' de ABD'nin konteyner gemilerinde güvenliği oluşturmak amacıyla Container Security Initiative (CSI) uygulamasını başlatması mevcuttur [7].

1982 BMDHS, BMDK kararları ve diğer sözleşmeler çerçevesinde deniz haydutluğu ile mücadele yapabilecek askeri operasyonlar ayrıca yargılama konuları ele alınmaktadır. BMGK, deniz haydutluğunun Somali bölgesine ilişkin ilk defa 2007 yılında harekete geçmiştir. Asya' da Gemilere Karşı Deniz Haydutluğu ve Silahlı Soygun ile Mücadele Konusunda Bölgesel Anlaşma (RECAAP) Kasım 2004 tarihinde 16 Asya ülkesi kendi aralarında imzalamıştır. Daha çok çevrenin korunması ve insan hayatı konularını esas alan IMO ile 15 bölge devletinin de olduğu Batı ve Merkezi Afrika Denizcilik Örgütü Temmuz 2008' de kurulmuştur [43] .

Batı Hint Okyanusu ve Aden Körfezi'nde silahlı soygun ve deniz haydutluğunun bastırılması üzerine IMO' nun Cibuti' de yapılan Cibuti Davranış Kuralları anlaşması imzalanmıştır. Somali Sahillerindeki Deniz Haydutluğu Temas Grubu ise bir diğer önemli organizasyondur. Amacı ise Somali de deniz haydutların yakalanması ve silahlı soygunların sonuçlarının bilgilerine karşılık koordinasyonunun uluslararası işbirliği ile sağlanmasıdır. Bünyesinde 45 devlet ve 7 uluslararası örgütü barındırmaktadır [10].

BMDHS çerçevesinde deniz haydutluğu için oluşturulan kurallar günümüzde saldırıların iyice artmasıyla hukuksal olarak yeniden gözden geçirilmeli ve şartlar göz önüne alındığında yeniden yapılandırılması gereklilik arz etmektedir. Denetim ve güvenlik görevlerini yerine getiremeyen ülkeler deniz haydutları için elverişli bir bölge olarak görülmektedir [38].

Kesintisiz takip hakkına başvurulmasıyla yapılacak olan müdahalelerde devletlerin egemenliği ile mücadelenin etkinliği arasında denge sağlanması gerekmektedir. Bölgesel düzeyde gerçekleştirilecek işbirliği ile coğrafi konum özellikleri dikkate alınarak tehdidin şiddet düzeyine göre hava ve deniz yolu ile gözetim yapabilecek araçların görevlendirilmesi üzerine tedbirler alınabilmektedir. Deniz haydutluğunun hukuki açıdan evrensel yargı sistemine tabi tutulsa bile devletlerin göstereceği işbirliği, irade ve isteğine bağlıdır [9].

Yapılacak olan önlemler gemileri ve denizciliği ilgilendirmesiyle uluslararası seviyeden başlaması gerekir. İhtiyaç duyulan temel unsurlar arasında hukuki zeminin sağlam bir

şekilde yapılandırılması, suç unsurları, saldırılara karşı yetkiler ve yargılama esasların belirlenmesidir [48].

Takip, koordinasyon ve istihbarat hususunda bilgi dağıtımında yoğunlaşmaya dair çalışmalar yer almaktadır. Önlemler her geminin yapısına, özelliğine ve oluşacak tehdidine göre farklı ele alınmalıdır. Deniz haydutluğuna yönelik eğitimlerin arttırılması gerekmektedir. Gemilerde güvenlik teçhizatlar ve öldürücü olmayan silahlar yaygınlaşmaktadır. Personel için kurşungeçirmez yelekler, gece görüş cihazları, şok verici cihazlar verilmektedir. Camların kurşungeçirmez özellikte olması, tüm kapıların merkezi sistem ile kapatılması, makine dairesi gibi önem arz eden yerlerin ulaşımını zorlaştırmak amacıyla kaporta konulması, uzaktan kumanda yardımı yardımıyla sistemlerin devre dışı bırakılması gemide teknik bakımından yapılacak değişikliklere örnek verilmektedir [9].

2. Sonuç

Denizyolu taşımacılığı her ne kadar taşıma sektöründe diğer türlere nazaran maliyet ve taşınan yük miktarı bakımından önde olsa da küresel ticaretin güvenli gerçekleşmesi açısından bünyesinde risk ve tehditleri barındırmaktadır. Bu risk ve tehditleri günümüze kadar gelmiş olup artışların görüldüğü deniz haydutluğu oluşturmaktadır.

Deniz haydutluğu saldırıları hukuki boşlukların olması, siyasi alanında dalgalanmaların baş göstermesi gibi otorite eksikliğinin bir sonucudur. Doğrudan uluslararası gerçekleşen ticareti olumsuz yönde etkilenmektedir. Yapılan saldırılar arasında gemi kaçırma, fidye isteme, mürettebata karşı yönelik şiddet, yüke ve gemiye el koyarak sigorta maliyetlerinin yükselmesi gibi denizyolu taşımacılığını her yönden etkileyecek faaliyetler mevcuttur. Deniz haydutluğunun yaptığı saldırılar arasında tankerlerin de olması çevre kirliliğini büyük oranda etkilemektedir. Dolayısıyla denizde ekolojik sistem tehlike altına girmektedir.

Deniz haydutluğu saldırıların önlenebilmesi için uluslararası örgütler mevcuttur. Örgütlerin yaptıkları çalışmalar sayesinde sorunun kök nedenleri araştırılmalıdır. Yaşanan sorunlar yoğun bölgelerde ele alınarak önlemlerin uygulama seçenekleri belirlenmektedir. Liman güvenliği için operasyonların arttırılması, sözleşmeler ile birlikte

işbirliğinin sağlanması, gemide güvertenin her tarafının elektrikli veya dikenli teller ile çevrilmesi, hortumlar aracılığı ile su sıkılması, gemi personelinin gerek eğitim gerek araç gereçlerle donatılması, teknolojinin takip edilmesi yapılan çalışmalar arasında yer almaktadır.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Analyzing Organizational Culture for Innovation Performance in Maritime Industry

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ABSTRACT

Innovation performance has an important topic for maritime sector in digitalized era. It is known the organizational factors has shaped the approach of innovation philosophy in organizations. In this study it is aimed to understand the premises of organizational culture in maritime sector for an effective innovation performance. A survey has been conducted to understand the relationship between premises of organizational culture and innovation performance, with the participation of 80 technical and operational staff in maritime companies. The results show that "foreign market orientation" and "collective work" has high correlation with innovation performance factors.

Keywords: Maritime, innovation, organizational culture

1. Introduction

Following the loss of productivity and the failure of the organization, many companies around the world have begun to rethink and change their competitive approach. The rapid technological change and the change of international trade and competition patterns put a lot of pressure on these organizations to keep up with a number of new and often unpredictable opponents. According to researches, there are two important findings for a competitive approach: One of these is creating a new organizational shape such as single combination of management processes, structure and strategy. Second is developing internal mechanisms by organizations in the near future such as internal and external mediation, information system and marketing infrastructure [1]. At this point, an organizational culture must include adoption of technological change and innovation.

From the point of organizational view, an innovation can be described as introduction of new technology or new service into an organization. It can be seen as a process which includes adoption and diffusion of new product or new service. Accordingly, innovation process can be completed if the organization members accept it. Accordingly, organizational culture has arisen as an important concept for the values for the innovation process. Several studies showed that culture has plan an important role in innovation [2,3,4,5,6]. Among these studies, Hartman [7] stated that the main reason for innovative behavior was accepting innovation as a basic value of the organization. Thus, innovative culture needs innovative mindsets in the organizations.

It can be said that there must be a relationship between organizational culture and innovation performance for all sectors. Looking at the research, innovation performance is positively related to overall business process and firm performance [8, 9, 10, 11]. Therefore, it is important to examine the proposed phenomenon on the basis of the sector. In this research, it is tried to understand whether there is a direct relationship between organizational culture and innovation performance premises for maritime sector. The basic research objective is to provide a statistical relationship between them. Data were obtained via a survey carried by experience staff in the maritime industry.

With this aim, the following part of the paper includes a literature review about organizational culture and its premises as well as innovation performance and is premises. In the third part, survey data and a correlation analysis between organizational culture and innovation performance in the maritime sector are introduced. Finally, findings are discussed and a brief conclusion is given.

2. Literature Review

Innovation can be defined in terms of technology-related business because innovation introduces new products to the market and develops new processes [12]. Another definition of innovation can be given regarding the changes in the production functions and processes that companies are trying to acquire and develop their own technological competencies; it is understood as a set of resources owned by a firm and the way they are transformed by innovative capabilities. At this point, innovation performance must be examining on the basis of sector. When looking at the maritime sector, researches have claimed that maritime industry is less innovative when it is compared with the other sectors. [13, 14, 15]. On the other hand, according to some researchers, maritime industry is also experiencing digital transformation with innovations in efficiency, safety and protection of the environment [16].

Looking at the definition of innovation, it can be said that new product promotion and adoption of new technologies are premises of innovation performance in a sector. Also, other principles which innovation performance is related are as follows [17]:

- Innovation is about changes made by firms to maintain or improve competitiveness.
- These changes apply to products and services, market development, marketing, production processes, and technology used in administration.

Drawing from previous literature on maritime industry, the main hypotheses to be tested in the case of marine industry are as follows [18]:

1. The industry produces more incremental than radical innovations.
2. The industry produces more organizational and marketing than product, process, or service innovations.

3. The innovativeness of firms (to some extent) depends on size.
4. The innovativeness of firms is related to the intensity of their in-house and collaborative R&D activities.
5. The innovativeness of firms differs according to their level of internationalization.

Regarding organizational culture, its definition can be defined as basic assumptions about the world and the values that guide life in organizations [19]. Examining the literature about organizational culture, it can be said that the premises of it are organizational climate, foreign market orientation, supporting innovations and collective work.

Organizational climate is briefly defined as the meanings people attach to interrelated bundles of experiences they have at work. Also, organizational climate may be defined as the shared perceptions of and the meaning attached to the policies, practices, and procedures employees experience and the behaviors they observe getting rewarded and that are supported and expected [19]. On the other hand, organizational culture may be defined as the shared basic assumptions, values, and beliefs that characterize a setting and are taught to newcomers as the proper way to think and feel, communicated by the myths and stories people tell about how the organization came to be the way it is as it solved problems associated with external adaptation and internal integration [19]. It means that organizational climate and organizational culture are two alternative constructs for conceptualizing the way people experience and describe their work settings.

According to the internationalization process view, the elapsed time of operations in the foreign market affects the learning ability of the entrant firm. However, elapsed time in itself does not generate knowledge about foreign markets; time has to translate into business experience [10]. For example, if the entrant firm performs no activities in the foreign market, or if the current activities are restricted by certain organizational routines that leave no room for variation, the learning effect will be limited even though the firm has been in the country for a while. Each new foreign market brings new challenges and experiences for the management of the entrant firm in terms of customers, competitors, cultures, and institutions [5].

Research on market orientation and organizational learning addresses how organizations adapt to their environments and develop competitive advantage. A significant void exists in current models of market orientation because none of the frameworks incorporates constructs related to innovation. The authors present a conceptual framework for incorporating constructs that pertain to innovation in market orientation research. Some of the critical relationships in this conceptual framework are tested among a sample of 9648 employees from 56 organizations in a large agency of the U.S. federal government. The results indicate that higher levels of innovativeness in the firms' culture are associated with a greater capacity for adaptation and innovation (number of innovations successfully implemented). In addition, higher levels of innovativeness are associated with cultures that emphasize learning, development, and participative decision making. The authors make recommendations for incorporating constructs related to innovation into research on market orientation and organizational learning [20].

Regarding organizational culture, there is an agreement in the literature about its importance for innovation [21]. In order to innovate and adopt technological progress successfully, firms have to meet certain requirements in terms of their internal behaviour and their external relationships [22]. Furthermore, Siguaw et al. [24] point out the organizational culture as a facet of operational competency shaped by the innovation orientation of the firm.

Organizational culture consists of the beliefs, values, norms, customs and practices of the organization [19] defined the concept as a system of norms, shared values, concerns, and common beliefs that are understood and accepted by the members of the organization. The members of the organization accept these as valid, follow them and teach them to incoming members as a pattern to be followed for problem solving and as required thinking style and behavior. Newcomers to an organization may bring with them prior expectations about the culture when they join, but culture is also transmitted to new arrivals by established staff, sometimes explicitly but more often implicitly. The organizational culture is shaped and articulated not just by individuals but also by new

and old organizational features. The organizational structures, routines, command and control expectations, and operational norms all have influence [24].

Total Quality Management (TQM) can have a dramatic impact on the culture of an organization [25]. TQM is a management approach in which the application of practices such as teamwork, internal customer relationship, and supplier partnership are tools for cultural transformation, and involves a major cultural change in the organization. TQM is a complete change in an organization's culture and the way people behave at work. On the other hand, organizational culture appears to be a crucial factor in understanding the ability of any organization to perform and compete and some work in health care confirms this. This is especially an issue in health care institutions such as hospitals where individual health care services provided by a group of providers such as doctors, nurses and clinicians with different cultural values. Interaction between internal and external customers of health care organizations is vital for providing quality services.

Innovation is the key to organizational survival and therefore the study of processes that support innovation should be of interest to researchers and practitioners alike. Schein's multi-layered model of organizational culture offers a useful framework for thinking about processes that foster innovation. A defining characteristic of the model is the subtle but important distinctions between the varied "layers" of organizational culture (i.e., values and norms, artifacts and behaviors). The basic assumption of this study is that Schein's model offers a tractable explanation of cultural processes that support organizational innovation, especially in service firms. Despite the intuitive appeal and practical value of Schein's conceptual framework, empirical research in relation to the model is limited. This paper develops a rationale for an empirical model based on Schein's conceptual model; the study reports a test of an empirical model. Data collected from approximately 100 principals of law firms provides a suitable empirical context for a test of the model. The findings generally support the hypothesized relationships. A key result is how layers of organizational culture, particularly norms, artifacts, and innovative behaviors, partially mediate the effects of values that support innovation on measures of firm performance. The findings have implications for theory and practice, especially in

relation to building an organizational culture within professional service firms that fosters innovative behavior.

3. Methodology

The "5-Scale Likert Type Survey" was used in our study to understand the relationship between the premises of organizational culture and innovation performance in the maritime sector. The survey has been originated from Shahzad et al. [24] presented in the Appendix is based on from "strongly disagree" to "strongly agree" scale and consists of 16 terms. In this study, organizational culture is identified by several premises. These premises of the organizational culture are foreign marketing orientation, organizational climate, supporting innovations, collective work. The innovation performance has been described by promotion of new product/service and adoption of new technology/service. The data used in the study was obtained from 80 experienced staff who have been working in various technical and operational departments in offshore maritime industry for over many years.

The survey has been conducted through e-mail. The demographic characteristics of participants are shown in Figure 1. As indicated in the chart below, 46% of our participants in the maritime sector (on the land side) are aged 40 years or older and the majority of the operations department is seen with 34% of the surveyed. In addition, 47.5% of participants have 16 years and more experience in the maritime industry. All of these participants are graduates of maritime higher education institutions.

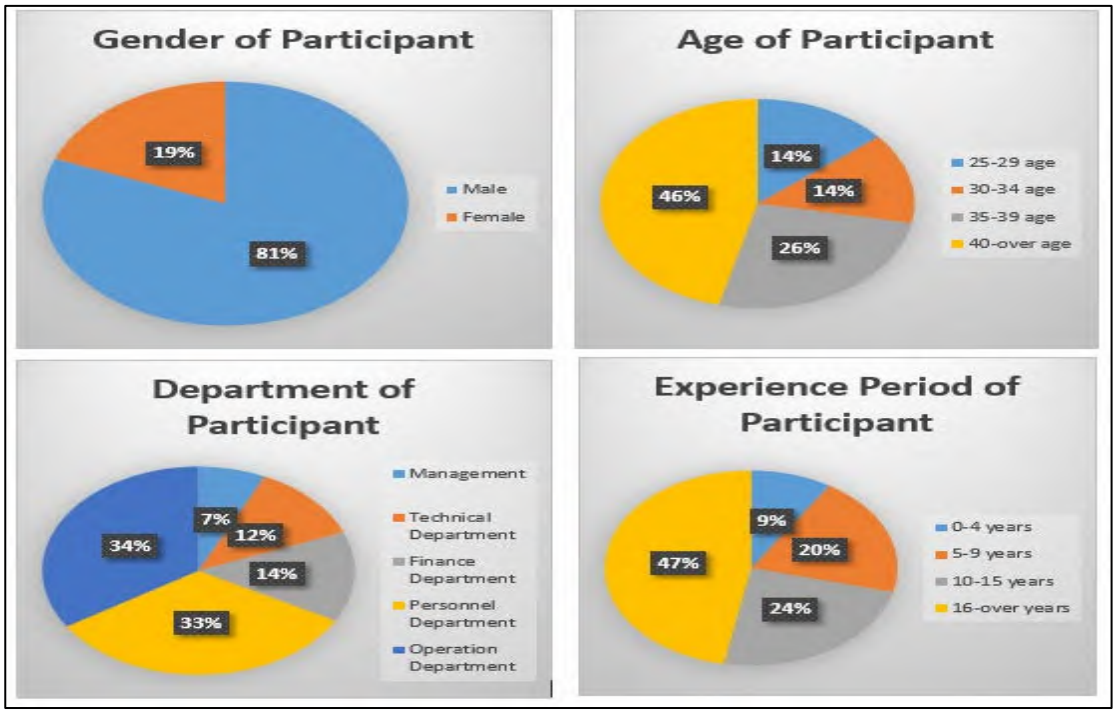

Figure 1: Demographic Characteristics of Participants

3.1 Reliability and Correlation Analysis

To understand the relationship between organizational culture premises and innovation performance in the maritime sector, a descriptive analysis has been conducted for each premise using IBM SPSS Statistics 24.0. The descriptive characters of the premises have been shown in Table 1. Cronbach's Alpha coefficient and Spearman's correlation of each premise have been obtained to assess the reliability (validity) of the factors and to present the relation between each other.

When Table 1 has been evaluated, the mean value of the variables has indicated that these factors have been highly significant for innovation performance in maritime sector. As the two highest mean values have been "Foreign Market Orientation" and "Collective Work" with 4.60 and 4.43 respectively amongst all premises, it can be concluded that these two factors play an important role in the innovation performance in maritime industry. Also, Cronbach 'Alpha values of the six factors have been within the desired range (.7-.9), proving the validity of all factors.

Table 1: Descriptive Characters

Organizational Culture and Innovation	Term	Mean (SD)	Median	Min	Max	Cronbach's Alpha
Foreign Market Orientation	5	4.60 (.65)	5	1.20	5	.80
Organizational Climate	4	4.26 (.81)	4.5	1.50	5	.79
Supporting Innovations	5	4.12 (.93)	4.5	1.20	5	.85
Collective Work	5	4.43 (.78)	4.6	1.40	5	.90
New Product Promotion	4	4.13 (.94)	4.37	0	5	.81
Adoption of New Technologies	3	4.06 (.89)	4.33	0.67	5	.76

To understand the relationship between the premises and the innovation performance factors, Spearman's Correlation Test has been performed, shown in Table 2, due to the fact that the data were not normally distributed and the sample count was low. From Table 2, it can be concluded that foreign market orientation from factors is significantly related to the premise of "organizational climate" and "supporting innovation" (R> 0.5). Likewise, the organizational climate factor is significantly related to the other five premises. The results show that there is a positive and significant relationship between all the factors.

Table 2: Spearsman's Correlation

	Foreign Market Orientation	Organizational Climate	Supporting Innovations	Collective Work	New Product Demonstration
Foreign Market Orientation	1,000				

Organizational Climate	,619**				
Supporting Innovations	,503**	,676**			
Collective Work	,469**	,716**	,626**		
New Product Demonstration	,492**	,606**	,694**	,681**	
Adoption of New Technologies	,430**	,585**	,709**	,679**	,717**

According to the reliability and correlation analysis between factors, the following hypotheses have been established:

H1: There is relationship between foreign market orientation and organizations' innovation performance in maritime sector.

H2: There is relationship between organizational climate and organizations' innovation performance in maritime sector.

H3: There is relationship between supporting new technologies and organizations' innovation performance in maritime sector.

H4: There is relationship between collective working and organization's innovation performance in maritime sector.

As the distribution of data has not been normal, to test the validity of our hypotheses strongly, we performed the Kruskal-Wallis test on our non-parametric data. The Kruskal-Wallis test results have been presented in Table 3. It is understood that the hypothesis H1, H2, H3 and H4 have not been rejected ("Asymp Sig" <0.05).

Table 3: Kruskal Wallis Test

Test Statistics[a, b]

	B1_Ort	B2_Ort	B3_Ort	B4_Ort
Kruskal-Wallis H	22,889	33,668	43,672	39,792
df	3	3	3	3
Asymp. Sig.	,000	,000	,000	,000

a. Kruskal Wallis Test

b. Grouping Variable: C1andC2_Ort

(B1_Ort; Foreign Marketing Orientation, B2_Ort; Organizational Climate, B3_Ort; Supporting New Technologies, B4_Ort; Collective Working, C1andC2_Ort; Innovation Performance)

4. Conclusion

The focus of this study is to confirm that organizational culture has a relationship with innovation performance of the maritime industry and establishing an innovative organization should need innovative mind sets. The empirical results in this study proved a strong positive relationship between four factors of organizational culture and innovation performance in the maritime industry of Turkey. According to these results, it was seen that foreign marketing orientation, organizational climate, supporting new technologies and collective working, which are the factor of organizational culture, support innovation performance.

Besides that, in Turkish maritime industry, the factor of foreign marketing orientation and collective working affect innovation performance more than other factors. On the other hand, in the study of Shahzad et al (2017), the factors of organizational climate and flexibility/ supporting to changes affect innovation performance more than others in software industry of Pakistan.

Appendix

Survey Items

Foreign Market Orientation - B1 (Marine company which I am working ...)	
B1A	regularly follows changes in the sector

B1B	is informed by key customers about the sector
B1C	attaches importance to relations with external stakeholders
B1D	has enough flexibility and adaptability to cope with the possible difficulty
B1E	approaches to problems with a positive attitude
Organizational Climate – B2 (At marine company which I am working ……)	
B2A	employees share information about their work on a regular basis
B2B	employees take the time to listen to each other
B2C	employees are sincere in bilateral relations
B2D	all the social activities that everyone has come together are doing
Supporting Innovations – B3(Marine company which I am working …)	
B3A	provides regular training opportunities to employees for technological developments
B3B	effectively follows the business opportunities that it faces
B3C	employees question their knowledge of technological developments
B3D	provides training for employees in the necessary areas
B3E	is eager to use new technologies
Collective Working – B4(At/Marine company which I am working …)	
B4A	there are a team spirit among their employees
B4B	employees help each other when they are needed
B4C	come up with teamwork from above challenges
B4D	Management department is friendly and accessible to staff
B4E	when management department takes an important decision it considers the thoughts of its employees
New Product Promotion – C1(At/Marine company which I am working …)	
C1A	technological developments in recent years have been adequately adapted and implemented
C1B	the product specifications are sufficiently noted during technological developments

C1C	when the need for new technology is determined and it considers the customers' opinions and specific features
C1D	benefits from the new technologies used
Adoption of New Technologies - C2 (At/Marine company which I am working …)	
C2A	new technologies that use increase the employee's belief in innovation
C2B	changes in organizational structure encourage organizational innovation
C2C	the introduction of new technology programs to its employees facilitates the adoption of organizational innovations

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Impact Analysis for Explosion Scenario of a Sailing Gas Tanker

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ABSTRACT

Combustible, flammable, explosive and toxic cargoes have been transported by various types of tankers according to specification of cargo. There are international rules and implementations for safe and secure transportation of these cargoes. Dangerous cargoes which transported via tankers increase the risk of security threat due to their characteristics. A possible attack on a tanker carrying dangerous goods may cause catastrophic results depending area, amount and characteristics of cargo. It is much more important to provide safe and secure transportation in the regions such as Turkish Straits where the number of transit tankers is high and the surrounding settlements are dense. In this study, Boiling Liquid Expanding Vapor Explosion (BLEVE) impact analysis was performed for the explosion scenario of a sailing gas tanker. Areal Location of the Hazardous Atmosphere (ALOHA) software was used for impact analysis. The aim of the study is to emphasize importance of security for maritime transportation.

Keywords: Tanker, Explosion, BLEVE, LPG, Security

1. Introduction

Energy sources such as crude oil, fuel oil, diesel oil, gasoil, petroleum gas etc. are classified as dangerous cargoes because of their flammable, explosive and other dangerous characteristics. Dangerous cargoes have been transported by various tankers according to specification of cargo for many years. International regulations have been developed and implemented to provide safe transportation and safe cargo operations for tankers. International Maritime Organization (IMO) establishes these regulations by cooperating with industry stakeholders that gather under the roof of international marine forums like Oil Companies International Marine Forum (OCIMF) and International Tanker Owners Association (INTERTANKO) as consultative committee. On the other hand, security issues compared to safety issues of tankers have been pushed into background. The September 11 suicide attack on the twin towers via aircraft hijacking demonstrated that transportation security is as important as safety. After The September 11 terrorist attack, IMO developed The International Ship and Port Facility Security (ISPS) code under Safety of Life at Sea (SOLAS) convention. ISPS code is described as a comprehensive set of measures to enhance the security of ships and port facilities, developed in response to the perceived threats to ships and port facilities by IMO. This code supports stakeholders in detecting security threats and taking preventative actions against security incidents. Despite all security precautions, maritime transportation is still at risk in terms of security [1]. Especially tankers carrying dangerous cargoes have become a serious threat for maritime transportation about security issue. According to the statistical data provided by the Turkish Directorate General of Coastal Safety, an average of 50,000 ships pass each year from the Turkish Straits. Approximately 9000 of these ships are tankers [2]. To provide safe and secure transportation is crucial in the regions such as Turkish Straits where the number of transit tankers is high and the surrounding settlements are dense. In this study, BLEVE impact analysis for explosion scenario of a sailing gas tanker was analyzed by using ALOHA software which is able to estimate how a toxic cloud might disperse after a several fires and explosions scenarios, developed by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Environmental Protection Agency

(EPA) [3]. American Institute of Chemical Engineers (AICE) defines BLEVE as explosively rapid vaporization and corresponding release of energy of a liquid, flammable or otherwise, upon its sudden release from containment under greater-than-atmospheric pressure at a temperature above its atmospheric boiling point [4]. ALOHA has been used for analyzing various explosion accidents and scenarios. Hui and Guoning analyzed a leakage accident of natural gas plant and defined flammable threat zone by using ALOHA [5]. An accident scenario for gas industry developed and affected areas analyzed after explosion of 85% filled propane tank in a study [6]. Çetinyokuş used ALOHA software for determination of explosion, fire and toxic emission physical effect areas of chlorine as toxic gas, hydrazine as toxic liquid and propane as flammable substance [7]. Tiwari et all compared effects of ethane and methane gas release scenarios at various conditions using ALOHA [8]. Potential risks of LGP filling stations that located near densely populated areas revealed by Varta and Krocova with the same method [9]. In this study, effects of a sailing gas tanker explosion scenario analyzed and preventive actions were discussed. Aim of this study is to emphasize the importance of security for maritime transportation, reveal probable consequences by creating a disaster scenario.

2. Method

ALOHA is a software which is designed to provide an assessment of threat zones using Gaussian and Heavy Gas, semi-empirical air dispersion models and BLEVE-Fireball model which is a solid flame model based on studies of fireballs resulting from BLEVEs involving flammable gases liquefied under pressure and stored at ambient temperatures. Burn rate, flame height, angle of tilt, and emission of radiation from the surface are based on empirical correlations [1]. ALOHA which include an extensive database of chemical database, requires input data on local atmospheric conditions, the identity of the chemical, geographical position and details about the scenario for analyzing effects of BLEVEs [10].

ALOHA can estimate the thermal radiation from fireballs associated with BLEVEs and separates threat zones as red, orange and yellow according to Mudan and Core's

definition about effects of heat flux density. 10 kW/m^2 heat flux defined as fatality threshold, 5 kW/m^2 can cause second degree burns on skin and 2 kW/m^2 can cause pain [11].

In this study, explosion scenario of a sailing gas tanker carrying propane in spherical tank were analyzed. Table 1 indicates required input data for ALOHA software and Figure 1 shows software interface of input data.

Table 1: Input Data

Input Data	
Chemical Name	Propane
Molecular Weight	44,10 g/mol
LEL(Lower Explosion Limit)	21000 ppm
UEL(Upper Explosion Limit)	95000 ppm
Ambient Boiling Point	-42 ° C
Cargo Tank	Spherical
Tank Volume	9250 cubic meters
Chemical Mass in Tank(98% full)	4493 tons
Wind	8 knots from SW at 3 meters
Air Temperature	23° C
Stability Class	E
Relative Humidity	50%

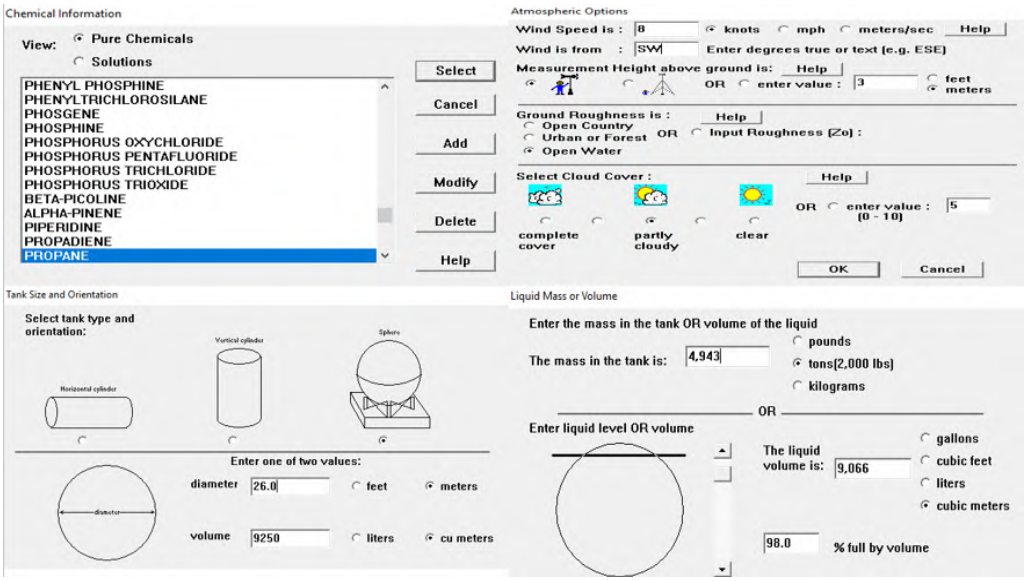

Figure 1: Software Interface

In the scenario, 98% filled spherical propane tank containing pressurized flammable liquid of a sailing gas tanker explodes after a terrorist attack and chemical burns in a fireball. One of the most important potential hazard from BLEVE, thermal radiation from fireball and pool fire determined.

3. Results

As a result of the explosion scenario, BLEVE effect created potentially lethal area, second degree burns area and pain area within 60 second.

Source Strength

BLEVE of flammable liquid in spherical tank

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 956 meters Burn Duration: 41 seconds

Threat Zone

Threat Modeled: Thermal radiation from fireball. Figure 2 shows threat zone as described below.

Threat Modeled: Thermal radiation from fireball

Red: 2.0 kilometers --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 2.8 kilometers --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 4.3 kilometers --- (2.0 kW/(sq m) = pain within 60 sec)

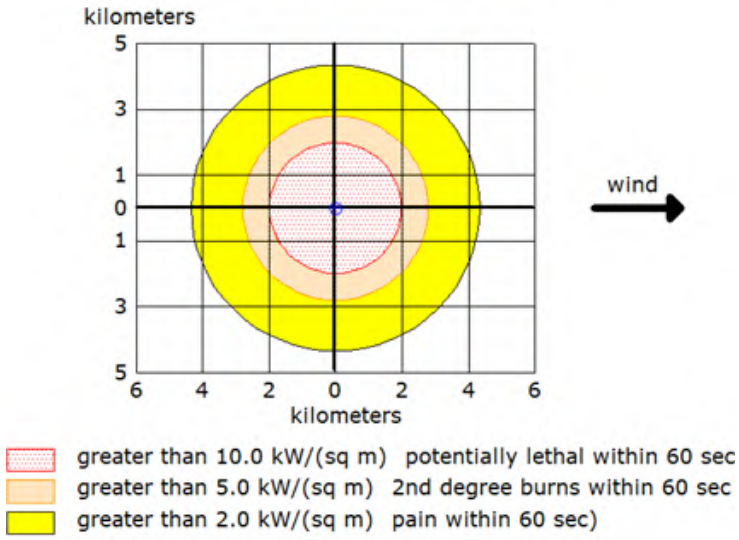

Figure 2: Threat Zone

4. Conclusion

Explosion scenario of a sailing gas tanker carrying 4943 metric ton propane in spherical tank analyzed by using ALOHA and catastrophic consequences determined because of BLEVE effect. The scenario created in contemplation of security threats revealed the importance of providing security for maritime transportation of dangerous goods. Additional security measures should be applied at tankers and tanker terminals especially near densely populated and residential regions. As a result, security measures for maritime transportation of dangerous goods should be enhanced. This enhancement can be enabled by IMO in scope of ISPS code.

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Are The Ships Fully Secured Against the Cyber-Attacks?

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ABSTRACT

Cyber security, as one of the most important component of Industry 4.0, is defined as the capability of preparedness, reaction and response to the attacks originating from other connected devices. In addition to the facilities it provides, the 4th industrial revolution which has risks especially targeting the information security has caught the shipping industry unprotected. For this reason, the main purpose of this study is to increase the level of awareness in the importance of information security in shipping companies in Turkey. To do this, initially the relevant literature has been reviewed in order to determine the variables of cyber security phenomena. Then the semi-structured interview form created with the adoption of those elements to the shipping industry. It has been applied to the experts of shipping companies operating a large part of the Turkish shipping fleet. As a result, it was found that shipping companies have taken certain measures for information security both in the offices and on their ships, but there is no complete protection against cyber attacks. In this context, it is recommended that the investments in the Information Technology (IT) department of shipping companies have to be increased in order to fight to possible future attacks.

Keywords: Industry 4.0, Shipping, Cyber Security, IT, Turkey

1. Introduction

The shipping industry supports community and the economy through the movement of passenger and other materials, such as energy, food, etc. [1]. Technology supporting cyber security has become principal to the operation and management of many systems critical to the safety and security of shipping and protection of the marine environment [2]. With approximately 50,000 ships cruising all around the world at the same time, the shipping industry is highly exposed to cyber-attacks [3]. Vessels are increasingly utilizing equipment using computational systems and automation, which requires effective cyber security measures on board [4].

In recent years, many reports published including security gaps against cyber-attacks in the sectors of energy, transportation and manufacturing [5]. The fact that maritime transport is the locomotive of the transport sector makes this industry more attractive for cyber terrorists [6]. The biggest maritime companies such as Maersk Line, COSCO, BW Group and shipbroker Clarkson's have been subjected to cyber-attack and as a result, significant commercial losses occurred due to the hacking of commercial data [7]. Besides, cyber-security cooperation displayed the 16 security gaps of defense system of the world's 20 largest container shipping lines. Gaps can be generated by deficiencies in design, and/or fixing of systems, as well as lapses in cyber discipline. The latest high-profile attacks have increased awareness of the threats exposed by shipping companies and increased the need for the sector to take the issue seriously [8].

In this context, the purpose of this study is to determine the awareness level of shipping companies operating in Turkey on cyber-security issues. To do this, the relevant literature was reviewed, and the interview was carried out with the experts as the representatives of shipping companies.

2. Literature Review

Cyber security is the practice of protecting computers, systems, networks and data from cyber-attacks [9]. Rapid developments in information technologies and cyber security

have become an important issue in recent years and this has led to an increase in the number of scientific studies [10].

Jensen (2015), in his study, pointed out the existence and tangible outputs of cyber-attacks and their effects on the computer systems [11]. Tam and Jones (2018) carried out a study aiming the analysis of the effects of cyber threats on the maritime security policies and global fleet security [12]. Polat et al. (2016) conducted survey with the purpose of to analyze the worldview of Turkish seafarers to ship cyber security and their cyber security awareness level by collecting data with surveys and interviews [13]. Heymann et al. (2016) used First Principle Vulnerability Assessment (FPVA) methodology in order to point out cyber-security issues in shipping with the scope of main problems and current initiatives [14]. Brasington and Park, (2016) in their study, aimed to increase the level of awareness in security measures taken against cyber-attacks in sea ports [15].

Cyber risks threaten not only transportation but also a whole supply chain including offices on shore, terminals and, on board infrastructure. Today's ships use equipment with high technology enabling big data storage, computing power, and sensor technology [16]. Cyber security experts revealed how easy it was to hack a ship's digital equipment especially using data sharing method. In addition, the development of technology used in ship equipment is important in terms of data transfer and data sharing, and it also raises the risk of cyber-threat, especially for equipment sharing data in digital platform with both internal and external units [17]. The digitization environment of vessel is shown in Figure 1.

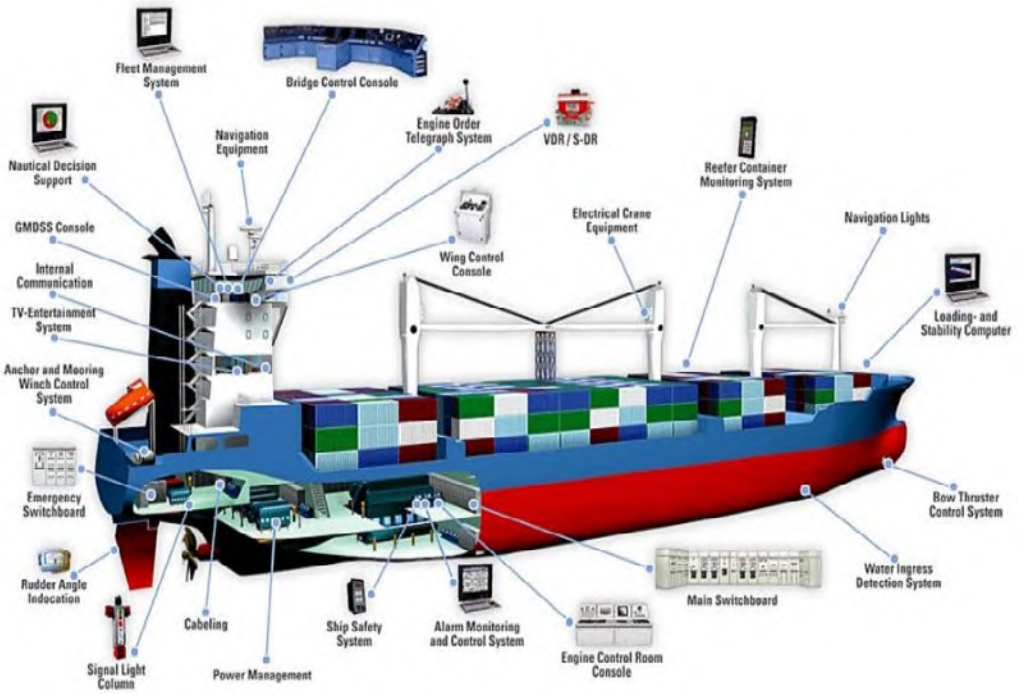

Figure 1: Vessel Computerization Environment [18].

As understood from the figure that, vulnerable systems could include, but are not limited to, bridge systems, cargo handling and management systems, propulsion and machinery management and power control systems, access control systems, passenger management systems, public networks, administrative and crew welfare systems, and communication systems [2]. Those systems can be protected against cyber threats with taking proper actions as shown in Figure 2 [19].

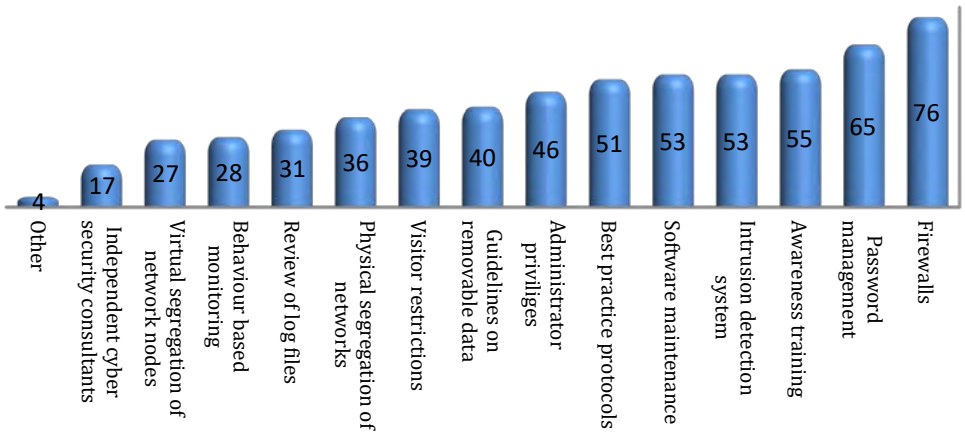

Figure 2: Measures for Protection.

Today's modern ships, especially passenger ships, have become floating computers. On these ships, wireless internet service is available for passengers for all times in the middle of the ocean. Besides, cargo ships have complex cargo handling operations managed by unmanned platform. For example, cargo winches are handled by GPS. The area's most frequently selected as target source for cyber terrorists are shown in Figure 3.

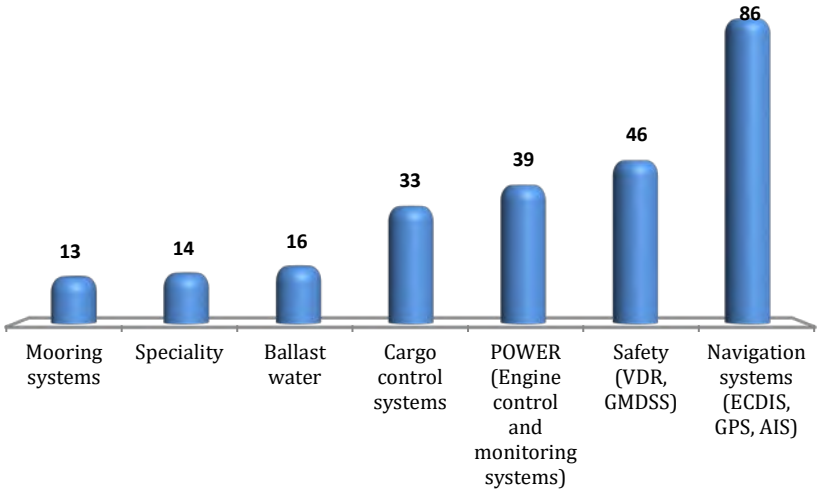

Figure 3: Areas as Most Vulnerable to Attack.

All navigation systems are not encrypted and hence are vulnerable to attacks. For these reasons the navigation systems are the most attractive target on board, which will lead an accident in case of hacked [8]. For example, terrorist may create of "ghost" vessels at any global location, with modifying all ship details through AIS. The GPS signals can be blocked by jammers which will affect adversely other navigation equipment receiving data from GPS [20]. GPS signals in cargo tracking systems forced to be cut and as a result the cargo cannot be tracked due to loss of connection. Machinery operations can be shut down if remote operations are carried out. Furthermore, cargo and ballast operations can be controlled by attackers if the system infected by viruses [21].

3. Materials and Methods

3.1. Aim of Study

The aim of this study is to examine how the maritime industry is handling digital protection against cyber-attacks in Turkey. Furthermore, the sub-purpose of this paper is to determine the awareness level of Turkish shipping companies on cyber security issues in shipping.

3.2. Method

In this study, the qualitative research methods were used in order to determine the state of awareness of ship operators in cyber security issues. Unlike quantitative studies, the framework of a qualitative research is related to the agenda of determining the reason of a particular phenomenon [22]. For this reason, interviews are the most important instrument in data collection for qualitative studies. In this study, initially, the literature was reviewed and then the interviews were organized and conducted.

3.3. Data Collection and Research Sample

In this study, the semi-structured interview technique was used as a data collection method. This method is not as rigid as fully structured interviews nor as flexible as unstructured interviews. Just like structured interviews, this type of interview also an outline of topics and questions prepared by the researcher [23]. With this technique, the

researcher is able to create a wide research area that allows asking new questions. The semi-structured interview is most preferred for qualitative data collection [24]. The survey was developed from the data collected from the literature review concerning the cyber security issues and protective measures. Every item was checked by experts in terms of internal consistency. Finally, the interview form was taken its final form with revised statements.

In this study convenience sampling method was applied due to fact that the method needs short period of time, easy to conduct and cheaper than the others. A total of 14 company representatives participated to this study. The details of experts are shown in the Table 1.

Table 1: Interview Details.

Date	Company	Duty	Experience (yrs.)
28.11.2018	Geden Lines	HR Manager	12
07.12.2018	Düz-Git Shipping	HR Manager	18
07.12.2018	Active Shipping	Technical Man.	21
07.12.2018	Bilka Tanker	HR Manager	11
07.12.2018	Armona Shipping	HR Manager	14
29.11.2018	Kaşif Shipping	General Manager	23
06.12.2018	Ditaş Shipping	HR Manager	11
26.11.2018	Omikron Crew Man.	CEO	13
26.11.2018	Maritime Trainer	Project Manager	7
28.11.2018	Angora Shipping	CEO	19
27.11.2018	Research Shipping	Captain	9
06.12.2018	YA-SA Shipping	Training Man.	13
06.12.2018	Ince Shipping	HR Manager	16
29.11.2018	Chem-Fleet Ship.	Captain	12
29.11.2018	Med-Log Shipping	HR Manager	11
29.11.2018	Borealis Shipping	HR Manager	14

The interviews were held face to face between 26/11/2018 and 07/12/2018 at the "Career Days" organized by Dokuz Eylul University Maritime Faculty. It is seen that the participants are the employees who work at the top level in shipping companies operating a large part of the Turkish shipping fleet that travels all over the world.

3.4. Findings and Results

A total of 14 participants responded to questions about cyber security issues. As a result, it is found that most of the shipping (12) companies have already started to develop strict policies and strategies in order to provide secured platform for protecting commercial and operational data. To do this, initially new investment policies are being developed. However, only one company representative declared that they are now in the preparation phase and it will be completed next year. The other participant stated that they did not take any security measures and acted on the past events and experiences. In particular, the company's employee, who operates the research vessel, stated that very strict information security measures were taken, and that these measures were also controlled by the flag state.

It is concluded that, in all companies, information security policies are well understood and implemented by all departments actively. In addition, when a new regulation on information security is adopted, it is announced to the departments as soon as possible through meetings. In addition, regular audits ensure that security policies are implemented in all level of operations.

A large part of the participants (9) emphasized that the employees of their company were continuously practiced, educated and trained by the IT department on the subject of security gap avoidance and information security defense systems. Besides, proactive measures that protect strategic data are updated by IT departments frequently and it is applied to all departments of the company at the same time. In addition, the spam mail generated by the IT departments are sent to the users unannounced and the system protection level and the user's awareness level is measured frequently. Three participants stated that the information security of company is provided by the third-party security

companies. They told that they were informed and educated by those companies at regular intervals.

All company representatives said that their company's software networks are continuously protected by the firewall.

According to the results of the study that only one shipping company has 4 developers and one of them is only interested in information security issues. The other one has two software developers who were employed in the company for 4 and 6 years. Two companies were protected by the IT departments, within the holding body, which employs at least 9 employees. Other representatives have declared that information security activities in their company are carried out not by department but by individuals. However, they stated in the future that these activities should be managed by a department within the framework of institutionalization.

It has been stated that seven shipping companies are implementing minimum security measures for on board equipment required by legislation. Three of them set some procedures on the restriction of data transfer through USB by physically locking and blocking the USB Ports. This application reduces the risk of data leakage, data theft, computer viruses and malware. Only threat-free web sites are allowed during the use of the internet alone. One sector representative stated that they are providing supervision and support services to the ships from specialized IT companies. He said the licensed anti-virus programs are being used and that this program is being monitored from the land and that the updates have been checked. Prior to the ship's embarkation, the captains were given special training from IT experts.

One of the measures taken against any network leakage on ships is that the PH program is preferred instead of the Outlook program. Besides, it is ensured that the new personnel joining ship is trained by the designated person about data security.

4. Conclusion and Recommendations

In this study it is concluded that cyber security, as a component of Industry 4.0., is growing phenomena in shipping industry in Turkey. It is observed that in recent years the

investments for information security infrastructure is increasing dramatically in Turkish shipping sector. Although the companies are taking their measures related to cyber security, it has not reached the desired level. Due to the global structure of the maritime sector, shipping companies have no luxury to adopt slowly macro environment variables such as technology and security. That's why vulnerability of the undefended data will lead to large commercial losses.

Today, global shipping companies make their investments in infrastructure to enable securing of their data. Hence, the IT department in the organizational structure of shipping companies has become more important than ever. In the modern organizational charts, the IT department stands out as the strategically important unit of the organization. Therefore, the shipping companies are strongly recommended to re-structure their organization to meet the requirements of Industry 4.0.

It has been seen that there is not enough qualified workforce in information security and information technology. Therefore, competent and qualified personnel should be trained and employed in this sector. This education should be given intensively in higher education institutions starting from the first level of education.

The other conclusion is that, the shipping companies in Turkey could not be fully adapted to the cyber-security system meeting requirements of Industry 4.0. Although it is seen that the companies take some measures on their own dimensions, it is seen that there is a non-standard structure in the sector.

In addition, it is concluded that there is a lack of digital vision on cyber security issues of shipping companies in Turkey. Insufficient technology infrastructure of a country and lack of security culture of company may cause extension of adaptation process period.

In this study, the representatives of the companies that operate a large part of the Turkish maritime trade fleet were interviewed. For further studies it is recommended that sample size can be increased, and also foreign ship-owners can also be included.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Maritime Investigation Reports Involving Man-Over-Board (MOB) Casualties: A Methodology for Evaluation Process

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ABSTRACT

Flag states must prepare and issue maritime investigation reports in accordance with the international agreements. International Maritime Organisation (IMO), in published circulars, specifically refers to 'lessons learned' from an accident or incident should be included in maritime reports. In order to identify the root cause of an event, therefore to include 'lessons learned information' in reports, there must be enough detail of information about the investigated event included in an investigation report. Detailed information included in reports may help identifying the procedural deficiencies or technical challenges. In this study, Man-Over-Board (MOB) events are considered as a sub group of maritime accident investigations and authors systematically reviewed over 100 reports containing MOB events. Reports indicate major differences in formats, type of information, and detail level of information content included in the reports. Authors developed and proposed a systematic methodology for reviewing and reporting the overall information retrieved from maritime accident reports. To cover all information from reviewed reports, this study identifies 113 information items and an associated standard form to use for extracting information from investigation reports. Enabling the data collected systematically from reports, issued by the world maritime accident reporting states and agencies, and successively populated into a database for overall analysis, this form is called "Maritime MOB Events Investigation Form (MEI Form)". This paper presents the content of the MEI Form and demonstrates the methodology of use for collecting, formatting, and analysing MOB investigation reports using several case

examples. Benefits of collecting this data in a structured execution methodology as part of the BIG DATA project is discussed.

Keywords: Maritime Accident Investigation, Casualty Investigation Code, Man Over Board (MOB), Lessons Learned, Big Data, Database, Data Format, Report Forms

1. Introduction

International conventions, such as Safety of Life at Sea [1], Maritime Pollution Act [2] and Load Line Convention [3], introduce liability and responsibility of casualty investigations assumed by the flag states. Therefore, flag states must prepare accident or incident reports and share findings as mandated by these international agreements. An international convention [4] clearly states that flag states are required to carry out an inquiry for the ships sailing under their flag at open seas. IMO adapted Casualty Investigation Code (CI Code) [5] in year 2008 in order to set an international standard for conducting the safety investigations and reporting. This code brings liability to very serious marine casualties. While MSC brings responsibility for the investigation of very serious marine casualties, Maritime Labour Convention (MLC) additionally introduces flag states to investigate serious marine casualties [6]. In order to classify a marine casualty as 'very serious marine casualty', the incident must involve; 'the total loss of the ship or a death or severe damage to the environment [7].

CI Code also clearly states that objective of a marine safety investigation is 'preventing marine casualties and marine incidents in the future [8]. It also states inclusion of 'the identification of causal factors and the making of safety recommendations' as necessary and yet 'the reports must be provided to the Organization to enable a wide dissemination of information to assist the international marine industry to address safety issues' [8].

A marine safety investigation report written as a result of a marine safety investigation must contain certain information, such as basic facts about the casualty or incident, relevant details about the ship, a narrative detailing the incident or marine accident [8]. Including such information, casualty investigation reports are submitted to the IMO Secretariat by the member flag states. IMO has a designated group called Correspondence Group on Casualty Analysis and this group reviews the submitted reports according to the guidelines included in a document called Casualty Analysis Procedure [9]. This group drives important information from casualty investigation reports, such as the analysis and lessons learned information, which is published for maritime community. The

authors studied the investigation reports and identified several inconsistencies in presenting the data as well as missing information.

Massive amount of digital data being collected from all sorts of sources every year and is very large. According to a report in 2014, almost 90 percent of the world's data collected until that year was generated during the past two years of 2014, with 2.5 quintillion bytes of data added each day [10]. Being in massive amounts, this data is called 'BIG DATA' [11]. Collecting and structuring this data using standardized forms, procedures, and conventional relational database techniques are of very big importance for analysis. While volume of data is increasing with a big velocity, majority of data is still having big variety and veracity [12]. According to a study, analytics related to unstructured data constitutes 95 percent of BIG DATA [12].

Although the business sector initiated and leading this BIG DATA project, governmental agencies has also begun to support this big effort in many ways [10,13]. There were already many proposals to governments through publications to help them serve the citizens using big data [13,14]. Focusing on benefits, procedures of developing BIG DATA and lessons learned from such efforts may be example to introduce the process into maritime sector. So far, there is no internationally established or shared idea about what should be regarded as big data in maritime affairs [12]. Although current maritime safety reports are submitted to IMO and lessons learned items are shared, the process is defined at a high level and issues exist with this important yet 'unstructured data'. Lambrou, M. [15] elaborated their knowledge management approach and framework in view of a maritime business case. Such efforts may help defining the structuring 'BIG DATA' process in maritime sector. A generic and detailed format description for extracting information from investigation reports, proposed in this paper, introduce a methodology for enabling analyses of data.

In current practice, MSC recommends root-cause analysis performed in the investigations; however, there is no guideline provided. In literature, according to comparison criteria [16], an effective Root Cause Analysis process meet the six

generalized criteria. There are several methods for analysing root causes of an accident/incident. Arslan [17], listed main root cause analysis methods for chemical tanker management as; FTA (fault tree analysis), ETA (event tree analysis), FMEA (Failure Mode and Effect Analysis), What/If Method, HAZOP (Hazard and Operability Analysis) and SWOT-AHP. According to a study, there are 20 different accident analysis methods; the mostly used ones are fault tree analysis, Pareto analysis [18]. Kececi [18] developed and presented a criterion, with 18 items, as conditions for appropriately application of root cause analysing marine accidents that that a root cause analysis method should have that is going to be used. Akyuz et. Al. [19] proposed an investigation model to apply to marine accidents that may help identify and reduce human errors in marine accidents. Their study includes a man overboard situation during a lifeboat drill, chosen as a novel case for their model demonstration. So far, there are no proposals in literature for standardizing the investigation forms to use or process current data other than what is laid out by current procedures issued by IMO, which are very generic with inconsistencies in formats resulting a big yet unstructured use by maritime agencies awe well as academia. Some of the other studies about marine casualty investigation and CI Code focus on limited aspects of casualty investigation and proposal for use in local regions [20]. Schröder-Hinrichs studies Accident investigation reporting deficiencies related only to organizational factors limited only with machinery space fires and explosions [21]. Some of these studies are centered on general casualty investigation (not IMO casualty investigation code) such as; [22] proposes a fuzzy model for Iranian marine casualty management and [23] studied the relationship between latent conditions and the characteristics of holes in marine accidents based on the Swiss cheese model.

Another perspective of maritime casualty reporting is the data being publicly available and structured such that agencies of academia may digitally retrieve and conduct analysis. The methodology introduced in this paper provides a methodology of structuring the data and sharing using a proposed form with a better standard information for enabling automated processes for analysis. With this approach, lessons learned based on statistics from world's reported MOB events may easier be driven. Therefore, this methodology

may be viewed as the first step definition and guidance for automating the lessons learned process for better understanding the areas for procedural improvements or introducing new techniques and technologies.

The most important outcome of maritime accident reports is the lessons learned and sharing this outcome with maritime user's community and technology developers. Weber [24], defines tasks in lessons learned process as; collecting, validating, storing, disseminating, and reuse. Weber [24] lists various methods of lessons learnt systems and proposes a system called 'Active Lessons Delivery System (ALDS)' [24]. Such studies point out that there is a wide range of lessons learned process and procedures. However, for driving lessons learned information from marine casualty investigations, specific procedures and processes are yet to be described.

Outcome of this study is the proposed use of the form, MEI Form, which is specific to the MOB event reports and may be viewed as guidance for automating the information acquisition and formatting the reports for driving a more structures process for driving lessons learned from MOB cases. World maritime investigation agencies can also use the proposed MEI Form as guidance in standardizing their data collection process.

2. Current Methodology Employed in Maritime Accident Reporting

Section 2.1 describe and discuss the current process used in world's maritime community for reporting MOB events and Section 2.2 describe current process performed by IMO for collecting and issuing the lessons learned items. Section 2 also presents statistics of reports submitted by Flag States and lessons learned items collected from various countries.

2.1. Process for Maritime Accident Investigation Reporting Involving MOB Events

Marine Safety Investigation reports must be prepared, reported, and shared with the IMO Secretariat by the investigating Flag States. According to IMO Maritime Safety Committee Regulation [25], a marine safety investigation report is written as result of a marine safety investigation must contain the following specific information:

- a **summary** outlining the basic facts of the marine casualty or marine incident and stating whether any deaths, injuries or pollution occurred as a result
- the **identity** of the flag State, owners, operators, the company as identified in the safety management certificate, and the classification society (subject to any national laws concerning privacy)
- where relevant the **details** of the dimensions and engines of any ship involved, together with a description of the crew, work routine and other matters, such as time served on the ship;
- a **narrative** detailing the circumstances of the marine casualty or marine incident;
- analysis and comment on the **causal factors** including any mechanical, human and organizational factors;
- a discussion of the marine safety investigation's findings, including the identification of **safety issues**, and the marine safety investigation's **conclusions**; and
- where appropriate, **recommendations** with a view to preventing future marine casualties and marine incidents.

For further review and analysis of these reports focusing in events involving casualties, these reports are reviewed by various different groups of the IMO according to the guidelines included in a document called Casualty Analysis Procedure. Figure 1 shows details of this process. In this process, IMO Casualty Analysis Working Group (CAWG) drives out the following information from casualty investigation reports [26]:

- the analysis of casualty report
- draft lessons learned for presentation to seafarers;
- potential safety issues, when appropriate; and
- draft safety recommendations, when appropriate.

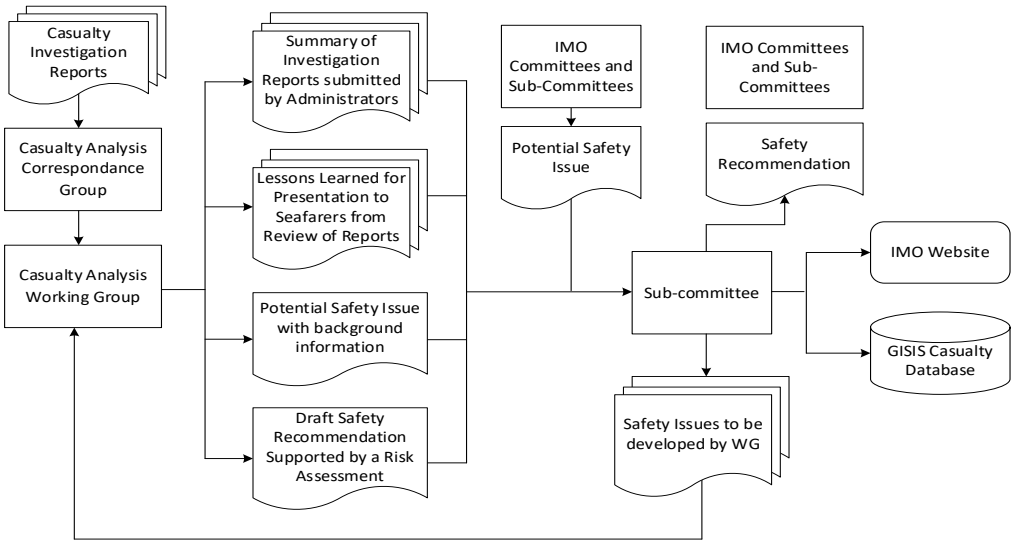

Figure 1: Graphic Representation of a Typical Flow of Casualty Information [26] (redrawn for clarity).

2.2. Investigation of Current Maritime Safety Reports

Authors accessed to IMO's public database, called Global Integrated Shipping Information System (GISIS) [27], and studied the current maritime safety reports and relevant publications. Until 31.12.2018, there has been 3876 recorded incidents categorized as 'very serious' in IMO database with 1603 of these incidents having maritime safety reports. Table 1 shows the number of reports submitted to IMO by some of the Flag States and populated in IMO website. The countries with highest submission records is also shown. In maritime community, total very serious incidents: Table 1 includes both "total number of 'very serious incidents'" and "with public investigation form", respectively, reported to IMO for the ships under Flag of the mentioned state. As these are involving ships with the respective Flag State, some of these investigation reports might be submission by other countries.

Table 1: Number of Investigation Reports Submitted to IMO by Major Flag States.

	Italy	Belgium	France	Japan	Turkey	Tunisia	US	Norway	Egypt	Brazil
Total very serious incidents	35	13	141	223	187	1	294	209	31	32
With public investigation form	6	4	71	50	14	0	13	18	5	8

So far, authors found 24 'Lessons Learned' documents in different formats published by IMO in English [7], 13 of which is found published in French [26] and 15 of which is in Spanish [28]. However, up to date, there are 3100 reports are submitted in GISIS website [7] This may be an indicator for that GISIS website could announce not many lessons learned items, using the current process.

For better understanding the content of current submitted reports with MOB involvement, authors studied and evaluated more than 50 reports and selected seven reports randomly among the collected reports, Table A.1 (Appendix A) lists the specifics about these reports and Table 2 presents an overview of these reports, as a case study and presentation. First 7 rows in Table 2 includes the information required by CI Code [25], listed in previous section, and the next four rows provide the total number of information available in pertaining report, shown in the next seven respective columns. Some of the reports included very little information, as specified in CI Code and listed in Table 2; therefore, those reports were purposely discarded for use in this study for presentation. Table 2 gives some idea about total pages, what type of information included and the total number of words used in the reports, yet it does not provide enough detail for what specific information and how much detail is provided. This and several other issues noted when reviewing these reports are, for example:

- Report No 5 provides four recommendations while Report No 7 provides only one.

- All recommendations were for different targets. For example, one recommendation was for 'Ministry of Health Care Services' while several recommendations were reminding notes on 'Code of Practice on Safety Standards for Class II Vessels.
- CI Code clearly states that, an investigation report must contain, 'where relevant the details of the dimensions and engines of any kind of ship involved.' One report provides detailed information about the relevant engine details whereas another report gives only engine power and one other includes no engine information.
- Additionally, format of the content between the reports are inconsistent; yet there is no tool to identify this observation by measurable methods.
- Total number of pages used in several reports are few pages, i.e. only 4 in one report, while some other reports are more than 30 pages.
- There are some reports with one or several missing information areas. For example, there is information in all of them about the narrative; however, specifying seven items in the contents does not indicate what detailed level of information exist.

Table 2: Review Results of Several Accident Investigation Reports According to Requirements of RESOLUTION MSC.255(84).

Report Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Summary	√	-	-	√	√	√	√
Identities	√	√	√	√	√	√	√
Details	√	√	-	√	-	√	√
Narrative	√	√	√	√	√	√	√
Casual Factors	√	√	√	√	√	√	√
Discussions	√	√	-	√	√	√	√

Report Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Recommendations	-	√	-	√	√	√	√
Total Pages	8	8	4	17	35	33	11
Total Pages Without Cover Page	8	4	4	14	31	31	11
Total Number of Words (estimate)	3806	1738	1317	2433	12305	10468	4221
Percent Field Complete (estimate)	85,70%	85,70%	42%	100%	85,70%	100%	100%

Below is a summary of learnings authors obtained as the outcome of this study:

i. CI Code requirement gives a general idea about what must be the contents of an investigation report; however, it does not specify the detailed contents should be. This may be because the investigation reports, in practice, are in specific subjects, such as ship accident, personal injury during work, or other.

ii. CI Code's content recommendation is not specific for the MOB events. When specific MOB event is studied from investigation reports, many specific information become relatively very important for understanding the procedures and techniques used and how in order to understand the root cause as well as to drive tangible lessons learned items.

iii. For populating the report information such that those can be crosschecked through analysis tools from databases, the MOB reports should be structured accordingly, allowing the reports have consistent formats. It would allow statistical analysis of reports.

3. Investigation of MOB Events for Developing MEI Form

Authors studied the factors affecting an MOB event to start driving the required information that should be presented in investigation reports involving MOB events. Section 3.1 present these factors with several examples from the studied reports.

3.1. Important Factors in an MOB Event

Detailed information is needed to understand all details associated with an MOB event. Initially, authors made the following considerations to understand what areas of information should be included in the reports:

- What information is already requested by IMO
- The information areas missing in the reports for extracting lessons learned information
- Factors affecting the event is being initiated
- Factors affecting the development of the process negative or positively
- Techniques used during the response action
- Factors affecting the end result, which is casualties' survival or ending with minimal health risks
- Information to derive should be standard such that it can be extracted and inserted into a database with appropriate tags.

Examples below provide an understanding for what detail level of information need to be included in the reports.

Example 1: During cargo operation at port, a deck rating fell overboard resulting with fatality on vessel Joanna [29]. Even though there was an alcohol policy, Analysis of postmortem blood revealed that Stanislaw had a blood alcohol concentration of 93mg/100ml. There was a procedure but it was not applied properly. Casualty was not using proper safety equipment and there were no proper safety equipment onboard. From this event, following questions were driven and added on MEI form:

- Alcohol / Drug Influence; 'Describes the alcohol or drug influence of the casualty at the time of event.'
- Working as per the safety rules; 'Was the work being performed as per the safety rules and instructions?'
- Workplace conditions as per the safety rules; 'Was the work conditions set as per the rules and safety instructions'

Example 2: Response actions and times are very critical when removing the casualty from water. According to the report of MOB event onboard Hyundai Dangjin (Appendix A, Report No. 2), the casualty was alive when seen and became not meanwhile there was a removal procedure continuing. To understand the details of why the casualty could not survive, sea temperature and time of removal of the casualty from water must be known, yet this information is not found in this report.

3.2. Factors Considered for Developing the Contents of the Proposed MEI Form

MOB event starts with the time of a person falling over board and ends when the MOB response operation is terminated. There are many factors affecting an MOB event, for example, "how it occurred", "how it developed", "how it was responded", and "how it was terminated". To understand what specific details are associated, authors reviewed over 100 reports and focused on the details of information. Starting with the seven content items provided in CI Code, authors studied over 100 reports and labelled information items with a unique code. There became 113 information fields identified in this study with unique codes assigned for each information items, as presented in section 4.

Using the evaluation of the reviewed reports as well as listed aforementioned factors, specific to MOB event information in reports, the all information that can be found in reports was categorized as follows:

- Vessel Information
- Navigation Conditions
- Information about the Casualty/Casualties
- Meteorological Conditions

- Work Type and Conditions
- Managerial/Procedural Conditions
- Start of the Event and Initial Timings
- Response Times and Actions
- Search and Rescue (SAR) Operation
- Health Status of the Casualty
- Type of Recommendations

Break down of the above categories yielded in 113 information items, with unique codes, shown in the sections of MEI form, presented in sections below.

4. Page Layout and Format

This section describes the contents of the MEI Form, proposed to use by Maritime Investigators when the investigation involves a Man-Over-Board (MOB) casualty. There is a group of 11 sub-categories with 113 form items under all categories in the proposed MEI Form. Each item has a unique identifier, named as 'Field Code', for future use in electronic form submissions into a database. The user could search the MEI Reports Database with the Field Code of the specific item and do analysis for one item or do a more complex analysis with correlation study.

Note: In tables in this section, Tables 3 thru 12, 'NA' means 'Not Applicable' and 'NI' means 'Not Indicated' in the report.

4.1. Vessel Information

This field group is to drive information from a report about the vessel, associated with the MOB event at the time of the event occurring. Table 3 shows the detailed contents of the Vessel Information to retrieve from reports with short descriptions for guidance.

Table 3: Proposed MEI Form: 'Vessel Information' Section.

Field Code	Field Name	Short Description /Guide
V01	Event number	Event investigation number, which is an identifier for the MOB event.
V02	Vessel name	Name of the ship recorded during the MOB event investigation.
V03	Flag	Registered flag of the vessel.
V04	Vessel type	For example, cargo ship, passenger ship, research ship, military ship, etc.
V04.1	Vessel sub category	G04.1 is a sub-category for the vessel type. For example, crude oil tanker, container, and bulk carrier fall under cargo ship sub-category.
V05	Age group	The age group of the ship's age. Age intervals mainly are as follows: 0-3, 4-6, 7-10, 11-15, 16-20, 21-30, 31+, or 'NI'. If the report does not specify, the difference between the MOB event date and ship's construction date is used.
V05.1	Exact age	Construction year of the vessel.
V06	Tonnage group	Gross Tonnage of the vessel, which specifies the predetermined tonnage range of gross tonnage of the ship. Tonnage intervals are: 0-49, 50-99, 100-299, 300-499, 500-999, 1000-1999, 2000-2999, 3000-4999, 5000-9999, 10000-49999, and 50000+.
V06.1	Tonnage (GRT)	The exact value of the gross tonnage recorded in the ship's registry.
V07	Length group	The following interval of the registered full length (LOA) of the vessel, in meters: 0-11, 12-19, 20-49, 50-99, 100-199, or 200+.
V07.1	Vessel length	The registered full length (LOA) of the vessel in meters.
V08	Vessel classification	The classification organisation of the ship.
V09	Number of personnel	The number of personnel listed in the ship's log at the time of the MOB event. At ports or during anchorage, registered personnel or passenger's being out of the ship does not change this number.

4.2 Navigation Conditions

This field group is for extracting the navigation conditions under which the ship is navigating on the sea and / or what operations it is performing during the MOB event. Table 4 shows the detailed contents of the 'Navigation Conditions' category of information to retrieve from reports.

Table 4: Proposed MEI Form: 'Navigation Conditions' Section.

Field Code	Field Name	Short Description /Guide
N01	Navigation status	Select 'Yes', 'No', 'NA' or 'NI' as an answer for the following question: 'Was the ship in navigation during the MOB event?'
N02	Operational state	The operational status of the ship during the accident. Enter Navigation, Port, Anchorage, Drift, Shipyard, In-Manoeuvre, Other, or 'NI'.
N03	Was duty officer alone?	Select 'Yes', 'No', 'NA' or 'NI'.: Note: Need to fill this item if S03 is one of the following choices: Navigation, anchorage, drift, In-Manoeuvre, or Other (if the ship has way?). Otherwise, enter "NA".
N04	Who has the command-in-charge?	Indicates which one of the personnel had the responsibility of the ship at the time of MOB event: 'Watch keeping Officer', 'Ship's Captain', 'Pilot', 'No Command'. Note: Need to fill this item if S03 is one of the following: Navigation, anchorage, drift, In-Manoeuvre, or Other (if the ship has way?). Otherwise, enter "NA".
N05	Distance to nearest land	The distance, in nautical miles, to the nearest land part at the time of the event.
N06	Location	Preferably the latitude and longitude of the ship's location. If exact location is not available in the report, geographic name of the location is used.
N07	Ship's draft (m)	Draft of the vessel, in meters.
N08	Ship's speed (knots)	Ship speed, in nautical miles (knots). Enter: Ship speed value in knots, if the ship in navigation or "0" is the ship is anchored or at port

4.3 Casualty Status/Information

This section provides a general information about the person(s) involved in the MOB event as per the studied report. It also helps to understand whether a person was under influence of alcohol or drug recorded at the time of the event.

Table 5: Proposed MEI Form: 'Information about the Casualty/Casualties' Section.

Field Code	Field Name	Short Description /Guide
C01	Rank	Enter the rank or status of the casualty on-board ship. Captain, Deck Officer, Passenger, Other Service Personnel are some examples. "Integrated Rating" classification can be entered if the casualty's position is identified as both deck and engine personnel.
C02	Nationality	Nationality of the casualty.
C03	Age	Age of the casualty.
C04	Overall on-board work experience	Work experience of the casualty in years.
C05	Work duration (on-board Ship)	Work duration on-board the current ship of the casualty, in months.
C06	Alcohol / drug Influence	Describes the alcohol or drug influence of the casualty at the time of event. Select 'Yes', 'No', 'NA' or 'NI'.

4.4 Meteorological Conditions

This section of the form is to extract the environmental, especially meteorological conditions during the MOB event.

Table 6: Proposed MEI Form: 'Meteorological Conditions' Section.

Field Code	Field Name	Short Description /Guide
M01	Adverse weather	Information to drive the weather conditions having any adverse effects to the MOB event. Information to consider in general are the effect of wind, sea waves, current, visibility, and temperature. Select 'Yes', 'No', 'NA' or 'NI'.
M02.1	Wind speed	Wind speed in 'beafort scale'.
M02.2	Wind direction	Wind direction in angle, as true direction.
M03	Sea scale	Sea Scale indicating the condition of sea waves, entered in 'beafort scale'.
M04.1	Sea current speed	Enter sea current speed in knots.
M04.2	Sea current direction	Direction of the sea current's angle, as true direction.
M05	Rain	Indicates the existence of rain or snow conditions during the event. Information to include rain, snow, slow rain, no rain, etc.
M06	Visibility	Indicates the visibility recorded at the time of the event. The information is entered as per the visibility scale from 0 to 8 or 'NI' is entered. If the reports states 'normal visibility', enter '6' for a neutral visibility level.
M07	Sea temperature	Sea temperature in Celsius (°C).
M08	Air temperature	Air temperature, in Celsius (°C).
M09	Sea depth	Sea depth in meters.
M10	Darkness	Indicate the weather being 'dark' or 'not dark'.
M11	Lightning conditions	Lightning conditions, recorded at the time of the event. Enter as follows: Yes: Enough light conditions No: Lightning is not enough
M12	Day/night	Enter 'Day-time' or 'Night-time' if additionally indicated in the report.

a. Work Type and Conditions

This section of the form is to extract the information about the work type and conditions during the MOB event.

Table 7: Proposed MEI Form: 'Work Type and Conditions' Section.

Field Code	Field Name	Short Description /Guide
W01	Relevance to work	Information to drive whether the event was work related. Yes: Work related event No: Not a work related event During transportation: Both for passengers and for employees during their transportation to/from work. Enter 'NI' if no information found in the report.
W02	Working as per the safety rules	Was the work being performed as per the safety rules and instructions? Fill this section with a 'Yes', 'no', or 'NI. Example: The answer is 'No' when not wearing a life jacket where a person 'must' wear, at the time of the event.
W03	Workplace conditions as per the safety rules	Select 'Yes', 'No', 'NA' or 'NI' as answer to the following q: "Was the work conditions set as per the rules and safety instructions?". Example: The answer is 'No' when there is no life jacket available where there 'must' be, at the time of the event.
W04	Wearing a life jacket	Was the casualty wearing a life jacket (or personal floatation aid), as recorded at the time of the event? Select 'Yes', 'No', 'NA' or 'NI'.
W05	Alone	Information to understand if there was a secondary person (other than the casualty) witnessing the event. Select 'Yes', 'No', 'NA' or 'NI'.

4.6 Managerial/Procedural Conditions

This section of the form is to extract the documentation and process related managerial/procedural conditions of the vessel, indicated in the event report.

Table 8: Proposed MEI Form: 'Managerial/Procedural Conditions' Section.

Field Code	Field Name/Short Description	Guide
P01	Applicable checklist	Is there a document requirement (checklist or form) before the work of which the event occurred? For example, a checklist must be filled at each time a work will be at the overboard. Select 'Yes', 'No', 'NA' or 'NI'..
P01.1	Checklist filled	If P01 cell is filled with a 'Yes', then this section is filled. Select 'Yes', 'No', 'NA' or 'NI'.
P01.2	Checklist filled properly	If P01.1 cell is filled with a 'Yes', then this section is filled. Select 'Yes', 'No', 'NA' or 'NI' depending on the checklist or form fulfilled properly as per the instructions.
P02	Applicable general work procedures	This section is to understand whether the safety instructions or procedures were described per the safety manuals. Select 'Yes', 'No', 'NA' or 'NI'.
P02.1	General work procedures implemented properly?	Select 'Yes', 'No', 'NA' or 'NI'. Note 1: If the result of the section P02 is a 'yes', then this section is to fill. Note 2: If the result of the section P02 is other than a 'yes', 'NA' is to enter in this field.
P03	Fatigue condition	This section is to extract information from the report for that there could be a fatigue situation involved with the casualty. Select a Standard Answer.
P04	Implementation of MOB drills	Was the MOB drills were carried out in required periods? Select 'Yes', 'No', 'NA' or 'NI'.
P05	Was there a SAR Procedure?	Select 'Yes', 'No', 'NA' or 'NI'.
P05.1	SAR Procedure implemented appropriately?	Select 'Yes', 'No', 'NA' or 'NI'. Fill this section only if the result of the section P05 is a 'yes'. Or, fill with 'NA'.

4.7 Start of the Event and Initial Timings

This section of the form is to extract information about the MOB Event's Time and Initiation, from the event report. In other parts of this study, this time is mentioned as T0. All other times are given as time passed from this moment.

Table 9: Proposed MEI Form: 'Start of the Event and Initial Timings' Section.

Field Code	Field Name/Short Description	Guide
M01	Date	Date of the MOB event.
M01.1	Time	Time recorded for the man become overboard. Time format in formats, such as ZT, GMT or national time formats are all acceptable.
M02	Action causing the MOB event	The action casualty was performing when the MOB event occurred. Some examples: 'Rigging pilot ladder', 'engaging in fishing', 'slipping', 'hit by waves', 'extreme wind', 'intentional'.
M03	From where?	Information about from which part of the vessel, the casualty fall overboard. The following are the choices to enter: 'Forecastle', 'Starboard bow', 'Starboard', 'Starboard quarter', 'Aft deck', 'Port quarter', 'Port', 'Port Bow', 'Other', or 'No information'.
M04	Immediate/late awareness	Was the MOB event seen immediately by another person? Fill this section with an answer, namely, 'yes', 'no', or 'NI'.
M05	Latency	Minutes passed between MOB and the time that a person became aware of the situation.
M06	Assumed over board	There are cases where man-over-board event is not witnessed but assumed with an investigation. Was the MOB event had to be the assumed? Select 'Yes', 'No', 'NA' or 'NI'.
M06.1	Decision duration	Minutes passed between the time of the actual event and the time the MOB event had to be assumed. Enter 'NA' if M06 is other than a 'yes'.

4.8 Response Times and Actions

This section of the form is to extract information about the initial practices implemented for preventing a casualty or a further damage.

Table 10: Proposed MEI Form: 'Response Times and Actions' Section.

Field Code	Field Name/ Short Description	Guide
T01	Event notification to the bridge	When MOB event actual time is considered to be t0, enter the duration, in minutes, passed between t0 and the time of the event notified to the bridge (when in navigation) or cargo control station (during loading/unloading).
T02.1	Alarm	Enter the duration, in minutes, passed between t0 and the time of alarm.
T02.2	Announcement	Enter the duration, in minutes, between t0 and the time of internal announcement.
T02.3	Whistle	Enter the duration, in minutes, between t0 and the time of whistle.
T03	Buoy	Enter the duration, in minutes, between t0 and the time of throwing buoy.
T04	Manoeuvring	Enter the duration, in minutes, between t0 and the time of the start of manoeuvring. For search and rescue events, generally 'Williams Turn' method is implemented. If the ship is not in navigation, enter 'NA'.
T05	Captain	Enter the duration, in minutes, between t0 and the time of the ship's captain gaining control over the situation.
T06	GPS MOB	Enter the duration, in minutes, between t0 and the time of the activation of the GPS MOB system.
T07.1	Notification to close by ships	Enter the duration, in minutes, between t0 and the time of the notification broadcast to close by ships. Note: If the notification to the SAR stations performed with a VHF type general announcement, this could also be considered as the announcement to the close by ships.
T07.2	Notification to SAR stations?	Enter the duration, in minutes, between t0 and the time of the notification broadcast to the Shore or SAR stations.

Field Code	Field Name/ Short Description	Guide
T07.3	Other notifications	Enter the duration, in minutes, between t0 and the time of the notification to other organizations, such as ship operating company.
T08	Rescue boat is ready	Enter the duration, in minutes, between t0 and the time of the Rescue Boat is ready.

4.9 Search and Rescue (SAR) Operation

This section of the form is to drive information about the rescue operation, as indicated in the event report.

Table 11: Proposed MEI Form: 'Search and Rescue (SAR) Operation' Section.

Field Code	Field Name/Short Description	Guide
R01	Rescue boat	Was there a rescue boat utilized in the MOB event? Select 'Yes', 'No', 'NA' or 'NI'.
R02	Timing of rescue boat in water	Duration, in minutes, between t0 and the time of the rescue boat placed in water.
R03	Other ships	Was there other ships involving with the rescue operation? Select 'Yes', 'No', 'NA' or 'NI'.
R04	Timing of other ships	Duration, in minutes, between t0 and the time of the other ships joined in the rescue operation. Note 1: If there are more than one ship joined to the operation, the duration is for the first ship involved Note 2: If R03 is 'no', fill this with 'NA'.
R05	SAR ships	Was there SAR ships joined into the SAR operation? SAR ships are boats designed to operate only for SAR operations. Select 'Yes', 'No', 'NA' or 'NI'.
R06	Timing of SAR boats	Duration, in minutes, between t0 and the time of the SAR Boat joined in the SAR operation. Note 1: If R05 is 'no', fill this with 'NA'.
R07	Air operation	Was there Air Vehicles joined into the SAR operation? Select 'Yes', 'No', 'NA' or 'NI'.

Field Code	Field Name/Short Description	Guide
R08	Timing of Air operation	Duration, in minutes, between t0 and the time of the Air Vehicle(s) joined in the SAR operation. Note 1: If R07 is 'no', fill this with 'NA'. Note 2: If there are more than one air vehicle, enter the duration for the first air vehicle.
R09	Shore assistance	Was there shore personnel or teams (such as ambulance and medical teams) joined into the SAR operation? Select 'Yes', 'No', 'NA' or 'NI'. Note: Enter 'NA' if the ship is not in port.
R10	Timing of shore assistance	Duration, in minutes, between t0 and the time of the Shore Assistance started in SAR operation. Note 1: If R09 is 'no', fill this with 'NA'. Note 2: If there are more than one team or person, enter the duration for the first team joined into the SAR operation.
R11	Casualty removed from the water	Was the casualty removed from water (regardless of survival status)? Select 'Yes', 'No', 'NA' or 'NI'.
R12	Removed by	Enter the team or personnel removed the casualty from water. Fill this item if R11 is 'yes' or fill with 'NA'.
R13	Timing of removal	Duration, in minutes, between t0 and the time of the casualty was removed. Note: Fill this item if R11 is 'yes' or fill with 'NA'.
R14	Cancellation of the SAR operation	Enter the reason which cancelled the SAR operation other than 'removal' of the casualty from water. Examples are: Shore authorities command/order Ship decision Heavy weather conditions Other No info
R15	Duration, cancellation of the SAR operation	Duration, in minutes, between the start and cancellation time of the SAR operation.
R16	Limited Sighting of the Casualty in Water	Was there eye watch of the casualty, after the MOB, meanwhile the casualty in the water, for a limited time?

Field Code	Field Name/Short Description	Guide
		Select 'Yes', 'No', 'NA' or 'NI'.
R17	Duration, limited sighting of the casualty in the water	Duration, in minutes, of the casualty was under eye watch. Enter a value if R16 is a 'yes' or enter 'NA'.
R18	Uninterrupted sighting of the casualty in water	Was there a continuous eye watch of the casualty until the end of the MOB operation? Select 'Yes', 'No', 'NA' or 'NI'.

4.10 Health Status of the Casualty

This section of the form (Table 12) is to extract information about the health status of the casualty. Note that the investigator should fill all sections of the MEI Form separately for each casualty.

Table 12: Proposed MEI Form: 'Health Status of the Casualty' Section.

Field Code	Field Name/Short Description	Guide
H01	Death	Enter the status of the casualty (Did the casualty die?). Fill this section with: 'yes: Death', 'no', 'NA', or 'NI'.
H01.1	Witnessing death	Was the death identified through a medical check, such as controlling the pulse or with a similar method? Select 'Yes', 'No', 'NA' or 'NI'.
H01.2	Decision for death	Was the death of the casualty the result of a decision, considering the conditions, such as seawater temperature, waves, during the operation? Select 'Yes', 'No', 'NA' or 'NI'. Note: If the casualty could not be found, as per the report, select 'Decision for Death'.
H01.3	Timing of death	Was the death before or after the end of SAR operation? Fill this section with a 'before', 'after', 'missing/assumed death', 'NA', or 'NI'.

Field Code	Field Name/Short Description	Guide
H02	Cause of death	Fill this section if H01 is a 'yes' or, enter 'NA'. Some examples to enter are 'hypothermia', 'cardiac arrest', 'head injury', 'drowning'.
H03	Duration until death	Duration, in minutes, between t0 and the time of death. Fill this section with a 'yes', 'no', 'NA', or 'NI'. Note 1: If the report does not include this information, use the information in the death announcement. Note 2: If the casualty could not be found or not taken from the sea, enter 'not clear'.
H04	Rescue to death timing	Duration, in minutes, between the time of rescue and time of casualty's death. Note 1: Fill this section only if both H01 and R11 are 'yes'. Note 2: If the report does not include this information, use the information from the death announcement.
H05	First aid	Was there a first aid needed? Select 'Yes', 'No', 'NA' or 'NI'.
H05.1	Duration MOB to first aid	Duration, in minutes, passed between the MOB and first aid given. Note 1: Fill this section only if H05 is 'yes' or enter 'NA'.
H05.2	Duration rescue to first aid	Duration, in minutes, passed between the times of rescue of the casualty to the first aid started. Note 1: Fill this section only if both H05 and R11 are 'yes' or enter 'NA'.
H06	First Aid at or by the medical facility (Shore side)	Was there a first aid performed by the medical care personnel (shore based), i.e. at an ambulance, hospital or at a health centre? Select 'Yes', 'No', 'NA' or 'NI'.
H06.1	Duration, time passed until first aid given by at or by an established medical facility (shore side)	Duration, in minutes, passed between MOB time and time of first aid given by shore side medical care personnel. Enter 'NA' if H06 is not a 'yes'.

4.11 Type (Category) of Recommendation

This section of the form is to extract recommendations properly from reports. Recommendations are categorised as 'Human', 'Management', and 'Equipment'. The form shown in Table 13 is used for extracting the recommendations with categorisations.

Table 12: Proposed MEI Form: 'Type of Recommendation' Section.

Field Code	Field Name/Short Description	Guide
L01	Existence of Recommendation	Fill this section with a 'yes' or 'no'.
L02	Number of Recommendation	Enter the number of recommendations indicated.
L03	Recommendation Cat I	Enter 'yes' if there is a recommendation in 'Human' category Enter 'no' if there is no such recommendation. 'Yes' would indicate at least one recommendation is made in this category.
L03.1	Content of Rec Cat I	Enter all recommendations as indicated in the report in 'Human' Category'.
L04	Recommendation Cat II	Enter 'yes' if there is a recommendation in 'Management' category Enter 'no' if there is no such recommendation. 'Yes' would indicate at least one recommendation is made in this category.
L04.1	Content of Rec Cat II	Enter all recommendations as indicated in the report in 'Management' Category.
L05	Recommendation Cat II	Enter 'yes' if there is a recommendation in 'Equipment' category Enter 'no' if there is no such recommendation. 'Yes' would indicate at least one recommendation is made in this category.
L05.1	Content of Rec Cat II	Enter all recommendations as indicated in the report in 'Equipment' Category.

5. Benefits of Using the MEI Form

Appendix A shows the use of MEI Form for extracting information from three different Investigation Reports. List of these three reports are as follows:

Authors noted benefits while implementing the MEI Form for these reports. This section summarizes the benefits of using the MEI Form with a standard content and format, allowing the data from MOB investigations populated in a database, called MEI database.

Authors were able to populate information from over 50 investigation reports with MOB events and derived many results. This paper's focus is to describe the MEI Form and discuss the benefits; therefore, some of the benefits observed during this analysis and research study are reported and discussed in sections below. Further discussion on the analysis results will be a topic of another report paper.

5.1 Obtaining Statistical Data

Using standard fields in digital forms populated in a database, statistical data can easily and accurately be driven. As an example, according to data provided by Boat Owners Association of the United States Reports, U.S. boating MOB events between 2003 and 2007 [30]:

- In deaths from MOB events occurring during day times, the rate of the casualties' being under the influence of alcohol was 27 percent. Whereas, the same rate was found as 50 percent at night times.
- 90 percent of events occurred in low weather conditions with wave height being less than one feet.
- 24 percent of the deaths were at night and 76 percent were during day.

Academia and industrial researchers can easily generate similar statistical results using the data on global perspective. Additionally, several parameters between the information across all reports could be analysed for more elaborated statistical evaluations.

5.2 Providing Useful Data for Obtaining Lessons Learned

Very few of the current reports provide some lessons learned information and IMO Sub-Committees are then can review and evaluate the information. However, the statistical results using the data can provide direct information as 'lessons learned'. For example:

- Alcohol has a very high (27 percent at day, 50 percent at night) in MOB casualties in boating events
- Influence of alcohol in MOB casualties at night is nearly twice (1,852 times) a day.
- A great percentage (90 percent) of events occur in favourable weather conditions (wave height being less than 1 feet).

As well as providing useful data for obtaining lessons learned, standardized and digitized forms provides exact numbers and data instead of generic numbers.

5.3 Better Understanding of the Root Cause

In the MOB event of Graig Rotterdam, casualty fell overboard when cargo at deck collapsed. There was an applicable checklist titled; 'Refer to Log & Timber Cargo Operations Checklist'. Checklist was filled by chief officer and verified by master but no control measures were taken and requirements of checklist was matched. When the information is extracted from this report using MEI Form, P01, P01.1 and P01.2 are the applicable fields and while extracting the information, the process is shown in Figure 2. To better understand this process, below mentioned three questions are taken from the proposed MEI form:

- P01 Applicable checklist; was there a document requirement (checklist or form) before the work of which the event occurred?
- P01.1 Checklist filled; if P01 cell is filled with a 'Yes', then this section is filled with a 'yes', 'no', 'NA', or 'NI'

- P01.2 Checklist filled properly; if P01.1 cell is filled with a 'Yes', then this section is filled. Fill this section with a 'yes', 'no', 'NA', or 'NI' depending on the checklist or form fulfilled properly as per the instructions.

Answers of these three questions are enough to distinguish that the root cause of this event is a human factor or managerial issue.

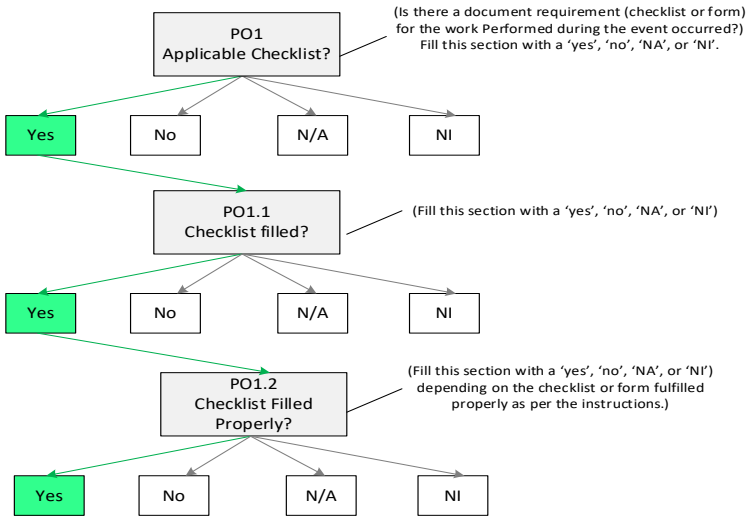

Figure 2: Methodology Applied for Extracting the Data related to Checklists (Applied and properly filled according to the information in the report under review).

5.4 Correlation between Relevant Parameters in a Report

From data mentioned above 'Obtaining Statistical Data' title, 24 percent of the deaths were at night and 76 percent were during day. In order to drive these sort of information and to find out the factors affecting event, many questions are required to be asked and analysed for relevance to see if the relation is coincidental or actual.

Using MEI Form data applied to 50 MOB event reports, the following statistical results were obtained: 36.7 percent of the casualties were alone and 63.3 percent of the casualties were not alone at the time of the MOB event. In MEI Form, P03 under 'Managerial/Procedural Conditions', fatigue condition is specifically indicated. According to this, in 85 percent of the events, fatigue was not an issue.

5.5 Automating the Lessons Learned Process

Although MEI Form does not directly cover a 'Lessons Learned' section. Relational topics to 'Lessons Learned' can easily be generalized and information extracted from the reports via categorizations. Designing of a database architecture considering the categories of the lessons learned could improve the current Lessons Learned process of IMO, shown by Figure 1. The use of MEI Form and process described in this paper helps bring lessons learned from five studies that could be performed on the reports populated in MEI Database (Figure 3)

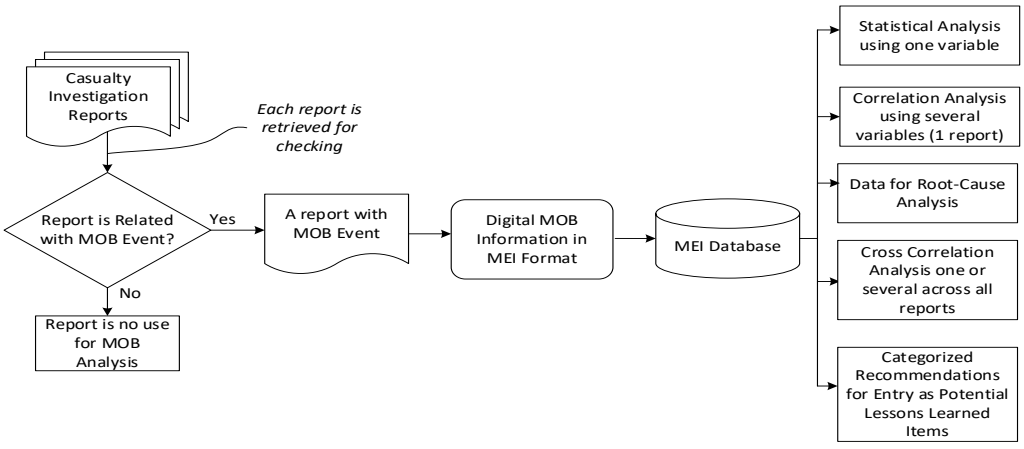

Figure 3: Methodology of MOB Reports Data Retrieval, Formatting, and Analysis Process.

5.6 Readiness for BIG DATA with Structure and Format

One of the key points in this study is that the data can be used as part of the BIG DATA project in maritime investigations. This paper showed the benefits of using a standard form, proposed and called MEI Form in this paper, for extracting information from maritime investigation reports.

6. Conslusions

Having the data investigated using MEI Form showed a structured methodology for populating all MOB related maritime accidents digitally with a unique format. It is also a proposed methodology for maritime investigating agencies to utilize the MEI Form, as guidance, for driving usable "lessons learned" information and "recommendations" from all existing reports in their databases. Three examples are provided for formatting, populating and analysing the data.

Obtaining the statistical analysis results may be automated and the results may directly help areas to identify as for the improvements in, for example:

- MOB procedures
- Innovative technologies to utilize for detecting the event, preventing it from happening, or minimizing the risk level to casualty before, during or after the MOB event respectively
- Analysing one or several parameters for allowing lessons learnt information gathered from analysis results

The authors study is continuing with acquiring, formatting, populating the information into the MOB Events Global Database.

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Appendix A: Investigation Reports

Table A.1: Reports Selected for Reviewing their Contents as per the Requirements of RESOLUTION MSC.255(84).

#	Ship Name	Publishing Agency	Flag State	Report Name	Report Date
1	Forth Guardsman	MAIB Marine Accidedent Investigation Branch	UK	Fatal injuries to a crewman during mooring operations on FORTH GUARDSMAN South of Jura	September 2011
2	Hyundai Dangjin	Australian Transport Safety Bureau	Australia	Man overboard fatality from Hyundai Dangjin	19 January 2016
3	Federal Champlain	The Transportation Safety Board of Canada	Canada	Marine Transportation Safety Investigation Report M17C0292	06 September 2018
4	Kwong Fei 38	Marine Accident Investigation Section	Hong Kong	Report of investigation into the fatal accident of a sailor fell overboard a local dumb lighter "Kwong Fei 38" and drowned in the waters east of Round Island on 13 January 2017	20 July 2018
5	Ribeye 785	Accident Investigation Board	Norway	REPORT ON MARINE ACCIDENT – RIB, FALL OVER BOARD IN OLDEN 22 JULY 2015	March 2017
6	Skawlink III and Nord Gardenia	The Danish Maritime Accident Investigation Board	Denmark	2017SKAWLINK III and NORD GARDENIAFall overboard on 29 September 2016	11 May 2017
7	MV MSC Ravenna	Marine Safety Investigation Unit	Malta	MV MSC RAVENNA Fatal fall overboard of a crew member in the port of M'Xlokk 22 June 2017	June 2018

Appendix B: Case Studies for Use of MEI Form

This appendix shows these of the MEI Form with three example reports as shown in Table B.1. The report examples shown in Table B.1 are the first three reports shown in Table A.1 in respective order.

Table B.1: Use of MEI Form for extracting information from investigation reports: Extraction study for three example reports shown.

CAT.	Code	Field Name	Reports		
Vessel Information	V01	Event Number	1	2	3
	V02	Vessel Name	Forth Guardsman	Hyundai Dangjin	Federal Champlain
	V03	Flag	British	Liberia	Marshall Islands
	V04	Vessel Type	Commercial (Other)	Cargo Ship	Cargo Ship
	V04.1	Sub Category	Landing craft	NI	Bulk Carrier
	V05	Age Group	21-30	0-3	NI
	V05.1	Exact Age	28	3	NI
	V06	Tonnage Group	500-999	50000+	NI
	V06.1	Tonnage (GRT)	654	132587	NI
	V07	Length Group	20-49	200+	NI
	V07.1	Vessel Length	48.46	329.95	NI
	V08	Vessel Classification	None	Nippon Kaiji Kyokai	NI
	V09	Number of Personnel	6	NI	NI
Navigation Conditions	N01	Navigation Status	No	No	No
	N02	Operational State	In-Manoeuvre	Port	Port
	N03	Was Duty Officer Alone?	No	NA	NA

	N04	Who has the Command-in-Charge?	Ship's Captain	NA	NA
	N05	Distance to Nearest Land	0	0	0
	N06	Location	55°47.4'N 006°01.3W	20° 35.33' S 117° 10.50' E	Thunder Bay Terminals
	N07	Ship's Draft (m)	NI	NI	8,08
	N08	Ship's Speed (knots)	0	0	0
Casualty Status/Information	C01	Rank	Deck Rating	Deck Officer	Deck Officer
	C02	Nationality	Polish	NI	NI
	C03	Age	47	NI	NI
	C04	Overall Work Experience (On-board)	NI	NI	NI
	C05	Work Duration (On-board Ship)	18 months	NI	NI
	C06	Alcohol / Drug Influence	NI	NI	NI
Meteorological Conditions	M01	Adverse Weather	Yes	Yes	Yes
	M02.1	Wind Speed	6 (Beaufort)	3-4 (Beaufort)	0
	M02.2	Wind Direction	NNE	NI	Calm
	M03	Sea Scale	3-4	NI	0
	M04.1	Sea Current Speed	NI	NI	NI
	M04.2	Sea Current Direction	NI	NI	NI
	M05	Rain	No	NI	No
	M06	Visibility	NI	NI	6
	M07	Sea Temperature	8	22	-2
	M08	Air Temperature	NI	NI	-12,1
	M09	Sea Depth	NI	NI	NI

	M10	Darkness	Yes	NI	NI
	M11	Lightning Conditions	Yes	NI	NI
	M12	Day/Night	Night	NI	NI
Work Type and Conditions	W01	Relevance to Work	Yes	Yes	Yes
	W02	Working as per the safety rules	No	No	NI
	W03	Workplace conditions as per the safety rules	No	Yes	NI
	W04	Wearing a Life Jacket	No	Yes	No
	W05	Alone	No	No	No
Managerial/Procedural Conditions	P01	Applicable checklist	Yes	No	NI
	P01.1	Checklist filled	Yes	NA	NA
	P01.2	Checklist filled properly	No	NA	NA
	P02	Applicable general work procedures	No	No	NI
	P02.1	General work procedures implemented properly	NA	NA	NA
	P03	Fatigue condition	NI	NI	NI
	P04	Implementation of MOB drills	NI	NI	NI
	P05	Was there a SAR Procedure?	NI	NI	NI
	P05.1	SAR Procedure implemented appropriately?	NA	NA	NA
Start of the Event	M01	Date	13.03.2011	10.07.2015	08.12.2017
	M01.1	Time	1912	0458	1950-2008

	M02	Action causing the MOB event	Impact of rope	Reading Draft Marks	Reading Draft Marks
	M03	From Where	Starboard Bow	Port	Port
	M04	Immediate/Late Awareness	Yes	Yes	Yes
	M05	Latency	NA	NA	NA
	M06	Assumed Over Board	No	No	No
	M06.1	Decision Duration	NA	NA	NA
Response Times and Actions	T01	Event Notification to the Bridge	1-2	1	0
	T02.1	Alarm	1-2	14	01-18
	T02.2	Announcement	1-2	14-22	02-20
	T02.3	Whistle	No	No	No
	T03	Buoy	1-2	1	0
	T04	Manoeuvring	No	NA	NA
	T05	Captain	0	2-4	0
	T06	GPS MOB	NA	NA	NA
	T07.1	Notification to Close by ships	2	No	No
	T07.2	Notification to SAR Stations?	No	No	No
	T07.3	Other Notifications	No	22-42	6-37
	T08	Rescue Boat is Ready	4-9	No	6-24
Search and Rescue (SAR)	R01	Rescue Boat	No	No	Yea
	R02	Timing of Rescue Boat In Water	NA	NA	6-24
	R03	Other Ships	Yes	No	Yes

	R04	Timing of Other Ships	11-20	NA	6-37
	R05	SAR Ships	Yes	No	No
	R06	Timing of SAR Boats	NI	NA	NA
	R07	Air Operation	Evet	No	No
	R08	Timing of Air Operation	49-72	NA	NA
	R09	Shore Assistance	No	Yes	No
	R10	Timing of Shore Assistance	NA	22	NA
	R11	Casualty Removed from the Water	Yes	Yes	Yes
	R12	Removed by	Ship's crew and other ship crew	Ship crew	Other ship crew
	R13	Timing of Removal	11-20	14-22	8-37
	R14	Cancellation of the SAR operation	NA	NA	NA
	R15	Duration, Cancellation of the SAR Operation	NA	NA	NA
	R16	Limited Sighting of the Casualty in Water	No	No	NI
	R17	Duration, Limited sighting of the casualty in the Water	NA	NA	NA
	R18	Uninterrupted sighting of the casualty in water	Yes	Yes	NI
Health Status of	H01	Death	Yes	Yes	No
	H01.1	Witnessing death	Yes	Yes	NA

	H01.2	Decision for death	No	No	NA
	H01.3	Timing of Death	After	Later	NA
	H02	Cause of Death	Trauma (chest)	NI	NA
	H03	Duration until Death	120	67	NA
	H04	Rescue to Death Timing	100-109	45-53	NA
	H05	First Aid	Yes	Yes	NI
	H05.1	Duration MOB to First Aid	1-9	14-22	NA
	H05.2	Duration Rescue to First Aid	11-20	1-8	NA
	H06	First Aid at or by the Medical Facility (Shore Side)	Yes	No	Yes
	H06.1	Duration, time passed until First Aid given by at or by the Medical Facility (Shore Side)	72-120	NA	19-37
Type of Recommendation	L01	Existence of Recommendation	No	No	No
	L02	Number of Recommendation	0	0	0
	L03	Recommendation Cat I	No	No	No
	L03.1	Content of Rec Cat I	NA	NA	NA
	L04	Recommendation Cat II	No	No	No
	L04.1	Content of Rec Cat II	NA	NA	NA
	L05	Recommendation Cat II	No	No	No

	L05.1	Content of Rec Cat II	NA	NA	NA

III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Investigation of Marine Accidents Under the HFACS-PV Structure

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ABSTRACT

Developing technology, legal and economic regulations occurring in the maritime transportation sector have affected and changed the shape of the accidents occurrence. Furthermore, human behaviors are not also easily predictable and interpretable. Therefore, it is very difficult to investigate the effect of human factor in the event of an accident and the selection of the appropriate method for accident analysis is extremely important. HFACS (Human Factor Analysis and Classification System) is a hybrid method that it enables to evaluate active failures and latent failures of accidents under the same structure. The structure of HFACS has undergone many structural changes since 1991 and has been adapted to the application field. In this study, the compatibility of HFACS for Passenger Vessels (PV) structure, which was developed by Uğurlu et al. (2018) for the analysis of passenger ship accidents, with other ship accidents was investigated. Therefore, marine accidents were examined under HFACS-PV structure and the applicability of the model was tried to be proved. In addition to the traditional, core HFACS structure, the biggest change in the structure is the addition of operational conditions as the fifth and final level to the main framework. Similarly, the HFACS structure has been aligned with the maritime sector by making changes associated with the unsafe acts and the corresponding preconditions. As a result of the study, it was seen that HFACS-PV structure is compatible not only with passenger ship accidents but also with accidents of other vessels. This is an advisory study that aims to make possible to examine marine accidents under the HFACS PV structure.

Keywords: HFACS, Human Factor, Accident Analysis, Marine Accident

Deniz Kazalarının HFASC-PV Yapısı Altında İncelenmesi

ÖZET

Gelişen teknolojiyle birlikte yürürlüğe giren yasal ve ekonomik düzenlemeler deniz kazalarının oluşum şeklini etkilemiş ve değiştirmiştir. Geçmişten günümüze kazalarda insan hatası baskın bir faktör olarak karşımıza çıkmaktadır. İnsan davranışları kolayca tahmin edilebilir ve yorumlanabilir bir yapıda değildir. Bu nedenle, kazalarda insan faktörünün etkisinin araştırılması oldukça zordur. Kaza analizi için uygun yöntemin seçilmesi son derece önemlidir. HFACS (İnsan Faktörü Analizi ve Sınıflandırma Sistemi), kazaları meydana getiren aktif ve gizli kusurları aynı yapı altında değerlendirmeyi sağlayan hibrit bir yöntemdir. HFACS çerçevesinde 1991'den bu yana birçok değişiklik yapılmıştır ve yapı uygulandığı sektöre adapte edilmiştir. Bu çalışmada Uğurlu vd. (2018) tarafından yolcu gemisi kazalarının analizi için geliştirilmiş olan HFACS-PV yapısının, diğer gemi kazaları ile uyumluluğu araştırılmıştır. Bu amaçla, farklı türdeki deniz kazaları HFACS-PV yapısı altında incelenerek modelin uygulanabilirliği kanıtlanmaya çalışılmıştır. Yapıdaki en büyük değişiklik, HFACS yapısındaki 4 ana seviyeye beşinci ve son seviye olarak operasyonel koşulların eklenmiş olmasıdır. Benzer şekilde, emniyetsiz eylemler ve bunlara yol açan önkoşullarda değişiklikler yapılarak HFACS yapısı, denizcilik sektörü ile uyumlu hale getirilmiştir. Çalışma sonucunda HFACS-PV yapısının sadece yolcu gemisi kazaları ile değil aynı zamanda diğer gemi kazaları ile de uyumlu olduğu ortaya konmuştur. Bu çalışma, deniz kazalarını HFACS-PV yapısı altında incelemenin mümkün olduğunu kanıtlama amacıyla yapılmış bir çalışmadır.

Anahtar Kelimeler: HFACS, Insan Faktörü, Kaza Analizi, Deniz Kazası

1. Giriş

Kazalar ve doğurduğu sonuçlar, başta Uluslararası Denizcilik Örgütü (IMO) olmak üzere birçok denizcilik kuruluşunu ve araştırmacıyı kaza analizine ve kazaları önlemeye yönelik çalışmalar yapmaya yöneltmiştir [1]. Böylelikle, 20. yüzyılın ortalarından itibaren deniz kazaları odaklı birçok çalışma ortaya konmuştur. Bu çalışmaların ortaya koyduğu en önemli sonuçlardan biri meydana gelen kazalarda insan hatasının payı ve önemidir [2].

Deniz kazalarını önlemek başta IMO olmak üzere, bayrak devletleri, denizcilik şirketleri, klas kuruluşları ve denizcilik sektörüyle ilgili birçok kurum ve kuruluşun başlıca hedefleri arasındadır. Kazaların denizcilik sektörüne etkisi oldukça önemlidir. Maddi ve manevi külfetin yanı sıra; denizcilik sektöründeki birçok kural ve yasal düzenleme büyük kazalar ve felaketler sonucunda ortaya çıkmıştır [3]. Örneğin; 1912'de meydana gelmiş olan Titanik gemi kazası deniz kazaları konusunda en bilindik örneklerdendir ve denizciliğin kilometre taşlarından biri olan SOLAS sözleşmesi bu kazadan sonra ortaya çıkmıştır. 2012'yılında İtalya'da meydana gelmiş olan Costa Concordia gemi kazasının ardından IMO, Sefer Veri Kaydedicisi (VDR) ve minimum emniyetli adam donatma gerekleri ile ilgili ilave düzenlemeler yapmıştır [4-6].

2. Kaza Araştırmasında Kullanılan Metotlar

1912'de İngiltere'de ilk kaza araştırmasının yapılıp resmi kaza raporunun yayınlanmasının ardından araştırmacılar kaza analizine yönelmiştir. Bu yönelim sonucunda yapılan kaza araştırmaları tek bir kaza analizi yaklaşımının her kazaya uygulanamayacağını göstermiştir. Bundan hareketle 1931-1997 yılları arasında farklı sektörlerde meydana gelen farklı kaza türlerinin analizinde kullanılmak üzere 50'den fazla kaza analizi metodu ve modeli ortaya konmuştur (Tablo 1).

Tablo 1'de örneklenen kaza analizi metotlarının her biri incelenen olaya göre farklı teorik ve pratik avantajlara ve dezavantajlara sahiptir. Bu yüzden kaza raporları temel alınarak analiz yapılacağı zaman metodun seçimi çok önemlidir.

Tablo 1: Farklı Sektörlerdeki Araştırmacıların Geliştirdiği Kaza Analizi Metotları[7].

Metodun Adı	Tarih
Domino Teorisi	1931
Kritik Olay Tekniği	1954
Faktörler Modeli Kombinasyonu	1956
Enerji Değişim Modeli	1964
Karar Modeli	1969
Davranışsal Metotlar	1970
Hata Ağacı Analizi	1971
Çoklu Doğrusal Olay Sıralama Modeli	1975
Yönetim Gözetim ve Risk Ağacı (MORT)	1975
Sistem Emniyet Analizi	1976
Risk Tahmin Modeli	1977
Olaysal Faktör Analizi Modeli	1978
Kaza Dizi Modeli	1978
Psikolojik Model	1978
Domino/Enerji Salınımı	1980
Merdiven Basamak Modeli	1980
Enerji Modeli	1980
Sistem Modeli	1980
Epidemiyolojik Model	1980
Güncellenmiş Domino Modeli, Güncellenmiş Domino Modeli II	1980
Trafik Çatışma Tekniği	1982
Ergonomik ve Davranışsal Metotlar	1984
İnsan Nedensellik Modeli	1984
Yakın Kazalar ve Olaylar	1985

Davranış Modeli	1986
Katkı Sağlayan Faktörler Modeli	1987
Tehlike Taşıyıcı Model	1988
Comet Modeli	1990
Kapsamlı İnsan Faktörleri Modeli	1990
Güvenlik Kararları Modeline İşçinin Bakışı	1990
Epidemiyolojik Model	1990
Evrensel Model	1990
Kaza Sigortalar Kurumu Federasyonu (Finlandiya) Modeli	1997
Geliştirilmiş İş Güvenliği ve Sağlığı Oluşumu Sonuç-Süreç Modeli	1991
Yerleşmiş Patojenler Metaforuna Dayalı İleri Eşlemeler Modeli	1991
İsviçre Peyniri Modeli	1991
Fonksiyonel Düzeyler Modeli	1992
Tripod Ağacı	1994
İlişkilendirme Kuramı Modeli	1994
İnsan Faktör Analizi ve Sınıflandırma Sistemi	1997

Her geçen gün gelişen teknoloji, sektörlerde meydana gelen yasal ve ekonomik düzenlemeler, eğitim reformları mesleğin kültürünü etkilemektedir. Bu durum da kazaların oluş şeklini değişmektedir. Örneğin, Titanik gemi kazasının yaşandığı 1912 yılında elektronik seyir donanımlarının sensor arızası bir kaza nedeni değilken, günümüzde kazaların tetikleyici faktörü olabilmektedir. Bu yüzden kaza analiz model ve metotları etkinliğini ve tutarlılığını koruyabilmek için sürekli değişim, gelişim ve revizyona ihtiyaç duymaktadır. Günümüzde farklı sektörlerde literatürde toplam 100'e yakın uygulanabilirliği en az bir çalışma ile kanıtlanmış kaza araştırma metodu ve modeli vardır [8-9]. Underwood ve Waterson [10], yaptıkları çalışmada analiz modeli ve metodu sayısının sürekli artmasını sosyo-teknik sistemlerin (insan, teknolojik ve çevresel

bileşenlerin etkileşimi ile oluşmaktadır) giderek karmaşıklaşmasına ve kaza nedensellik mekanizmalarının değişimine bağlamışlardır.

Analiz modelleri ve metotlarının sayısı artınca, çalışmalarda uygulanacak metodun kolay seçilebilmesi ve literatürün daha sistematik hale gelmesi için metotların gruplandırılması üzerine çalışılmıştır. Hollnagel ve Goteman [11], yaptıkları çalışmada kaza araştırma metotlarını; ortak noktalarını, temel prensiplerini ve kazaya yaklaşım şekillerini göz önüne alarak değerlendirmiştir. Buna göre kaza araştırma modellerinin ardışık (sıralı) modeller, epidemiyolojik modeller ve sistemik modeller olmak üzere üç ana grupta toplanabileceğini ortaya koymuşlardır. Bu sınıflandırma literatürde birçok araştırmacı tarafından kabul görmüştür [10,12-13]. Ancak literatürdeki tek sınıflandırma sistemi değildir, kazaların diğer karakteristik özellikleri temel alınarak yapılmış farklı sınıflandırmalar da mevcuttur [14-15].

Uygulayıcılar en uygun metodu seçmek için tercih yapmak durumundadırlar. Kaza analizinde kullanılacak metodun seçimi en az analiz işlemi kadar önemlidir. Çünkü metot seçimi kazaya yaklaşımı etkileyecek bu durum da doğal olarak sonuçlara yansıyacaktır. Mekanik arızalardan kaynaklanan basit bir kazanın sistemik yaklaşımla analiz edilmesi etkin olmayacaktır. Analizin birçok basamağında kazaya yöneltilen sorular cevapsız kalacaktır. Ya da insan faktörünün iç içe olduğu kazaları ardışık metotlarla incelemek insan faktörlerinin bir veya birkaçının istemsiz olarak ihmal edilme riskini doğuracaktır. Bu yüzden analiz edilecek kazanın karmaşıklığına ve analiz edilmek istenen unsurlara göre metot seçilmesi gerekmektedir [10,16].

3. İnsan Faktörü Analiz ve Sınıflandırma Sistemi (HFACS)

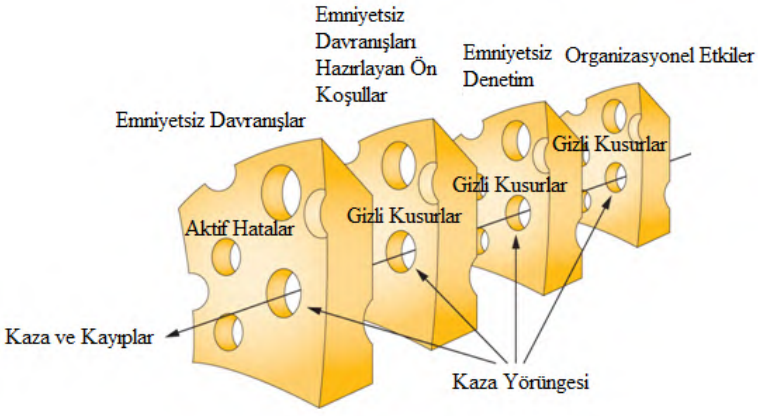
HFACS 1997 yılında Shappell ve Wiegmann tarafından ortaya konmuş insan hatası inceleme metodudur. Kazaları zincirleme olaylar silsilesi içerisinde incelemeyi mümkün kılar. Reason'un İsviçre Peyniri modelini temel alır. İsviçre Peynirindeki deliklere benzetilen gizli kusurlar ve aktif hatalar, HFACS sisteminde de aynen yer almaktadır. HFACS'ın avantajı insan faktörlerini sistematik şekilde ele alarak kazaların incelenmesinde nedenleri ve alt nedenleri detaylı ve güvenilir bir şekilde ortaya

koyabilmesidir. HFACS genel bir insan faktörü analiz yöntemidir; ancak bütün sektörlere adapte edilebilir, geliştirilebilir yapıdadır [17-18]. Klasik HFACS yapısı Reason'un modelindeki gibi 4 ana başlıktan oluşur. HFACS yapısı ve uygulanışının anlaşılabilmesi için öncelikle Reason'un modelini anlamak gerekmektedir.

1.1 Reason'un İsviçre Peyniri Modeli

İsviçre Peyniri modelinde kazayı meydana getiren olayları dört ayrı seviyede tanımlamıştır ve bu dört seviye gizli kusurlar ve aktif hatalar olmak üzere iki ana başlıkta gruplanmıştır. İlk üç seviye gizli kusurları, son seviye ise aktif hataları temsil etmektedir. Bu modele göre bir kazanın görülen (aktif) hataları ardında, görülmeyen (gizli) kusurları vardır (Şekil 1) [19].

Reason'un modeline göre kazalar; ilk 3 seviyedeki eksikliklerin, 4. seviyedeki emniyetsiz davranışlara zemin hazırlaması, bunun sonucunda operatörlerin emniyetsiz eylem ve davranışlarda bulunması ile meydana gelmektedir. Sistemdeki gizli koşulların çoğunlukla kaza meydana gelene kadar fark edilemediğine vurgu yapılmaktadır.



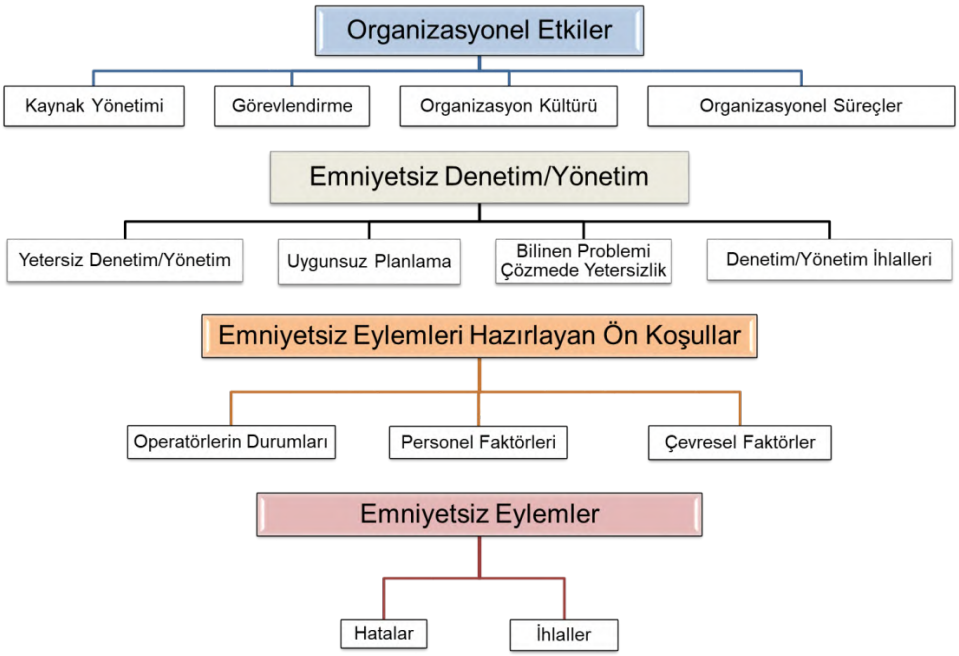
Şekil 1: Reason'un İsviçre Peyniri Modeli.

Reason İsviçre Peyniri modelini farklı sektörlerde meydana gelen 6 büyük olay (Çernobil nükleer felaketi, King's Cross metro yangını, Herald of Free Enterprise gemi kazası, Challenger uzay mekiği kazası, Bhopal felaketi, Three Mile adası kazası) üzerinde

uygulamış ve bu olaylardaki insan faktörlerinin etkisini ortaya koymuştur [19]. Reason, insanların hata yapmaya meyilli olduklarını, bu yüzden hatalara karşı önlem ve tedbirin belirlenerek uygulanması gerektiğini belirtmiştir. İsviçre Peyniri modeli, farklı sektörlerde birçok araştırmacı tarafından insan faktörünün kazalardaki rolünü araştırmak için kullanılmıştır [20-24].

3.2 HFACS Yapısı

Klasik HFACS yapısı Reason'un modeline benzer şekilde insan faktörünü; kurumsal etkiler, emniyetsiz denetim, emniyetsiz eylemleri hazırlayan ön koşullar ve emniyetsiz eylemler (Şekil 2) olmak üzere dört seviyede incelemektedir [18]. Modeldeki dört seviye aşağıdaki gibi tanımlanmıştır.



Şekil 2: HFACS Temel Yapısı.

Şekil 2'de sunulan dört ana seviye aşağıda açıklanmıştır:

1. Organizasyonel etkiler (gizli kusurlar): Örgüt yapısının zayıf, hatalı olması, takım kültürünün olmaması gibi olumsuz durumları kapsamaktadır. Bu durumlar tek

başına bir kaza etkeni olmayabilir ancak kazalara zemin hazırlar. Denetim ve yönetim mekanizmasının iyi çalışması ile ortadan kaldırılabilirler.

2. Emniyetsiz denetim ve yönetim (gizli kusurlar): İnsan kaynakları yönetiminin temel sorunlarından biridir. Denetimin eksik, yetersiz yapılmasını ifade eder, denetim eksik yapıldığında, kontrol mekanizması eksik olduğundan hatalı davranışlar, organizasyonel etkiler ve emniyetsiz davranışları hazırlayan durumlar tespit edilip önlenemez. Kaza için elverişli şartlar sağlanmış olur.
3. Emniyetsiz davranışları hazırlayan ön koşullar (gizli kusurlar): Zihinsel yorgunluk, iletişim eksikliği gibi performansı etkileyen durumları ve faktörleri kapsar.
4. Emniyetsiz davranışlar (aktif hatalar): Önceki üç seviyedeki faktörlerin bir düzen içinde bir araya gelmesi sonucu oluşur.

Kazalarda insan faktörünün etkisinin araştırılması oldukça zordur. Çünkü insan davranışları kolayca tahmin edilebilir ve yorumlanabilir nitelikte değildir. Bu nedenle insan faktörü analizinde çalışmaya uygun metodun seçimi çok önemlidir. Literatürdeki kaza analizi çalışmaları incelendiğinde HFACS metodunun insan faktörü analizinde oldukça etkili olduğu birçok araştırmacı tarafından ortaya konmuştur [25-27]. Ayrıca HFACS metodu, denizcilik sektörüyle yakından ilişkili olan havacılık sektöründe meydana gelen 1000'in üzerinde kazada uygulanarak, insan faktörünü ve organizasyonel faktörleri tespit etmedeki başarısını ve güvenilirliğini kanıtlamıştır [28-30]. Bu yüzden bu çalışmada kazaların analizinde ve tespit edilen faktörlerinin sınıflandırılmasında Shappell ve Wiegmann tarafından geliştirilen HFACS metodunun çekirdek yapısı kullanılmıştır.

4. Çalışmanın Kapsamı ve Araştırmada Kullanılan Materyal ve Metot

Bu çalışmada, ticaret gemisi statüsündeki gemilerde meydana gelen çatma/çatışma, karaya oturma, batma/su alma gibi gemi kazalarının oluşumu Yolcu Gemisi Kazaları için İnsan Faktörü Analiz ve Sınıflandırma Sistemi (HFACS-PV) yapısı [2] kullanılarak incelenmiştir. Çalışmada amaç HFACS-PV yapısının gemi kazaları ile uyumlu olup olmadığını ortaya koymaktır. Diğer bir ifadeyle örnek kaza oluşumları ile HFACS-PV yapısının diğer gemi tipleri ve kaza türleri ile uyumlu olup olmadığı araştırılmıştır. Bu

amaçla çalışmada öncelikle HFACS-PV yapısında yapılan modifikasyonlar tanıtılmıştır. Daha sonra 3 adet örnek kaza oluşumu HFACS-PV yapısı üzerinde incelenmiştir.

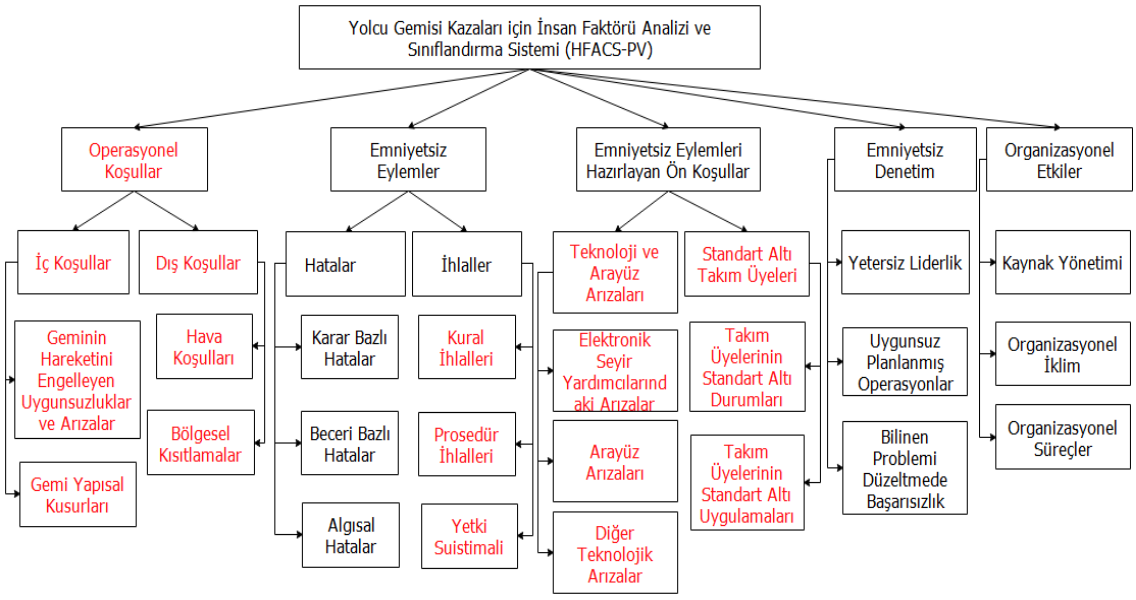
4.1 HFACS-PV Yapısı

Uğurlu vd., [2] yapmış oldukları çalışmada literatürde yer alan HFACS yapılarının yolcu gemisi kazaları ile bire bir uyumlu olmadığını ve yapıda değişime ihtiyaç duyulduğunu belirtmişlerdir. HFACS ana yapısında ve alt yapılarında revizyona giderek yolcu gemisi kazaları ile uyumlu HFACS-PV yapısını ortaya koymuşlardır. Şekil 3 te kırmızı ile yazılmış yazılar ana çatıda yapılan ilaveler ve değişimleri ifade etmektedir. HFACS-PV yapısı Wiegmann ve Shappell'in [18] geliştirdiği yapıdan farklı olarak 5 seviye içermektedir (Şekil 3);

1. Organizasyonel Etkiler,
2. Emniyetsiz Denetim,
3. Emniyetsiz Eylemleri Hazırlayan Ön Koşullar,
4. Emniyetsiz Eylemler,
5. Operasyonel Koşullar (Çevresel faktörler)

Onların çatıda yapmış oldukları ilk değişim operasyonel koşulları çatıya eklemek olmuştur. Bu yapıda operasyonel koşullar (çevresel faktörler) insan faktörü ile bire bir ilişkili olan diğer dört seviyenin en önünde yer almaktadır. Literatürde yer alan konvansiyonel HFACS yapılarında çevresel faktörler ya emniyetsiz eylemi hazırlayan ön koşul çatısı altında incelenmiş ya da emniyetsiz eylemi hazırlayan dış faktörler olarak ele alınmıştır. Gemi kazaları incelendiğinde operasyonel koşulların (çevresel faktörler) emniyetsiz eylemlerin oluşması için bir gizli kusur (ön koşul) değil aksine emniyetsiz eylemin kazayla sonuçlanabilmesi için gerekli bir üst seviye olduğu görülmüştür. Emniyetsiz eylemin kazaya dönüşebilmesi için uygun operasyonel koşullara ihtiyacı vardır. Eğer emniyetsiz eylem kaza oluşumu için gerekli operasyonel koşullar ile birleşmezse kaza oluşmayacaktır. Bu nedenle operasyonel koşulların gizli kusur olarak, organizasyonel etkiler ya da emniyetsiz eylemi hazırlayan ön koşullar başlıkları altında incelenmesi çok uygun olmayacaktır. Ayrıca operasyonel koşullar çatısı altında yer alan

etmenlerin insan hatasıyla ilişkisi de diğer seviyelerde yer alan faktörlerden farklıdır. Operasyonel koşullar kontrol edilemeyen ya da kısmen kontrol edilebilen faktörleri içerir. Bu etmenler her ne kadar insan faktörü tarafından elimine edilemese de kontrol altında tutulabilir. Karar verme sürecinde göz önünde bulundurularak kazaların önüne geçilebilir. Benzer şekilde, emniyetsiz eylemler ve ilgili önkoşullar çatılarında değişiklikler yapılarak HFACS denizcilik sektörü ile uyumlu hale getirilmiştir. Böylece, deniz kazalarının analizinde kullanılmak üzere modifiye edilmiş bir HFACS-PV yapısı geliştirilmiştir.



Şekil 3: HFACS-PV Yapısı ve Alt Kategorileri [2].

5. Örnek Kazalar

5.1 Örnek Kaza Çatma-Çatışma

Bu çalışmada kurulan çatıda operasyonel koşullar ayrı bir ana seviye olarak düşünülmüştür. Bu çalışmada eğer bir kaza oluşumunda operasyonel koşullar etken faktörler arasında yer alıyorsa onun gemi kazalarının oluşumundaki son aşama olduğu savunulmaktadır. Çünkü bir kaza oluşumu için gerekli tüm faktörler bir araya gelse bile uygun operasyonel koşullara sahip değilse kaza oluşmaz. Bunu bir örnek kaza oluşumu

ile açıklayacak olursak: P&OSL Aquitaine çatma kazasının oluşumunda rol oynayan faktörler;

Operasyonel koşullar: Pervane arızası (kontrol edilebilir piçli pervane), kısıtlı manevra alanı (liman),

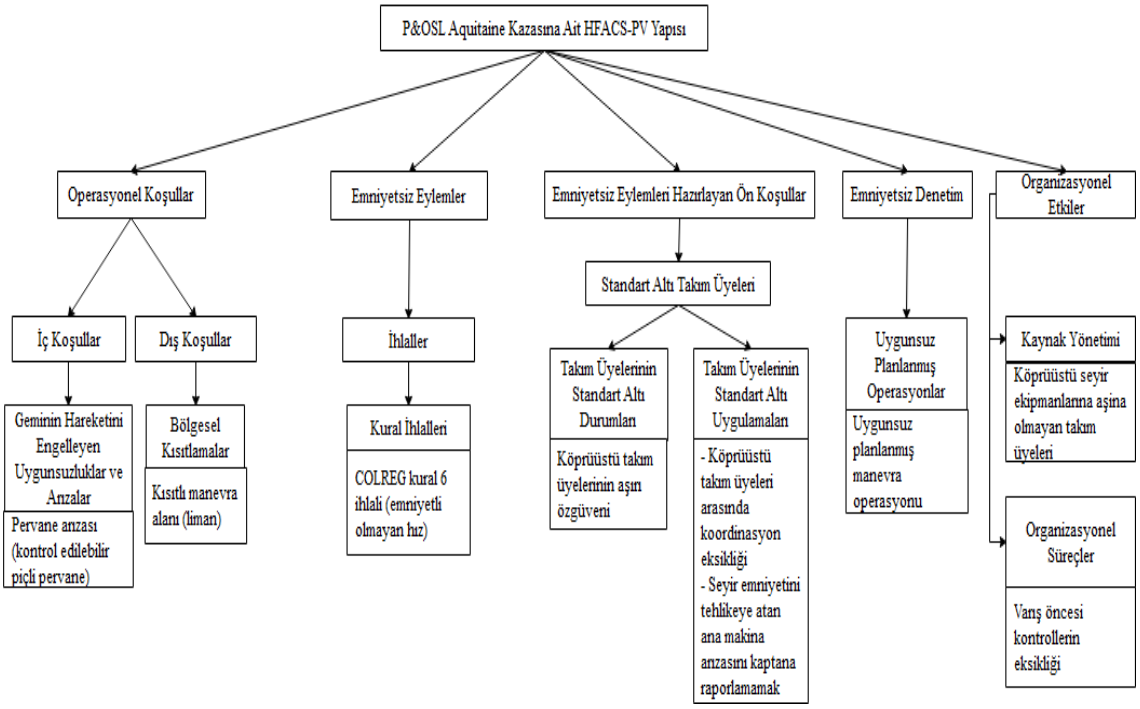
Emniyetsiz eylem: COLREG kural 6 ihlali (emniyetli olmayan hız),

Emniyetsiz eylemi hazırlayan ön koşul: seyir emniyetini tehlikeye atan ana makina arızasını kaptana raporlamamak, köprüüstü takım üyeleri arasında koordinasyon eksikliği, köprüüstü takım üyelerinin aşırı özgüveni,

Emniyetsiz denetim: uygunsuz planlanmış manevra operasyonu,

Organizasyonel etkiler: köprüüstü seyir ekipmanlarına aşina olmayan takım üyeleri, varış öncesi kontrollerin eksikliği (Şekil 4) [31].

Bu örnek kaza için düşünüldüğünde ilk 4 seviyede (Organizasyonel etkiler, Emniyetsiz denetim, Emniyetsiz eylemi hazırlayan ön koşullar ve Emniyetsiz eylemler) yer alan tüm faktörler bir araya gelse de kaza oluşmaz. Kazanın oluşması için uygun operasyonel koşul şarttır. Nedir uygun operasyonel koşul; kısıtlı manevra alanı/liman ve pervane arızasıdır. Limanda pervane arızası olmazsa kaza olayı oluşmayacaktır. Burada şu şekilde de sorgulama yapılabilir. Kaza, gemi emniyetsiz hızda ilerken (emniyetsiz eylem) limanda pervane arızası nedeniyle gerçekleşmiştir. Pervane arızası emniyetsiz hızın üstünde yer alan bir olaydır. Aynı şekilde limanda emniyetsiz hızın üzerinde yer almaktadır. Pervane arızasının limanda gemi kazasına sebep olmasının nedeni geminin emniyetsiz hızda seyir yapmasıdır. Pervane arızasını organizasyoanel etkinini ya da emniyetsiz eylemi hazırlayan ön koşullar altına koymak yanlış olacaktır. Pervane arızasına neden olan etmenleri eğer kaza raporunda belirtilmişse buraya yerleştirmek çok daha uygun olacaktır ama pervane arızasını değil. Çünkü pervane arızası emniyetsiz hızın oluşmasında rol oynayan gizli kusur değildir. Fakat emniyetsiz hız pervane arızasının limanda kazaya sebep olmasının altında yatan nedendir. Dolayısıyla tüm bu faktörlerin operasyonel koşullar ana çatısı altında yer alması uygun olacaktır.



Şekil 4: P&OSL Aquitaine kazasına ait HFACS-PV Yapısı.

Diğer taraftan operasyonel koşullar çatısı altında yer alan durumlar ya da olaylar insan faktöründen bağımsız ya da kısmen bağımlı olayları içerir. Operasyonel koşulların altındaki faktörlerin özellikleri emniyetsiz eylemleri hazırlayan ön koşullar altındaki faktörlerin özellikleri ile aynı değildir. Örneğin, yoğun sisten dolayı oluşan kısıtlı görüş ve yoğun gemi trafiğinden dolayı oluşan risk, emniyetsiz eylemleri hazırlayan önkoşullar çatısı altında sınıflandırılırsa baskın bir insan faktörü olarak karşımıza çıkacaktır. Ancak, bu faktörler geminin personeli tarafından engellenemez. Bu nedenle, diğer faktörlerden karakteristik olarak farklıdır. Yoğun trafiği önlemek veya yoğun sisi önlemek mümkün değildir. Diğer taraftan, dikkatsizlik, stres, durumsal farkındalık eksikliği gibi emniyetsiz eylemleri hazırlayan önkoşullar çatısı altındaki faktörler bu faktörlerden tamamen farklıdır. Bu nedenle, tüm bu faktörleri aynı kategori altında değerlendirmek uygun olmayacaktır.

5.2 Örnek Kaza Batma-Su Alma

HFACS-PV yapısının batma kazalarında uygulanabilirliğini ortaya koymak için Tostoy kazası ele alınmıştır. Tolstoy batma kazası 24.09.2008 tarihinde Kerç Kanalının çıkışında meydana gelmiştir. Bölgede hava sert ve deniz durumu ise ağırdır [32].

Tolstoy kazasını meydana getiren faktörler:

Operasyonel koşullar: şiddetli hava ve deniz koşulları, kıyı sularında seyir, eski tekne yapısı, geminin iç su gemisi olması ve makina arızasıdır.

Emniyetsiz eylemler: fırtınada seyir, uygunsuz stabilite ve geminin dizayn limitlerini aşan koşullarda kullanımıdır.

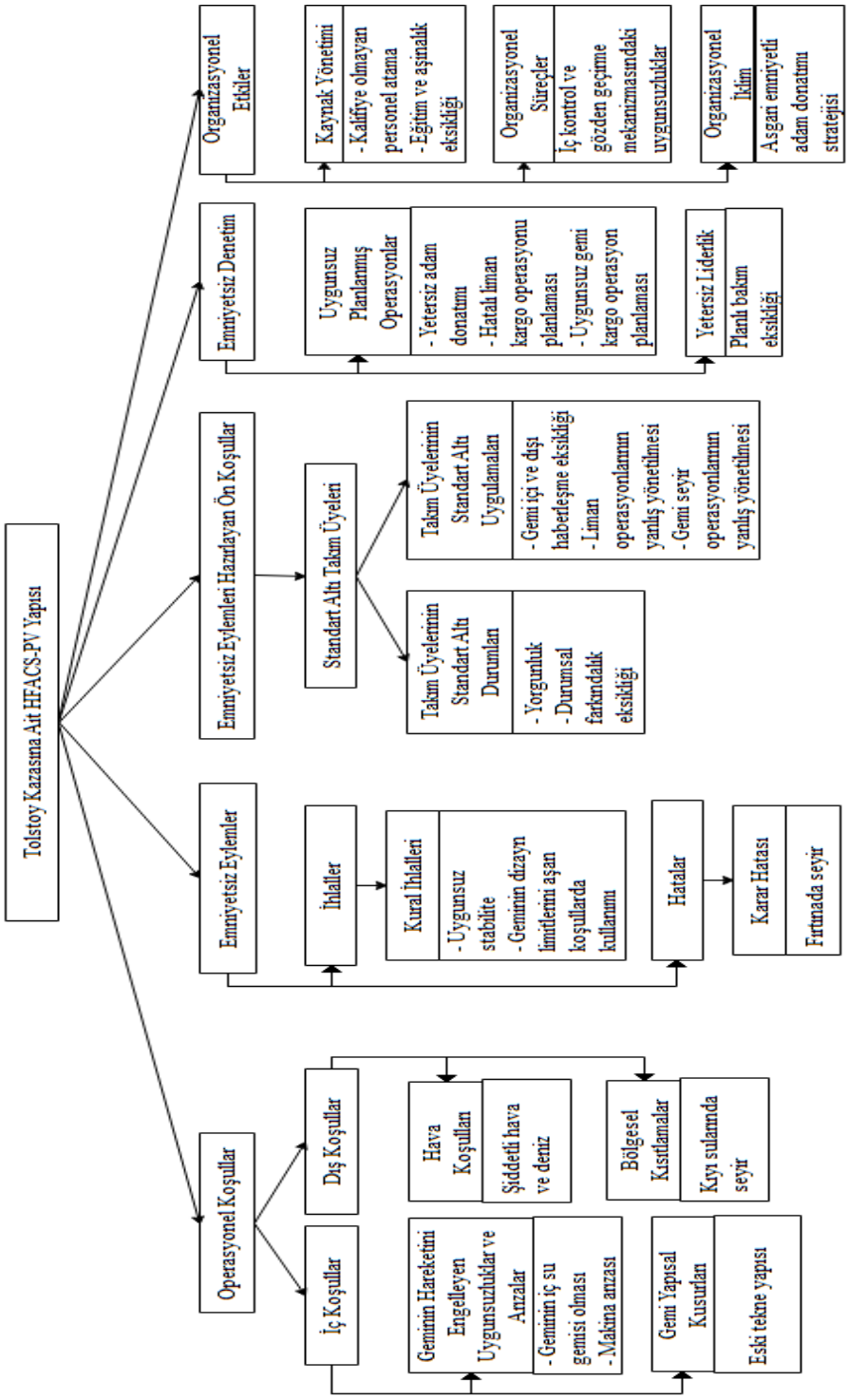
Emniyetsiz eylemleri hazırlayan ön koşullar: yorgunluk, durumsal farkındalık eksikliği, gemi içi ve dışı haberleşme eksikliği, liman operasyonlarının yanlış yönetilmesi ve gemi seyir operasyonlarının yanlış yönetilmesidir.

Emniyetsiz denetim: yetersiz adam donatımı, hatalı liman kargo operasyonu planlaması, uygunsuz gemi kargo operasyon planlaması ve planlı bakım eksikliğidir.

Organizasyonel etkiler: asgari emniyetli adam donatımı stratejisi, kalifiye olmayan personel atama, eğitim ve aşinalık eksikliği, iç kontrol ve gözden geçirme mekanizmasındaki uygunsuzluklar (Şekil 5).

Tolstoy kazası emniyetsiz eylemin kazayla sonuçlanması için uygun operasyonel koşullara ihtiyaç olduğunu gösteren güzel bir örnektir. Bu örnek kaza oluşumunda ilk 4 seviyedeki tüm faktörler bir araya gelse de kazanın meydana gelmeyeceği aşikârdır. Tolstoy kazası gemi uygusuz stabiliteyle (emniyetsiz eylem), dizayn limitlerine uygun olmayan koşullarda seyir ederken (emniyetsiz eylem), makine arızası (operasyonel koşul) oluşması sonucunda meydana gelmiştir. Ayrıca nehir tipi gemi yapısı, kötü hava ve deniz şartları ve eski tekne yapısı; makine arızasının batma olayı ile sonuçlanmasına

sebep olmuştur. Bu kaza oluşumu için, emniyetsiz eylemin kazaya dönüşmesinde rol oynayan kilit faktör makine arızasıdır. Makine arızası emniyetsiz eylemi doğurmamıştır. Tam aksine emniyetsiz eylemin kazayla sonuçlanmasında tamamlayıcı unsur olarak yer almıştır. Tolstoy gemisi ve buna benzer birçok gemi benzer koşullarda sefer yapmıştır ancak kaza olayı gerçekleşmemiştir. Bu gemi için seyrin kazayla sonuçlanmasının ana sebebi makine arızasıdır. Bu nedenle makine arızasını ve makine arızasının kazaya dönüşümünde rol oynayan operasyonel koşullar altında yer alan diğer faktörleri emniyetsiz eylemi hazırlayan ön koşullar altında incelemek çok da uygun olmayacaktır. Bu nedenle operasyonel koşullar, emniyetsiz eylemler ve emniyetsiz eylemleri hazırlayan ön koşulların ayrı değerlendirilmesi gerekmektedir.



Şekil 5: Tosltoy Kazasına Ait HFACS-PV Yapısı.

5.3 Örnek Kaza Karaya Oturma

Yapının karaya oturma kazalarında uygulanabilirliğini ortaya koymak için 24.09.2008 tarihinde İsveç, Trubaduren'de meydana gelen Maria M isimli tanker gemisinin kazası ele alınmıştır. Kazanin görüldüğü bölgede hava sakin ve görüş açıktır [33].

Maria M karaya oturma kazasını meydana getiren faktörler:

Operasyonel koşullar: geminin kıyı sularında bulunması.

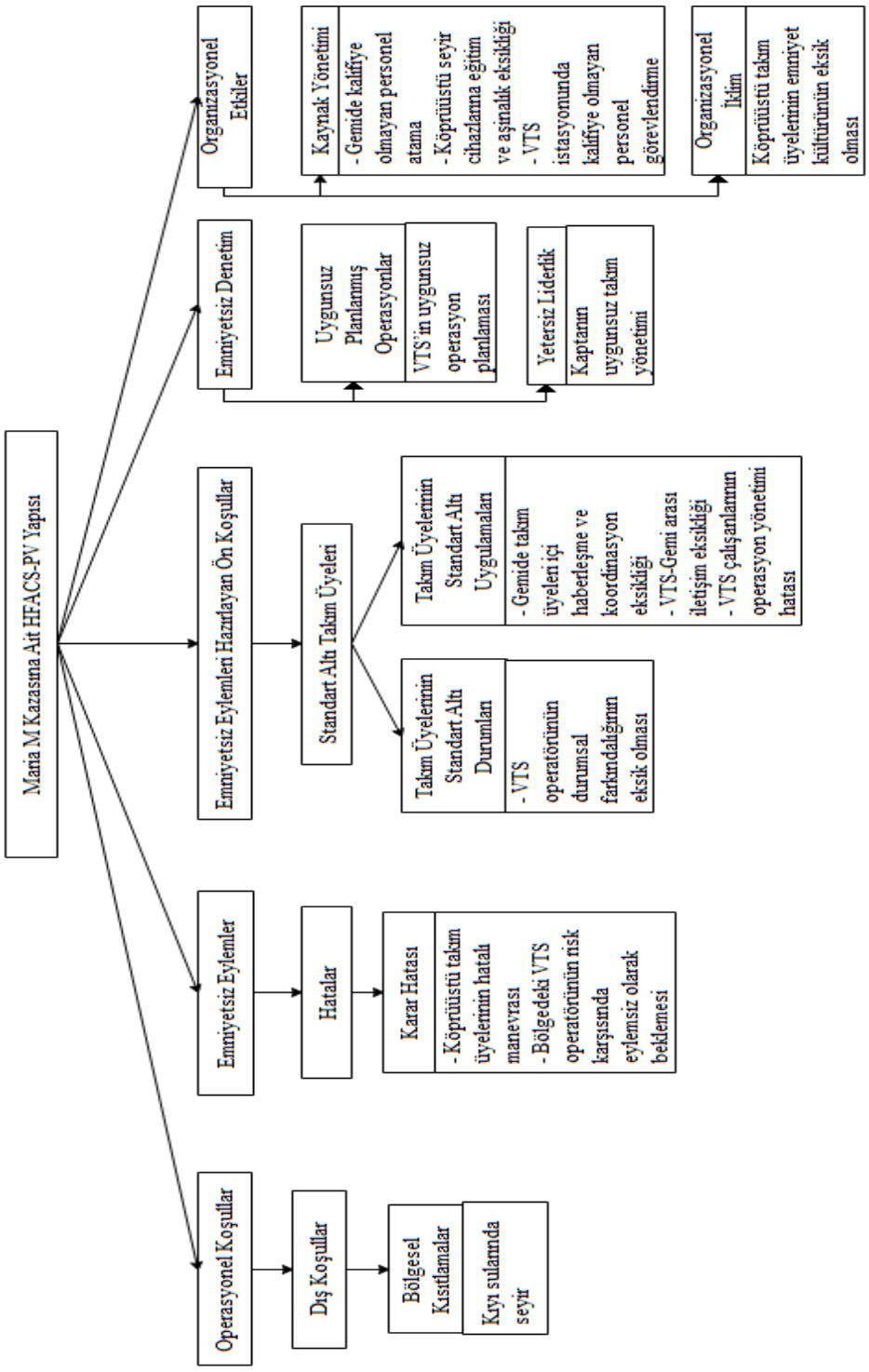
Emniyetsiz eylemler: kaptanın hatalı manevrası ve bölgedeki VTS operatörünün risk karşısında eylemsiz olarak beklemesidir.

Emniyetsiz eylemleri hazırlayan ön koşullar: gemide takım üyeleri içinde iletişim ve koordinasyonun olmaması, VTS operatörünün durumsal farkındalığının eksik olması, VTS-Gemi arası iletişim eksikliği, VTS çalışanlarının operasyon yönetimi hatasıdır.

Emniyetsiz denetim: kaptanın uygunsuz takım yönetimi ve VTS'in uygunsuz operasyon planlamasıdır.

Organizasyonel etkiler: gemide kalifiye olmayan personel görevlendirme, Köprüüstü seyir cihazlarına eğitim ve aşinalık eksikliği, Köprüüstü takım üyelerinin emniyet kültürünün eksik olması, VTS istasyonunda kalifiye olmayan personel görevlendirme (Şekil 6).

Maria M kazası HFACS-PV yapısının ticaret gemilerinde meydana gelen karaya oturma kazalarının da analizinde kullanılabileceğini kanıtlar niteliktedir. Bu kaza olayında tüm gizli ve aktif kusurlar bir araya gelmesine rağmen eğer gemi kıyı sularında seyir ediyor olmasaydı (sığlık bölge) karaya oturma gerçekleşmeyecekti. Maria M kazası kaptanın çevrede sığlıkların mevcut olduğu bir durumda hatalı manevra yapması ve aynı anda VTS operatörlerinin de olaya hiçbir şekilde müdahale etmemesi sonucunda meydana gelmiştir.



Şekil 6: Maria M Kazasına Ait HFACS-PV Yapısı.

Sığ su Maria M kazasında kaptanın hatalı manevrasının ortaya çıkmasına sebep olmamış, aksine hatalı manevra sonucu geminin karaya oturmasında tamamlayıcı unsur olarak rol oynamıştır. Sığ su emniyetsiz eylemi hazırlayan ön koşullar altında yer alan diğer faktörler gibi insan tarafından engellenebilir bir unsur değildir. Ancak gemi ve bölgeye aşina olan köprüüstü ekibiyle kontrol altında tutulabilir. Bu nedenle sığ suyun, emniyetsiz eylemi hazırlayan ön koşullar altında incelenmesi uygun olmayacaktır. Sığ su hem yapı hem de karakter olarak bu yapı altındaki diğer etmenlerden farklıdır. Bu nedenle emniyetsiz eylemin kazayla sonuçlanmasında tamamlayıcı rol oynayan bu ve benzeri faktörlerin operasyonel koşullar olarak ele alınması gerekir. Gemi kazalarının önlenebilmesi operasyonel koşulların operasyon planlaması (seyir, demir, vb.) öncesinde ve uygulaması esnasında göz önünde bulundurularak kontrol altında tutulmasıyla mümkündür.

6. Sonuçlar

Bu çalışmanın sonuçları yolcu gemisi kazaları için oluşturulmuş olan HFACS-PV yapısının karaya oturma çatışma ve batma kazaları ile uyumlu olduğunu göstermiştir. Gemi kazaları zincirleme olaylar silsilesidir [34]. Nedensel faktörler (gizli kusurlar) kök nedenleri (aktif kusurlar) doğurur ve kök nedenler uyun operasyonel koşullar ile birleşirse kaza kaçınılmaz hal alır. Her ne kadar kaza olayları anlık olaylar olarak görünse de altında yatan faktörlerin oluşması uzun bir zaman dilimini gerektirir. Bu nedenle kazaların oluşumunu anlamak ve farkında olmak kazaların oluşumunu engellemek için atılacak en iyi adımdır. HFACS gemi kazalarında insan faktörünün etkisini nedensellik zincirleri içerisinde değerlendirmeye mümkün kılan en iyi sistematik bir kaza analiz yaklaşım türlerinden birisidir. Yapıya hâkim olan bir araştırmacı kazaların oluşum örgüsünü ortaya koyabilir. Bu sistematik yaklaşık uygun niceliksel analiz modelleri ile birleştiğinde mükemmel sonuçlar verir.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Case Study on Marine Accidents Occurred in VTS Areas

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ABSTRACT

During the last decade, it became necessary to create alternative routes for sustainability of safe maritime trade. As a result, alternative routes are increasing day by day, in large marine areas such as open seas and oceans, by evaluating the safety of navigation and the economic efficiency of maritime trade. The other way to make safety sustainable in the growing maritime trade is to provide safer navigation on existing routes. To this end, national/international organizations are developing legal regulations and technological developments being adapted to the maritime industry. One of the most important safety providers is Vessel Traffic Services (VTS), especially since alternative routes are not possible in narrow channels and restricted waterways. VTSs have started to spread all over the world since the late 90s. Today, VTSs are working in more than forty different sea areas and contributing to navigation safety. Despite all the technological developments and legal regulations, however, marine accidents continue to occur especially in narrow channels and restricted waterways. One of the reasons for this is the human interaction between the VTS employees and the vessels involved in the accident. In this study, 3 cases of collisions and 1 case of grounding, in which VTS actions/attitudes were involved in the accident between 2005-2015. Causes and causal factors have been revealed. As a result, recommendations have been identified to improve actual VTS.

Keywords: Vessel Traffic Services (VTS), Maritime Surveillance, Sea Traffic Management

VTS Alanlarında Meydana Gelen Deniz Kazaları Vaka Çalışması

ÖZET

Son on yılda, emniyetli deniz ticaretinin sürdürülebilirliği için alternatif rotalar oluşturmak gerekli hale gelmiştir. Açık denizler ve okyanuslar gibi büyük deniz alanlarında, seyir emniyetini ve deniz ticaretinin ekonomik etkinliği değerlendirilerek alternatif rotalar günden güne artmaktadır. Büyüyen deniz ticaretinde emniyeti sürdürülebilir kılmanın bir yolu da mevcut rotalarda daha güvenli seyri sağlamaktır. Bu amaçla, ulusal-uluslararası kuruluşlar denizcilik sektörüne adapte edilmiş yeni yasal düzenlemeler geliştirmektedirler.

Özellikle dar kanallarda ve kısıtlı suyollarında alternatif rotalar mümkün olmadığından, en önemli emniyet sağlayıcılarından biri, Gemi Trafik Hizmetleri'dir (VTS). VTS'ler 90'ların sonundan beri tüm dünyada yayılmaya başlamıştır. Bugün, VTS'ler kırk farklı deniz bölgesinde çalışmakta ve seyir emniyetine katkıda bulunmaktadır. Tüm teknolojik gelişmelere ve yasal düzenlemelere rağmen, deniz kazaları özellikle dar kanallarda ve kısıtlı suyollarında meydana gelmeye devam etmektedir. Bunun nedenlerinden biri, VTS çalışanları ile kazaya karışan gemiler arasındaki insan etkileşimidir. Bu çalışmada, 2005-2015 yılları arasında VTS eylem / tutumlarının yer aldığı 3 çatma-çatışma vakası ve 1 karaya oturma vakası incelenmiştir. Çalışmada kazaya sebebiyet veren nedenler ve nedensel faktörler ortaya çıkarılmıştır. Sonuç olarak, gerçek VTS'yi iyileştirmek için tavsiyeler belirlenmiştir.

Anahtar kelimeler: Gemi Trafik Hizmetleri (VTS), Deniz Gözetimi, Deniz Trafik Yönetimi

1. Giriş

19. yüzyılın sonlarında radyo bağlantısı, radyo sistemlerinin geliştirilmesinden sonra önem kazanmıştır. Daha sonra, radar'ın gelişimi deniz trafiğini izlemeyi ve takip etmeyi mümkün kılmıştır. Radarın icadıyla gemilerin birbirlerini izlemesi kolaylaşırken, karaya kurulan radar istasyonları ile deniz trafiğinin karadan da takip edilebilmesi olanağı doğmuştur. Deniz trafiğinin karadan izlenmesine yönelik ilk uygulama 1948 yılında Liverpool/Birleşik Krallık'ta, liman gözlem radarının kurulmasıdır. Bunun ardından 1950 yılında Long Beach, California/Birleşik Devletler'de radar gözetleme sistemi kurulmuştur [1-3]. Bu örnekler; kıyı otoritesinin radar ile deniz trafiğini takip edebilme, radyo dalgalarıyla bu gemilere ilgili mesajları iletme imkânları ile birlikte, ilk resmi VTS sistemleri olarak kabul edilebilir. 90'lı yıllardan sonra Uluslararası Denizcilik Örgütü (IMO), Uluslararası Denizde Can Güvenliği Sözleşmesi (SOLAS) Bölüm 5 ve IMO VTS Kılavuzunu (A. 857 (20) sayılı karar) referans göstermesi ile birlikte VTS'ler deniz trafiğini yönetmek için temel sistem haline gelmiştir[4]. Günümüzde, VTS'ler kırk farklı deniz bölgesinde çalışmakta ve seyir güvenliğine katkıda bulunmaktadır [5].

VTS sistemi, tüm gemi hareketleri, operatör hareketleri ve belirli bir bölgedeki iletişim için kesintisiz bir kayıt özelliği sağlar. Herhangi bir olay meydana geldiğinde (büyük veya küçük olsun), VTS Sistemine sahip bir yetkili otorite, olayları kolayca analiz edebilir ve neyin yanlış gittiğini belirleyebilir, oysaki VTS sistemine sahip olmayan bir kıyı otoritesi kazada neyin yanlış gittiğini belirlemek için karmaşık bir soruşturmaya katılmak zorundadır. Bu karmaşık bir süreç olacak ve muhtemelen asıl nedenin belirsizliğini koruyacak şekilde çeşitli tarafların çelişkili ifadelerini içerecektir. VTS Sistemine sahip yetkili bir otorite, tüm bilgileri tek bir yerde toplar ve kendi birincil verilerini kullanarak neyin yanlış gittiğini kolayca ve hızlı bir şekilde değerlendirebilir. VTS'nin en önemli fonksiyonlarından bazıları, denizde can güvenliği ve seyir emniyetine katkıda bulunmak, gemi trafiği hareketlerinin verimliliğini artırmak, deniz çevresini korumak, deniz güvenliğini ve yasa uygulamalarını desteklemek olarak listelenebilir [6].

2. VTS Eğitimi

VTS'in ana amaçlarından biri; deniz trafiğinin güvenli, verimli ve çevre dostu bir şekilde işleyebilmesidir. Bu amacı gerçekleştirebilmek için VTS çalışanlarının en iyi düzeyde eğitilmesi çok önemlidir. VTS çalışanlarının uluslararası eğitim standartlarını düzenleyen IMO ya da alt komiteleri tarafından yayınlanmış bir konvansiyon bulunmamaktadır. VTS çalışanlarının eğitim standartları konusunda IMO, IALA'yı refere etmektedir. Ayrıca IMO Resolution A.857(20) ile VTS çalışanlarının eğitiminin yeterli olması konusundaki sorumluluğu taraf ülkenin yetkili makamlarına yüklemiştir [7].

Bu Çalışmada VTS alanında meydana gelmiş ve kaza raporunda VTS eylemlerinin de açık olarak değerlendirildiği 4 adet deniz kaza raporu incelenmiştir. Kaza nedenleri ve nedensel faktörlerinin tespit edilmesinde Uğurlu vd., (2018) tarafından ortaya konmuş HFACS-PV yapısı kullanılmıştır. Kazaların oluşum örgüsünün ortaya konması ve analiz edilmesi amacıyla Bayesian Network kullanılmıştır. Bayes Modelindeki düğümlerin koşullu olasılıklarının belirlenmesi için 3 kişilik uzman grubun görüşleri temel alınmıştır. Çalışma sonucunda VTS alanlarında kazalarda rol oynayan faktörler oraya konmuştur. Benzer kazaların gelecekte yaşanmasını önlemek amacıyla önerilerde bulunulmuştur.

3. Bayes Ağı

Bayes ağları kullanılarak belirsizlik ifade eden durumların tahmin edilebilmesi mümkündür [8-9]. Bayes ağları, modeli oluşturan parametrelerin arasındaki ilişki ve birbirine bağlılık derecesi bilindiğinde, karmaşık problemlerin (olayların) analiz edilmesini kolaylaştırmaktadır [8,10]. Bayes ağı, birbirini etkileyen durum ve olayları ağ örgüsü şeklinde modelleme imkânı sağlarken aynı zamanda koşullu olasılık yaklaşımıyla sayısal değerlendirme yapabilmeyi de sağlamaktadır [11-12]. Diğer bir deyişle mantık yürütülerek veya gerçek durumun modellenmesi ile oluşturulmuş olay örgülerinin, matematiksel olarak (Bayes teoremi kullanılarak) değerlendirilmesine, bu sayede tutarlılığının test edilmesine imkân vermektedir [13]. Bayes ağ'ın en büyük avantajlarından biri, modelin kolay adapte olabilmesidir; böylece her yeni bilgiyle, model

gerçek dünyayı yansıtacak şekilde güncellenebilir. Bayes ağlarının en önemli özelliği, belirsizlik hakkında modelleme ve mantık sağlama imkânı sağlamasıdır [14].

Bayes teoreminin matematiksel ifadesi; A ve B gibi birbirine koşullu olasılık bağı ile bağlı iki olay için B'nin bilinmesi koşuluyla A'nın olma olasılığıdır [9,15-16].

$$P(A|B) = \frac{A \cap B}{P(B)}, \text{P(B)} > 0 \quad (1)$$

ve A'nın bilinmesi koşuluyla B'nin olma olasılığı ise aşağıdaki gibidir.

$$P(B|A) = \frac{A \cap B}{P(A)}, \text{P(A)} > 0 \quad (2)$$

Bu koşullu olasılık formüllerini genel halde yazacak olursak; B olayıyla kesişen ve karşılıklı birbirini engelleyen k tane A olayı olduğunu varsayalım. B olayının bilinmesi koşuluyla A_i olayının olma olasılığı;

$$P(A_i|B) = \frac{P(A_i)\, P(B \mid A_i)}{P(B)}, \text{ i = 1, 2, 3, 4,..., k} \quad (3)$$

$P(A_i|B)$ = hipotezin posterior görülme olasılığıdır (A_i'nin belirli bir "B" durumunda görülme olasılığıdır)

$P(A_i)$ = hipotezin önceden belirlenmiş olasılığıdır, yani; A'nin belirli bir "i" durumunda olma ihtimalidir.

$P(B \mid A_i)$ = "B" durumunun A_i olayına göre koşullu olasılığıdır. (Test edilecek hipotezi veren kanıtların olasılığı)

$P(B)$ = A_i olayının görülme olasılığını koşullu olarak etkileyen "B" durumunun tek başına (ilk, prior) görülme olasılığıdır.

4. Materyal ve Metod

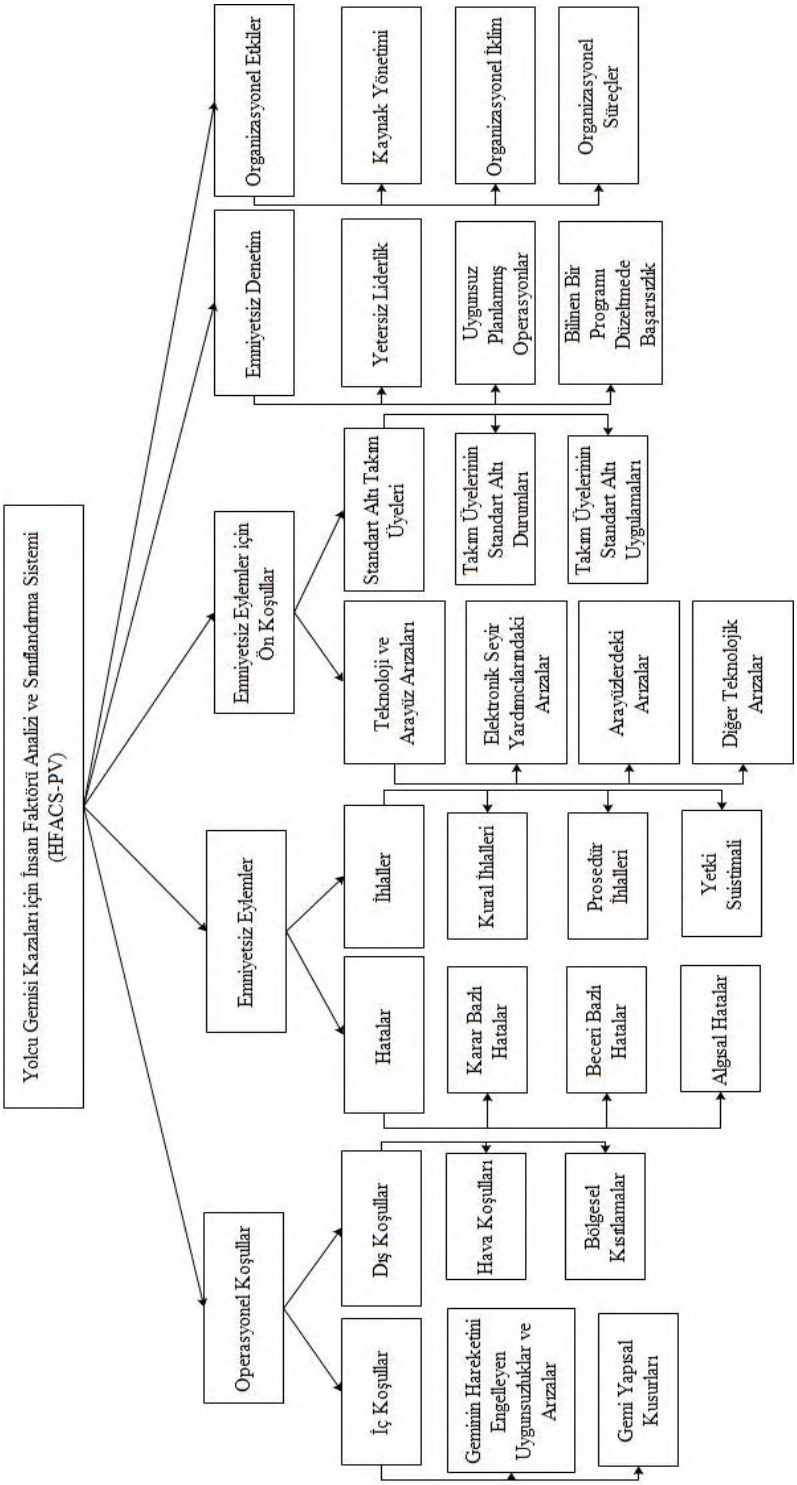
Çalışmada VTS alanında meydana gelmiş ve kaza nedenlerinde VTS eylemlerinin de yer aldığı 4 adet deniz kaza raporu incelenmiştir. İncelenen kazalar IMO'nun, Küresel Entegre Gemi Trafiği Bilgi Sistemi (Global Integrated Shipping Information System - GISIS) kaza veri tabanından elde edilmiştir. Kazaları raporlayan resmi kuruluşlar; Bahama Denizcilik

Otoritesi (BMA), Danimarka Deniz Kazaları İncelenmesi Bölümü (DMA), Amerikan Ulusal Ulaşım Güvenlik Kurulu (NTSB), İsveç Ulaştırma Ajansı (STA), Hong Kong Özel İdari Bölgesi-Denizcilik Bölümü'dür. İncelenen kazalar 2005-2015 yılları arasında meydana gelmiş olup, 3 tanesi çatışma/çatma ve 1 tanesi karaya oturma kazasıdır (Tablo 1).

Tablo 1: Çalışmanın Veri Setindeki Kazaların Genel Bilgileri.

İsim	Gemi Tipi	Kaza Yılı	Kaza Türü	Kaza Şiddeti	Kaza Pozisyonu
A1	Genel Kargo	2005	Çatma	Çok ciddi	55° 18.15' N-010° 52.26' E
A2	Konteyner	2006	Çatışma	Çok ciddi	24° 10.50' N-118º 17.00' E
A3	Kimyasal Tanker	2009	Karaya oturma	Daha az ciddi	57° 31.63' N-011° 40.30' E
A4	Konteyner	2015	Çatışma	Daha az ciddi	51° 24,82' N-004° 01,93' E

Çalışmada yer alan kaza raporları çalışma için oluşturulmuş 3 kişiden oluşan uzman grup tarafından analiz edilmiştir. Uzman grupta; alanında deneyimli, deniz kazaları alanında akademik çalışmaları olan ve kaza araştırmacısı eğitimi almış 3 akademisyen, bulunmaktadır. Analizin ilk aşamasında kaza raporları önce grup üyeleri tarafından bireysel olarak incelenerek her kazaya ait kaza nedenleri ve nedensel faktörleri tespit edilmiştir. İkinci aşamada grup bir araya gelerek kazayı tetikleyen ana olaylar ve nedensel faktörler arasındaki ilişkileri HFACS çatısı bağlamında değerlendirerek her kaza için kaza oluşum seneryosunu çıkarmıştır. Çalışmada kullanılanılan HFACS yapısı aşağıda sunulmuştur (Şekil 1) [17].



Şekil 1: Çalışmada Kullanılan HFACS Yapısı.

Tablo 2: Çalışmada Kurulan Bayes Ağında Kullanılan Kısaltmalar.

Kısaltma	Açılımı	Ebeveyn Düğümleri	Çocuk Düğümleri
IMVTS	VTS İstasyonunda Yetersiz Personel Donatımı	-	EWVTS, IVTSOP
UO	Kalifiye Olmayan VTS Operatörü	-	IVTSOP
LTFVTS	VTS Operatörünün Eğitim ve Aşinalık Eksikliği	-	IVTSOP
EWVTS	VTS Opertatörünün Aşırı İş Yükü	IMVTS	FTVTS, LOSAVTS
IVTSOP	Uygunsuz VTS Operasyon Planlaması	IMVTS, UO, LTFVTS	LOSAVTS, VTSOMF
FVTS	VTS Operatörünün Yorgun Olması	EWVTS	LOSAVTS
LOSAVTS	VTS Operatörü Durumsal Farkındalık Kaybı	FVTS, EWVTS, IVTSOP	SIVTS, ILVTS
LECCVTS	VTS Dışı İletişim ve Koordinasyon Eksikliği	LOSAVTS	SIVTS
VTSOMF	VTS Operasyon Yönetimi Hatası	IVTSOP	IUOVTSE
SIVTS	VTS Operatörünün Eylemsiz Kalması	LOSAVTS, LECCVTS, IUOVTSE	Karaya Oturma, Çatışma, Çatma
IUOVTSE	VTS Ekipmanlarının Yetersiz Kullanımı	VTSOMF	SIVTS, Çatma
ILVTS	VTS Operatörü Yetersiz Gözcülük	LOSAVTS	Çatışma, Çatma
CW	Kıyı Suları (Seyir Bölgesi)	-	Karaya Oturma, Çatışma
NC	Dar Kanal (Seyir Bölgesi)	-	Çatışma, Çatma
Karaya Oturma	Sonuç düğüm	CW, SIVTS	-
Çatışma	Sonuç Düğüm	CW, SIVTS, ILVTS, NC	-
Çatma	Sonuç Düğüm	SIVTS, IUOVTSE, ILVTS, NC	-

Üçüncü aşamada kaza nedenleri arasındaki ilişkiler Bayes Ağı ile modellenmiştir. Bayes Ağında düğümler kısaltılarak kodlanmıştır (Tablo 2). Dördüncü aşamada uzman grup üyeleri eşliğinde koşullu olasılık tabloları oluşturulmuştur.

Beşinci aşamada kurulmuş olan Bayes Ağı, Aksiyom testleri uygulanarak doğrulanmıştır. Bayes çalışmalarında Aksiyom testleri uygulanarak kurulan ağa kısmi doğrulama yapılması çok sık tercih edilen bir yaklaşımdır. Buna göre aşağıdaki aksiyomların doğrulanması beklenmektedir.

Aksiyom 1: Bir ebeveyn düğümün ilk olasılığındaki değişim, ilişkili çocuk düğümlerin posterior olasıklarını değiştirmelidir.

Aksiyom 2: Her bir ebeveyn düğümün öznel olasılık dağılımlarındaki değişimin büyüklüğü ile ilişkili çocuk düğümüne olan etki büyüklüğü tutarlı olmalıdır.

Aksiyom 3: Her bir ebeveyn düğümün çocuk düğümlerinde tek tek yapılan değişimlerin etkisi, o ebeveyn düğüme ait tüm çocuk düğümlerde yapılan değişimlerden daha az etkiye sahip olmalıdır.

Çalışmanın son basamağında analiz sonuçları ve VTS çalışanlarının eğitim ve belgelendirme standartları göz önünde bulundurularak kazalarda VTS etkisinin ne olduğu ortaya konmuştur. Çalışma sonucunda VTS eğitim ve uygulama standartlarının geliştirilmesine yönelik öneriler sunulmuştur.

5. Sonuçlar

Çalışmada incelenen kazalar uzman grup üyeleri tarafından değerlendirilirken HFACS ana çatıları göz önünde bulundurulmuştur. HFACS yapısından farklı olarak "Çevresel Faktörler" ayrı bir çatı olarak ele alınmıştır. Bu yapı gözönünde bulundurularak kaza raporunda ortaya konmuş her neden ve nedensel faktörler tespit edilmiştir.

Kazaların oluşumu incelendiğinde VTS eylemlerinin kazayı tetikleyici faktör yapısında olmadığı görülmüştür. Diğer bir deyişle kazayı meydana getiren tetikleyici emniyetsiz eylemlerin gemi personeli tarafından yapılan eylemler olduğu görülmüştür. Ancak VTS kazanın meydana gelmesini engelleyebilecek, kaza oluşumundaki zincirleme reaksiyonu son aşamada kırabilecek bir etkisi söz konusudur. Bu durum incelenen kaza raporlarında da belirtilmiştir. Bu nedenle kazalarda VTS operatörlerinin eyemsiz kalması aslında bir emniyetsiz durumdur. Eğer incelenen kazalarda VTS operatörleri, kazaya karışan

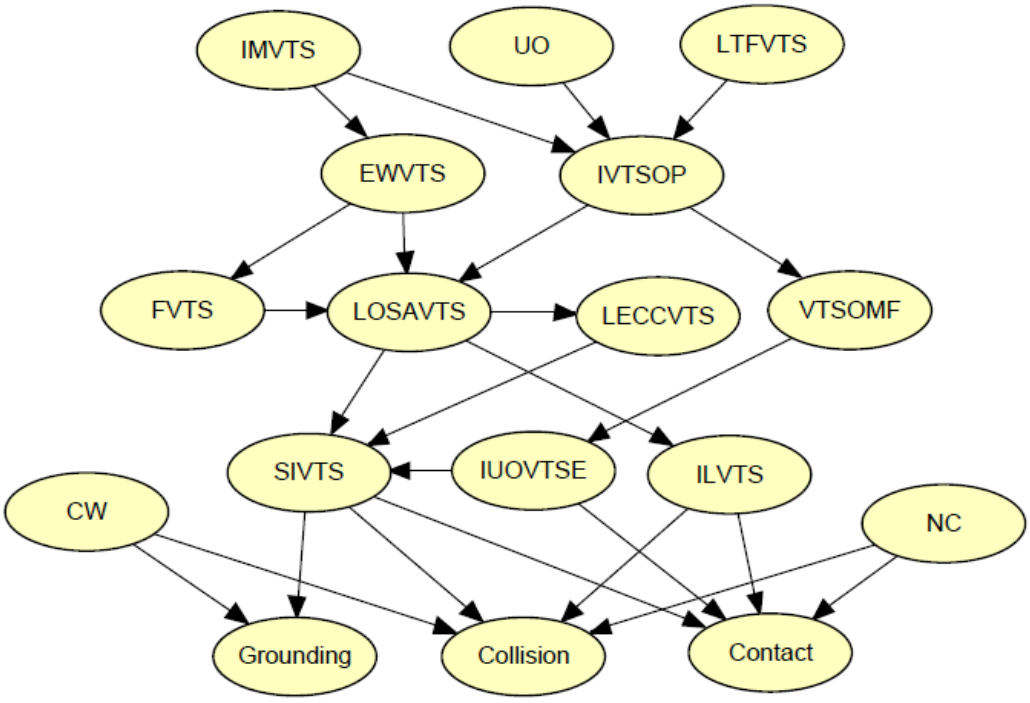
gemilerin emniyetsiz manevralarından şüphelenerek iletişim kurmuş olsaydı, bu kazalar meydana gelmeyecekti. Bu bakış açısıyla kazaya etkiyen VTS faktörleri HFACS çerçevesinde incelenerek tespit edilmiştir (Tablo 3).

Tablo 3: HFACS Yapısı Kullanılarak Kazalardan Çıkarılan VTS ile İlgili Faktörler.

Adı	Organizasyonel Etkiler	Emniyetsiz Denetim	Emniyetsiz Eylemleri Hazırlayan Ön Koşullar	Emniyetsiz Eylemler	Operasyonel Koşullar
A1	VTS İstasyonunda Yetersiz Personel Donatımı	VTS Operatörünün Aşırı iş yükü, Uygunsuz VTS operasyon planlaması	VTS operatörünün Yorgun Olması, Durumsal Farkındalık Kaybı, VTS Dışı İletişim ve Koordinasyon Eksikliği, VTS Operasyon Yön. Hatası	VTS Operatörü Yetersiz Gözcülük, VTS Ekipmanlarının Yetersiz Kullanımı, VTS Operatörünün Eylemsiz Kalması	Dar Kanal Görüş Mesafesi: İyi Hava ve Deniz Koşulları: Sakin
A2	Kalifiye Olmayan VTS Operatörü	Uygunsuz VTS Operasyon Planlaması	VTS Dışı İletişim ve Koordinasyon Eksikliği, Durumsal Farkındalık Kaybı, VTS Operasyon Yönetimi Hatası	VTS Operatörü Yetersiz Gözcülük, VTS Operatörünün Eylemsiz Kalması	Kıyı suları Görüş mesafesi: İyi Hava ve Deniz Koşulları: Sakin
A3	Kalifiye Olmayan VTS Operatörü	Uygunsuz VTS Operasyon Planlaması	Durumsal Farkındalık Kaybı, VTS Dışı iletişim ve Koordinasyon Eksikliği, VTS Operasyon Yönetimi Hatası	VTS Operatörünün Eylemsiz Kalması	Kıyı suları Görüş mesafesi: İyi Hava ve Deniz Koşulları: Sakin

A4	Kalifiye Olmayan VTS Operatörü, VTS Operatörünün Eğitim ve Aşinalık Eksikliği ve VTS Alanının Sınırlamaları	Uygunsuz VTS Operasyon Planlaması	VTS Dışı iletişim ve Koordinasyon Eksikliği, Durumsal Farkındalık Kaybı	VTS Operatörünün Eylemsiz Kalması	Dar Kanal Görüş Mesafesi: İyi Hava ve Deniz Koşulları: Sakin

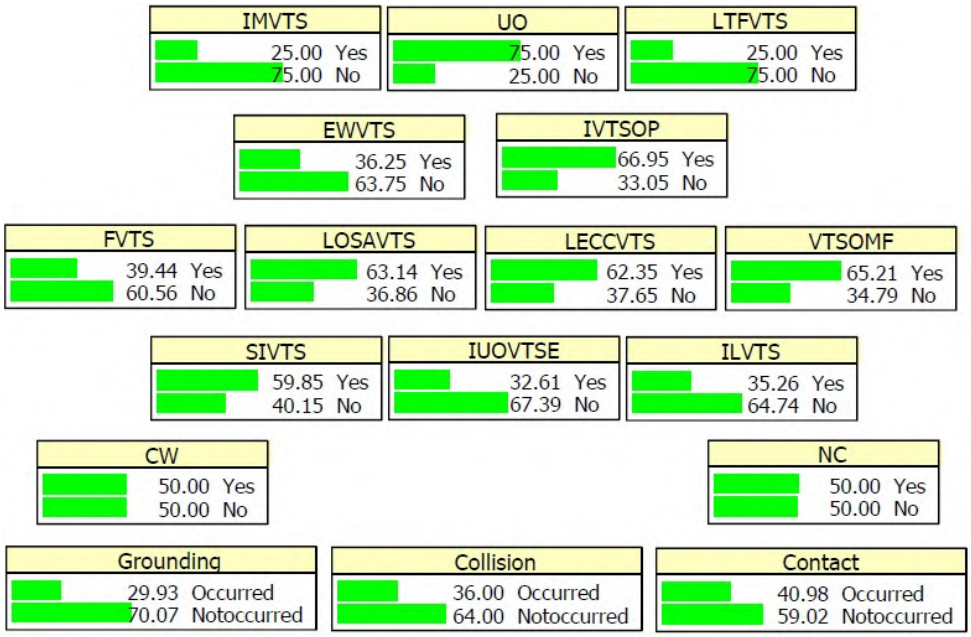
VTS faktörleri ortaya konduktan sonra yine HFACS seviyelerinin birbiriyle olan ilişkileri ve kazanın oluş şablonu (pattern) göz önünde bulundurularak uygun Bayes Ağı modeli kurulmuştur (Şekil 2). VTS faktörleri bayes ağında kodlanmış, kodların açıklamaları aşağıda sunulmuştur.



Şekil 2: VTS Faktörlerin Bayes Ağı.

Şekil 3'de üç adet uzmandan alınan ilk olasılıkların Hugin Researcher yazılımına girilerek analizinin yapılması sonucunda elde edilen posterior probability'ler görülmektedir. Buna

göre VTS alanlarında meydana gelen kazaların örgütsel seviyede en temel tetikleyicisi VTS operatörünün kalifiye olmamasıdır (75,0%).



Şekil 3: VTS Faktörlerin Olasılıkları.

Denetim ve liderlik seviyesindeki eksiklikler incelendiğinde, VTS operasyonlarının uygunsuz planlanması (66,95%) en önemli faktördür. Diğer taraftan, yetersiz sayıda operatör donatımından kaynaklı olarak mevcut işlerin daha az sayıda personele paylaştırılması VTS personelinde 36,25% oranında aşırı iş yükü oluşmaktadır.

Emniyetsiz eylemlere yol açan ön koşullar seviyesi altında ise en önemli faktörler sırasıyla VTS operatörlerinin operasyon yönetimi hatası (65,21%), VTS operatörlerinin tehlikeyi fark edememesi, durumsal farkındalığının olmaması (63,14%), VTS-Gemi arası iletişim ve koordinasyonun eksik olmasıdır (62,35%).

Kazaları diğer seviyedeki faktörlerden farklı olarak doğrudan etkileyen, bu yüzden HFACS yapısında aktif kusurlar olarak adlandırılan Emniyetsiz Eylemler seviyesi incelendiğinde, VTS Operatörünün Eylemsiz Kalması (59,85%), VTS Operatörünün Yetersiz Gözcülüğü

(35.26%) ve VTS Ekipmanlarının Yetersiz Kullanımı (32,61%) faktörlerinin sırasıyla kazalarda rol oynadığı görülmüştür.

6. Modelin Geçerliliği

Bu bölümde kurulan Bayes Ağının üç aksiyom testini sağlayıp sağlamadığı kontrol edilmiştir. Her aksiyom için ayrı ayrı her düğümün (ebeveyn ve aile düğümleri) koşullu olasılıkları arttırılıp azaltılmıştır. Yapılan aksiyom testleri sonucunda kurulan Bayes Ağının testleri sağladığı ve geçerli olduğu görülmüştür.

7. Tartışma

Örgütsel seviyede en temel tetikleyici VTS operatörünün kalifiye olmaması olarak ortaya konmuştur. Bunun temel nedeni VTS operatörlerinin birçok ülkede denizcilik kökenli ve aktif deniz tecrübesi olma zorunluluğunun olmamasıdır. Gemi kaptanlarını ve pilotları yönlendirme görevi oldukça hassas bir iştir ve denizcilik mesleğine hâkim olmayı gerektirir. Bu nedenle VTS operatörü ve VTS baş operatörü olmak isteyen kişilerde mutlaka deniz tecrübesi aranmalıdır.

VTS operasyonlarının uygunsuz planlanması, VTS operatörlerinin yeterli bilgi ve tecrübeye sahip olmaması, verilen teorik eğitimi pratiğe döküp uygulayamamasından kaynaklanmaktadır. Bunun önlenebilmesi için VTS operatörlerinin eğitim standartlarının IALA ve IMO işbirliğiyle gözden geçirilmesi revize edilmesi, gerekirse mesleki tecrübenin arttırılması için mesleğe başlamadan önce staj gerekliliğinin konması, bunun yanı sıra kılavuz kaptanlarda olduğu gibi yenileme eğitimlerinin zorunlu kılınması gerekmektedir.

Emniyetsiz eylemlere yol açan ön koşullar seviyesi altındaki VTS operatörlerinin operasyon yönetimi hatası; operatörlerinin mesleki eğitim ve aşinalıklarının eksik olmasından kaynaklanmaktadır. VTS operatörlerinin mesleğe tam olarak başlamadan önce mutlaka operasyon planlaması, risk analizi, risk yönetimi ve risklerle mücadele eğitimleri alması bu tür hataları azaltabilir. VTS operatörlerinin tehlikeyi fark edememesi, durumsal farkındalığının olmaması, operatörlerin yorgunluğu ve aşırı iş yükü gibi tetikleyiciler sonucu oluşabilmektedir. Bunun minimize edilebilmesi için çalışma-

dinlenme saatlerinin sadece ulusal düzeyde değil, uluslararası düzeyde daha sıkı düzenlenmesi ve işleyişinin sürekli olarak denetlenmesi gerekmektedir.

Emniyetsiz eylemler seviyesi altındaki; VTS Operatörünün Yetersiz Gözcülüğü riskin belirlenememesi, bunun sonucunda herhangibir eylemde bulunulmamasına yol açmaktadır. VTS operatörlerinin temel amaçlarından biri gemideki personelin gözünden kaçmış tehlikeyi fark ederek gemiyi uyarmak ve bu sayede olası bir kazayı engellemek olmalıdır. Bunun için VTS operatörlerinin mutlaka Denizde Çatışmayı Önleme Tüzüğü (COLREG) eğitimini en iyi şekilde alması gerekmektedir. Ayrıca birçok denizcilik şirketinin gemi personelini gemiye göndermeden önce tabi tuttuğu gibi bir periyodik COLREG sınavının zorunlu tutulması bilgilerin tazeliğini sağlamak açısından yararlı olacaktır. VTS Ekipmanlarının Yetersiz Kullanımı; incelenen kazalarda bunun en temel örneği, VTS otomatik alarm fonksiyonunun yeterince etkin kullanılamaması veya devredışı bırakılmasıdır. Bunun önlenebilmesi için her VTS bölgesinde mutlaka bölgeye özel ve değişken riskler tespit edilmelidir. VTS bölgelerinde belirlenen optimum rotalar mutlaka belli aralıklarla gözden geçirilmeli ve gerekiyorsa revize edilmelidir. Bu risklere göre VTS sistemlerindeki (VTS radarı, Elektronik harita sistemi, vb.) otomatik alarmlar optimum düzeyde ayarlanmalı ve gemideki "Ölü Adam Alarmı" gibi operatör inisiyatifinden çıkartılarak kullanımı zorunlu hale getirilmelidir. VTS Operatörünün Eylemsiz Kalması genellikle tehlikeyi belirleyememiş olmasından kaynaklanmaktadır. Bu durum önceki belirtilen önlemlerle kısmen önlenebilir.

Yapılan çalışmanın sonuçlarına göre VTS eylemleri direkt olarak kazaya yol açmamaktadır, ancak olası bir kazanın engellenmesinde VTS çok büyük bir önem arz etmektedir. VTS operatörlerinin kendi bölgelerinde bir çifte kontrol mekanizması gibi görev yaparak gemi personelinin gözden kaçırdığı riskleri fark ederek uyarıda bulunması hayati önem arz etmektedir. Bunun için mutlaka VTS operatörlerinin denizcilik bilgilerinin en az gemideki vardiya zabitleri kadar iyi olması gerekmektedir. Buna yönelik olarak VTS operatörlerinin eğitiminde uluslararası standardizasyonun sağlanması, bu standardizasyonun IMO, IALA ve yerel ülke otoriteleri iş birliğinde yapılması emniyetli deniz trafiğinin geleceği için oldukça önemlidir.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Relationship Between the Amount of Container Cargo Handled in Turkey with The Number of Turkish-Flagged Container Vessel

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ABSTRACT

The amount of cargo handled in Turkey is about 111M tonnes. It has been observed that the container cargo quantity handled in our country after 2008 decreased by the inventories. At the same time, when the total Turkish flagged container cargoes in our country were assesed, it was observed that the number of these ships decreased after 2008. In this study, it is aimed to optain a model that shows the relation between quantity of container cargo and the number of Turkish flagged container vessels over time. A multiple regression statistical analysis method is applied to determine whether there is a relationship between the amount of handled container cargo and Turkish flagged container vessels. This relationship will be used to estimate the numbers of Turkish flag ships by using forecasts on the container cargo handling in Turkey.

Keywords: Container cargo, Turkish-flagged vessels, multiple regression, statistical analysis, maritime

1. Introduction

The patterns of production and consumption are changing in a globalizing and liberalized world. A product is produced in more than one country at the same time and is distributed all over the world from where it was produced. Specializing in international trade, each country has begun to produce goods that are relatively superior. The raw materials and energy materials required for these products are imported from abroad for the countries without natural resources. The raw materials, intermediate goods and fossil fuels required for production are transported by sea. The final goods produced in the same way are transported as far as possible from one country to another or within the country by sea.

Maritime transportation is more advantageous than the other transportation modes in terms of the amount of freight it carries and in terms of cost. Expedition time is shortened with advancing technology and at the same time increased safety of life and property at sea. Increased level of production on a world scale, procurement of inputs for production and delivery of the resulting product to the consumers reveal the importance of maritime transport.

75% of the imported and exported cargoes of the world trade are transported by sea and the volume of international trade realized by sea in the world is increasing day by day. The maritime transport sector is a sector that is experiencing a downward trend in parallel with the country's import and export increases and decreases and even the changes in the world. In recent years, maritime transport has shown a rising trend within total trade volume [1].

All the conditions mentioned are valid for Turkey. Especially when the three sides of Turkey are thought to be surrounded by seas, the goods trade with other countries is heavily dependent on seaway. For example, due to its geopolitical position in the Sea of Marmara, which is an inland sea, there is intense flow of goods. In addition, the flow of goods is also provided by sea.

Accordingly, in this study, it is aimed to understand the effect of the amount import and export container cargo in Turkish port on the number of Turkish flag container vessels. With this aim, it is used Regression Analysis via SPSS 25. In the following part, research hypothesis formation phase is given by making literature review. In the final part, result of the analysis and discussion are presented.

2. Background

In the 21st century, world trade has grown significantly. Increasing trade has created demand for transport services and the volume of freight transported has gradually increased. The transportation sector is becoming more and more prominent with the cheaper, safer and faster transportation.

Maritime transportation has been used more frequently with the development of trade on the Earth and it has become more preferable because it is both safer and cheaper especially for the transportation of large volume cargoes. The fact that high-capacity transportation vehicles reduce the transportation costs per unit means the economies of scale in maritime transport [2]. The supply-demand balance in maritime transport occurs between the cargo to be transported and the tonnage carrying it; tonnage determines supply and cargo determines the demand [3]. The volume of international trade by sea is gradually increasing.

In addition, maritime transport in the world is moving from bulk transportation to container transportation. With the tendency to container, the size of container ships and the number of large tonnage vessels increased. In 1992, the largest container ship had a capacity of 4,500 TEU, whereas in 2002, 8,400 TEU ships were built. In later years, the size of container ships increased to over 14,000 TEU [4].

According to ISL Port Database, the first half of the last decade has been affected by the increase in both total cargo traffic and container traffic. The total cargo amount of approximately 450 ports constituting ISL's Port Database increased by 1.8% in 2016 after a slight decrease in 2015 [5]. Similarly, according to an example given by the Chamber of Shipping, in 2017, deliveries to the world trade fleet reached 95.3 million DWT tonnage.

Considering the delivery volume after 2014, it is observed that this limited growth for some sectors is excessive even though there is a downward trend [6].

At this point, ports are increasingly prominent in determining the levels of economic development of countries; The number and capacity of the port is an important criterion of the countries' national strength and competitiveness. The employment and value-added characteristics of the port sector have significantly improved with the increasing number of vessels in the world fleet and the impact of increased cargo volumes and the emergence of large container ships. For example, Kocaeli ports meet the logistic service needs of the region. There is an increasing number of ships and cargo entrances each year to the pier, port and container terminals in Kocaeli [7].

Looking at the fleet evaluation of world countries, Greece, Japan and China continue to be the world's largest merchant fleet on a capacity basis. They control about 46% of the world tonnage. Panama with 326 million DWT and 6,395 ships continues to be the country with the world's largest registry. This is followed by the Marshall Islands (230 million DWT) and Liberia (219 million DWT). Three-fourths of the world trade fleet uses one of the top ten flags and approximately 70% of the trade fleet belongs to the top ten countries. [8]. When the literature is analyzed, it is seen that import and export change has an effect on ship fleet change. According to Table 1, as of January 2012, the world fleet of 39,732 vessels was approximately 1.4 billion dwt. While the country with the highest number of commercial cargo ships is 3,989, it is the country with the highest volume of fleet with 224 million dwt. Greece's share in the sector is 16.1%, followed by Japan with 15.6% and Germany with 9%. Turkey has a 1.7% market share with the fleet consisting of 1,174 on board.

Table 1: World Maritime Fleet, 2012 [9].

Rank	Country	# of vessel	Total Volume (x1.000.000 Dwt)	Market Share
1	Greece	3321	224	16.1
2	Japan	3960	217.6	15.6

3	Germany	3989	125.6	9
4	China	3629	124	8.9
5	South Korea	1236	56.1	4
6	USA	2055	54.5	3.9
7	Taiwan	853	45.5	3.3
8	Norway	1992	43.1	3.1
9	Denmark	1043	39.9	2.9
10	Hong Kong	703	38.9	2.8
11	Singapore	1110	38.5	2.8
12	Bermuda	268	30	2.2
13	Italy	834	25	1.8
14	Turkey	1174	23.5	1.7
15	Canada	456	21.8	1.6
16	India	560	21.3	1.5
17	Russia	1787	20.4	1.5
18	England	710	18.4	1.3
	Other Countries	10042	223.7	16.1
	Total	39722	1391.8	100

Another similar study with the improvement in transportation services according to the improvement in import and export rates in the world is as Table 2 [7]. Looking at the Table 2, due to the global crisis, the volume of trade, which had contracted since 2008, began to expand after 2009. The volume of imports and exports in the world has increased by approximately 20% every year until 2012. In 2012, no significant change was observed in the world trade volume compared to the previous year. The export and import of transportation, which is a component of the total volume of exports and imports, grew

similarly in 2010 and 2011. On the other hand, the share of transportation services exports in total exports is 5%, while the share of transport services imports in total imports is 6% on average. In general, there is a parallel shift between the total import and export percentage changes in the world and the percentage change in the transport service.

Table 2: Total Exports, Imports, Imports and Exports of Transportation Services in the World, 2008-2012 [7]

Years	**2008**	**2009**	**2010**	**2011**	**2012**
Total Exports in the world (billion $)	16154	12545	15289	18291	18323
Change (%)	15.2	-22.3	21.9	19.6	0.2
Total Imports in the world (billion $)	16566	12776	15504	18487	18567
Change (%)	15.6	-22.9	21.4	19.2	0.4
Export of transportation services in the world (billion $)	890	692	802	874	887
Change (%)	16.2	-22.3	15.9	8.9	1.5
Import of transportation services in the world (billion $)	1052	831	979	1106	1128
Change (%)	16.8	-21.0	17.8	13.0	2.0
Share of transport services in total exports	5.5	5.5	5.2	4.8	4.8
Share of transport services in total imports	6.3	6.5	6.3	6.0	6.1

After all these background, it can easily be said that the amount of imported and exported cargo at the ports after is related to the amount of Turkish flagged vessels. A similar study conducted in 2012 by Korkmaz and it has been shown that there is positive and statistically significant relationship between the increase of shipping with industrial production in Turkey also total trade [10]. In Korkmaz's study, the effect of the number of ships entering and leaving the Turkish ports on the total trade was demonstrated. On the

other hand, in this study, the effect of the total container load imported and exported in Turkish ports on the number of Turkish flag container vessels was investigated. With this aim, data provided from the General Directorate of Maritime Trade Statistics Information System has been analyzed via SPSS version 25.

3. Methodology

In this study, the relationship between the total amount of imported and exported containers in Turkish ports and the number of Turkish flagged vessels was investigated by regression analysis.

For this purpose, data between 2004 and 2018 has been provided from the General Directorate of Maritime Trade Statistics Information System. Figure 1 and Figure 2 show that the total amount of container cargo handled in Turkish ports and the Turkish flag vessel ship fleet are changed over the years. Quantity of container cargoes and Turkish flag vessels have been referred as unit of deadweight (DWT). According to Figure 1, in 2008, there was a significant decrease in the amount of container cargo handled in Turkish ports due to the global crisis. Similarly, according to the data in Figure 2, although there is no significant decrease, it is seen that the increase amount is less than the other years. Besides that, in 2014 and 2015, it is observed that there is a decline in the amount of cargo handled, while a similar decline is observed in the Turkish flag fleet.

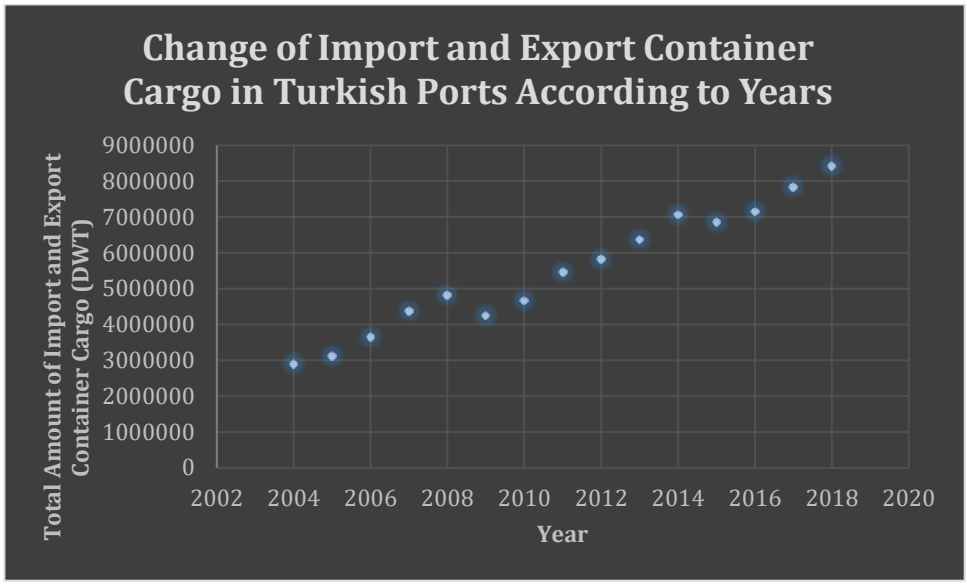

Figure 1: Change of Import and Export Container Cargo in Turkish Ports According to Years.

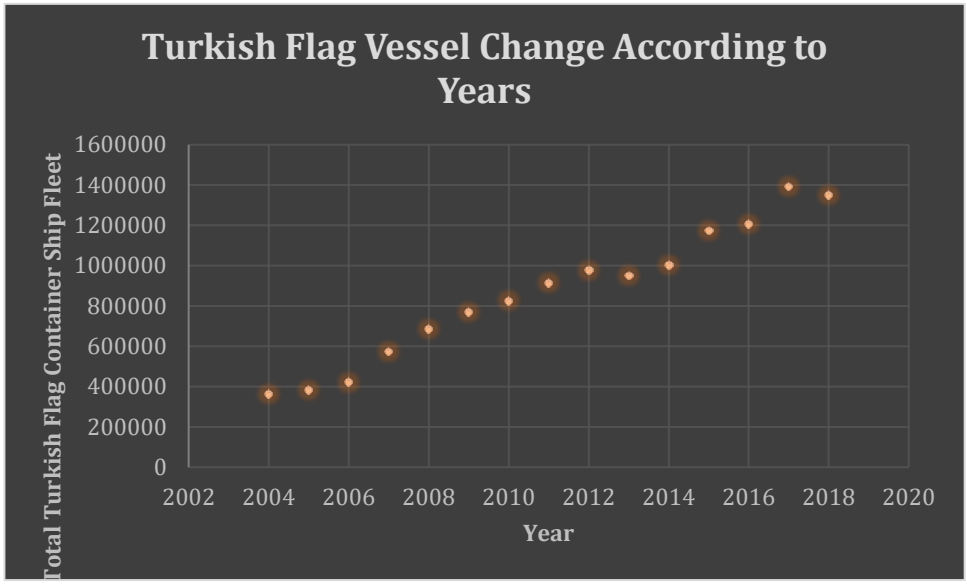

Figure 2: Turkish Flag Container Vessel Change According to Years.

In the light of the data obtained and the literature review, the total amount of imported and exported cargo in Turkish ports is expected to have a positive effect on the number of Turkish flagged vessels.

In this study, the effect of increasing or decreasing number of handled container cargo Turkish ports on Turkish flag container vessel was investigated. For this purpose, the following model is estimated by least squares method:

$$TFCV\ (dwt) = \beta_0 + \beta_1\ THCC\ (dwt) + \varepsilon \quad (1)$$

In Equation (1), Turkish Flag Container Vessel (TFCV) is determined dependent value and Total Handled Container Cargo (THCC), which is refer to total import and export container cargo in Turkish Port, is determined independent value. In this model, β_0 is constant value and β_1 reveals the coefficient of effect of THCC on TFCV.

Before the applied the simple regression analysis, the normality test, the heteroscedasticity test and the autocorrelation test, which are the prerequisites for simple regression analysis, were conducted. According to normality test, since the skewness and kurtosis values of the dependent and independent variables are between -1, 5 and +1.5, (Skewness of TFCV, -0,059; Kurtosis of TFCV, -0,992; Skewness of THCC, 0,088; Kurtosis of THCC, -1,122), it can be said the data is to have a normal value [11]. According to Durbin Watson test, there is no autocorrelation between the error terms (Durbin Watson value, 1,342) [11]. Also, as shown in Figure 3, there is no heteroscedasticity.

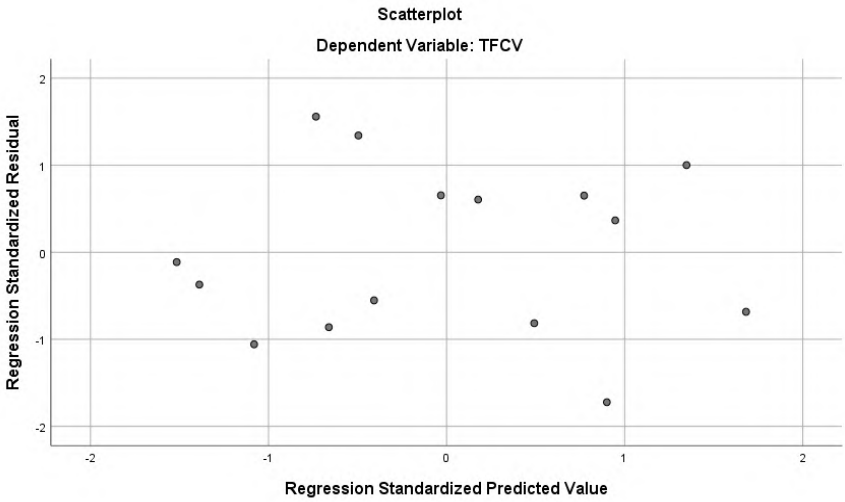

Figure 3: The Test of Heteroscedasticity.

After the convenience of the data have been proven, the data are analyzed with the least squares method and the results are presented as in Table 3. According to results, the model significantly explains the change of Turkish flag vessel (Sig value: ,000). Also, with reference to the R squared value, the cargo change handled at the Turkish ports explain 93.3 percent of the change in the number of Turkish flagged vessels. The increase of 1 unit in the total imported and exported cargo in Turkish ports causes an increase of 0.188 units in the number of Turkish flagged vessels.

Table 3: Relationship Between Total Import and Export Container Cargo and Turkish Flag Container Vessel.

Coefficients[a]					
	Unstandardized Coefficients				
Model	B	Std. Error	Standardized Coefficients Beta	t	Sig.
1 (Constant)	-170452,607	80176,401		-2,126	,053
THCC	,188	,014	,966	13,499	,000
a. Dependent Variable: TFCV					
R^2: 0,933			Durbin Watson: 1,342		
Skewness of TFCV: -0,059			Kurtosis of TFCV: -0,992		
Skewness of THCC:0,088			Kurtosis of THCC: -1,122		

4. Results

In this study, the effects of container trade volume in Turkey to the Turkish-flagged ships were statistically analyzed. According to the data obtained, it is observed that the increase in the amount of container import and export has a positive effect on the increase in the number of Turkish flagged vessels. When the three sides of Turkey are thought to be surrounded by seas and its considering geopolitical location is in key position between Europa-Asia-Africa. If this situation is used to expand the foreign trade volume, it is expected that the number of Turkish flagged vessels will increase in parallel. However, it is known that the only information required for flag selection is not the trade volume. In future studies, the addition of other factors such as annual fees and taxes will may give better results.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Maritime Security in The Framework of NATO Security Architecture

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ABSTRACT

The main objective of maritime safety strategies is to prevent the use of marine areas for illegal activities and to ensure people's movements and the flow of vital resources in the world. For the states that have the purpose of ensuring the security of the sea lines, new threats brought about by the modern era have emerged. For these new threats, NATO's elaborate maritime strategies and a holistic approach have been introduced. In this context, NATO has built its maritime security architecture on three main headings.

These headings are:

- Collective Defense and Deterrence
- Crisis management
- Partnerships and Collaborations in the Marine Area

In this study, NATO maritime security architecture is examined under the three headings and NATO's role in maritime security is presented.

Keywords: NATO, Maritime Security

NATO Güvenlik Mimarisinde Deniz Güvenliği

ÖZET

Deniz güvenliği stratejilerinin temel amacının, denizel alanlarının yasa dışı faaliyetler için kullanılmasını önlemek ve insanların hareketlerini ve dünyadaki hayati kaynakların akışını güvence altına almak olduğu söylenebilir. Dolayısıyla tarihin her dönemimde deniz hatlarının güvenliğini sağlamak aamcında olan devletler için, günümüz çağının getirdiği yukarıda da belirtilen tehditler ortaya çıkmıştır. Bu yeni tehditleri önlemek, Sadece askeri nitelikte olmayan ve sadece denizel alanları etkilemeyen veya denizel alanlardan kaynaklanmayan tehditlerin NATO tarafından ele alınması etkin denizcilik stratejileri ve holistik bir yaklaşımı zorunlu kılmıştır. Bunun için NATO, deniz güvenliğindeki mimarisini üç temel başlık üzerine kurmuştur. Bu başlıklar, "Toplu Savunma ve Caydırıcılık", "Kriz Yönetimi" ve "Denizel alanda Ortaklıklar-İşbirlikleri" olarak adlandırılır. Bu çalışmada, NATO deniz güvenliği mimarisi bahsi geçen üç başlık altında incelenmiş olup, NATO'nun deniz güvenliğindeki rolü sunulmuştur.

Anahtar Kelimeler: NATO, Deniz Güvenliği

1. Giriş

Küreselleşen dünyada hammadelerin, ürünlerin ve enerji kaynaklarının %90 'ından fazlası deniz taşımacılığı ile sağlanmaktadır. Mevcut durumda yaklaşık 50000 olan dünya ticaret filosunun önümüzdeki on beş yıl içerisinde iki katına çıkacağı öngörülmektedir (UNCTAD, 2017). 2000 yılında USS Cole'a yapılan terrorist saldırı, Fransız tanker Limburg'a yapılan saldırı ve Somali kıyılarında ortaya çıkan korsanlık, NATO açısından soğuk savaş sonrası ortaya çıkan yeni tehditlerin örnekleri olmuştur (Barnes, Baldino, 2018). Denizel alandaki terörizm, kitle imha silahlarının yayılımı, uyuşturucu kaçakçılığı, korsanlık gibi mevcut tehditler doğası gereği küreseldir ve bütüncü bir yaklaşımla ele alınması gerekmektedir.

Deniz güvenliği, NATO açısından yeni bir konu değildir. Denizel tehditlerle ilgili bir çok araç ve politika geliştirilmiştir. NATO'nun soğuk savaş sürecinde, deniz stratejisi, saldırıları engellemek ve Sovyetler Birliği Donanmalarına karşı bir savaş için sürekli hazır durumda bekleyerek olası bir savaşta Sovyet Donanmasını yenmek üzerine oturtulmuşken, 9/11 sonrasında uluslararası terörizmin yeni bir boyut kazanması ile güvenliğin boyutları genişleyerek, tehditlerin kaynakları ve hedefleri farklaşmıştır (Jopling, 2010). Denizel alanda terörizm, korsanlık veya organize suçlar gibi tehditlerin sayısı fazlalaşmış, deniz güvenliği sadece donanma gücü ve etkinliği ile değil, ekonomik refah, çevrenin korunması ve küreselleşme ile bütünleşme süreçleri için de önemli hale gelmiştir.

Uluslararası ticaret ve iletişime dayanan gelişmiş ekonomiler olarak NATO'nun üye ülkeleri için denizcilik endüstrisinin önemli bir pazar olduğunu söyleyebiliriz. Örneğin NATO üye ülkeleri, küresel öneme sahip limanları işletmektedirler. Dünyanın en büyük on denizcilik şirketinin dördü NATO ülkeleri arasındadır ve en yüksek tonaja sahip 8 üye ülke mevcuttur. NATO 2010 Stratejik Konsepti ile Nato ülkesi üyeler için denizel alanın önemine atıf verilmiş ve özellikle enerji kaynaklarının taşınması sürecinde deniz rotalarının kritik önemde olduğu vurgulanmıştır. 2011 İttifak Deniz Stratejisi (AMS) ile birlikte NATO'nun deniz politikalarındaki yeni paradigmaları sunulmuştur (NATO, 2011).

Fakat 2014 yılında İngiltere'nin yeni deniz güvenliği stratejisini açıklaması, ABD Deniz Kuvvetlerinin "21. Yy'da Denizcilikte İşbirliği Stratejisi" ile ulusal denizcilik stratejisini güncellemesi ve 2014 yılında AB'nin kendi deniz güvenliği stratejisini yayınlaması, NATO genelinde küresel denizcilik alanında ortaya çıkan zorluklarla ilgili belirsizliklerin olduğunu ortaya koymuştur (Horrell et al., 2016).

NATO, deniz ittifakı olarak güçlü bir mirasa sahiptir. Soğuk Savaş sırasında, NATO Deniz Kuvvetleri, Sovyetlerin Batı Avrupa'yı işgal etmesini engellemiş ve Atlantik Okyanusu'ndaki ABD'nin Avrupa'yı destekleyebilmesi konusunda önemli bir rol oynamıştır. Soğuk Savaş'ın sona ermesinden sonra ise NATO, Balkanlardan Afganistan'a uzanan çok çeşitli kriz yönetimi operasyonlarına katılmışve 36 operasyon başlatmıştır (Bryan, 2018). On operasyon doğrudan denizel alanlarla ilgili iken, Afganistan'daki Uluslararası Güvenlik Yardım Gücü (ISAF) çabaları ve Libya'daki Birleşik Koruyucu Operasyon çalışmaları gibi operasyonları, NATO'nun güçlü ve kalıcı deniz güvenliği faaliyetleri sürdürülebilir olmuştur (Cottey, 2018). Genel olarak incelendiğinde NATO'nun Soğuk Savaş'ın sona ermesinden bu yana geçen denizcilik faaliyetleri, kapasite geliştirme aşamasından savaş müdahalesine kadar geniş bir alanı kapsamaktadır. Ayrıca Çin ve Hindistan gibi yeni donanma güçlerinin ortaya çıkması, askeri teknolojinin gelişmesi, küreselleşme, kentleşme ve iklim değişiklikleri ile birlikte NATO için coğrafi alan kapsamında genişlemeyi beraberinde getirmiştir. Günümüzdeki deniz güvenlik tehditlerini

- Uluslararası terör faaliyetleri için liman, deniz kaynaklı enerji altyapıları, gemi gibi kritik altyapıların hedef haline gelmesi
- Deniz yollarının teröristler veya bazı devletler tarafından kitle imha malzemesi ve teknolojisinin silahlarının çoğaltılması için kullanılması
- Uyuşturucunun, insanların ve silahların yasadışı hareketindeki artışın yanı sıra, özellikle Afrika'dan Avrupa'ya kaçak göçmenlerin akışının artması ortaya çıkan deniz yönetişimi ve sınır kontrolü sorunları
- Korsanlık ve Somali kıyılarındaki silahlı soygun olayları

- Deniz ekolojisi ve gıda zincirini kıracak olan deniz kirlilikleri ve kaçak avlanma olayları
- İklim değişiklikliği sonucu olabilecek doğal afetler oluşturmaktadır.

Yukarıda bahsedilen hususlar çerçevesinde deniz güvenliği stratejilerinin temel amacının, denizel alanlarının yasa dışı faaliyetler için kullanılmasını önlemek ve insanların hareketlerini ve dünyadaki hayati kaynakların akışını güvence altına almak olduğu söylenebilir. Dolayısıyla tarihin her dönemimde deniz hatlarının güvenliğini sağlamak aamcında olan devletler için, günümüz çağının getirdiği yukarıda da belirtilen tehditler ortaya çıkmıştır. Bu yeni tehditleri önlemek, Sadece askeri nitelikte olmayan ve sadece denizel alanları etkilemeyen veya denizel alanlardan kaynaklanmayan tehditlerin NATO tarafından ele alınması etkin denizcilik stratejileri ve holistik bir yaklaşımı zorunlu kılmıştır. Bunun için NATO, deniz güvenliğindeki mimarisini üç temel başlık üzerine kurmuştur. Bu başlıklar, "Toplu Savunma ve Caydırıcılık", "Kriz Yönetimi" ve "Denizel alanda Ortaklıklar-İşbirlikleri" olarak adlandırılır (Gade & Hilde, 2018).

Bu çalışmada, NATO deniz güvenliği mimarisi bahsi geçen üç başlık altında incelenmiş olup, NATO'nun deniz güvenliğindeki rolü sunulmuştur.

2. Denizde Toplu Savunma Ve Caydiricilik

Kuzey Atlantik Antlaşması'nın 5. Maddesinde yer alan toplu savunma ve caydırıcılık, NATO'nun temel amaçlarından biri olmaya devam etmektedir. Soğuk Savaş döneminde, NATO'nun deniz güvenliğine toplu savunma bağlamında bir yaklaşımı olmuştur. Değişen güvenlik ortamı ile birlikte NATO, terörle mücadele operasyonları kapsamında denizel alandaki görevlerini geniş bir alana yaymıştır. NATO'nun bütünleşik askeri komuta yapısı içerisinde çeşitli denizcilik bileşenleri vardır. İki Müttefik Denizcilik Komutanlığı, MC Northwood ve MC Napoli, NATO politika ve operasyonlarının denizcilik unsurlarını geliştirmek ve uygulamakla görevlidir. İttifak ayrıca NATO'nun denizcilik yeteneğinin çekirdeğini oluşturan ve İttifak operasyonlarına denizcilik açısından destek sağlamak için sürekli hazır durumda olan çok uluslu biri Doğu Atlantik'de diğeri ise Akdeniz'de konuşlan iki Daimi NATO Denizcilik Grubu (SNMG) ve iki Daimi NATO Önleme Denizcilik

Grubu (SNMCMG) bulunmaktadır (Jopling, 2010). Ayrıca Northwood'daki NATO Lojistik Merkezi ve NATO'nun Sivil Acil Durum Planlama Komitesi altındaki Ulaşım Planlama Grubu, İttifak'ın deniz politikasını desteklemektedir. Bahsedilen bu güçler, NATO'nun geniş bir coğrafyada toplu caydırma ve savunma mimarisini de oluşturmaktadır.

Ayrıca soğuk savaş sonrası jeopolitik rekabetin ön plana çıkması toplu savunma prensibinin sürekliliğini gerektirmektedir. Asya-Pasifik bölgesi ile birlikte Ukrayna krizinin ve 2008 Rusya-Gürcistan savaşının ardından Avrupa'da bölgesinde de toplu savunma NATO'nun temel prensiplerinden biri olmuştur. Bu jeopolitik rekabet, gerçekleştiği bölgeden bağımsız olarak, denizel alanda da etkili olacak ve NATO'nun üyelerine savunma ve caydırıcılık sağlaması ve denizcilik alanındaki transatlantik güvenlik çıkarlarının şekillenmesinde önemli rol oynamaktadır (NATO, 2017).

Bahsedilen NATO deniz kuvvetleri ve destek güçleri için olası bir saldırının yada karışıklığın caydırılmasında, esneklikle birlikte dayanıklılık, hızlı hareket edebilme, gerektiğinde ölümcül olabilme gibi temel yeteneklere sahip olmak kilit unsurlardır. Ayrıca ittifakın deniz kuvvetlerinin füze savunması üzerindeki potansiyel rolü, NATO'nun kitle imha silahları ve dağıtımlarına verdiği bir tepki olarak da ele alınabilir. Deniz güvenliği açısından NATO üye ülkelerinin toplu savunma ve caydırıcılığa olan katkıları

- Nükleer caydırıcılığa katkıda bulunmaya devam etmek
- Üstün donanma ve amfibi kuvvetlerine dayanarak, herhangi bir rakibe karşı hızlı bir şekilde aksiyon alınması ve faaliyetlere başlanabilmesi
- Deniz haberleşme hatlarının kontrolü, etkin mayın koruma tedbirleri gibi önemli keşif kuvvetlerinin konuşlandırılması, sürdürülmesi ve desteklenmesi
- NATO kuvvetlerinin yüksek hassasiyetli enformasyon ile hareket özgürlüğüne sahip olmasını sağlamak.
- Deniz temelli bir balistik füze savunma kabiliyeti sağlanması ve NATO güçlerinin korunmasına ve NATO topraklarının ve balistik füze tehditlerine karşı NATO üye ülkelerinin korunmasına bir katkı olarak stratejik esneklik sunulması noktasında olmuştur (Jopling, 2010; Gade & Hilde, 2018).

3. Deniz Güvenliği Işbirlikleri Ve Ortakliklari

Soğuk Savaşın sona ermesiyle, ortaklıklar ve işbirlikleri NATO için kilit öncelik haline gelmiştir. Güvenlik işbirlikleri ile kapasitesini geliştiren NATO, özellikle Afrika ve Güney Akdeniz bölgelerinde etkili olmaya çalışmıştır. Soğuk Savaş sonrası güvenlik ortamının karmaşıklığı deniz güvenliği için kapsamlı ve koordineli bir yaklaşıma olan ihtiyacı artırmıştır. Deniz tehditlerine karşı uluslararası koordinasyon ve işbirliğinin etkinliği çeşitli kaynaklardan gelen bilgilerin paylaşılmasının sağlanması ile ortak denizcilik alanı bilinci ortaya çıkarılmak istenmiştir. Bu bağlamda NATO, öncelikle AB ve ABD ile birlikte uluslararası kurumlarla olan işbirliklerini genişletme yolunu seçmiştir. Ayrıca NATO'nun deniz kuvvetleri, operasyonları ve tatbikatları ile ISAF görevinin sona ermesinden sonra özellikle NATO ile doğrudan bağlantı kurma konusunda zorluklar yaşayan Japonya, Avusturalya ve Endonezya gibi ülkelerle işbirlikleri kurulması noktasında fırsatlar yaratmaktadır. Brezilya, Hindistan ve Güney Afrika gibi stratejik coğrafik konuma sahip lokasyonlarda arama–kurtarma tatbikatları ile güvenlik alanında ortak işbirlikleri geliştirmek NATO tarafından planlanan gelişmelerdendir (Horrell et al., 2016; Nordelman, 2015).

Birçok uluslararası kuruluş - ve özellikle de IMO - yıllardır deniz güvenliğini arttırmak için hem uluslararası hem de bölgesel çabaları desteklemektedir. Taraf ülkelerinin sayısı göz önüne alındığında IMO, deniz tehditlerinin küresel doğasını ele almak ve küresel bir yanıtı teşvik etmek için vazgeçilmez bir forum sağlar. Özellikle, Örgüt, uluslararası yasal çerçeveyi geliştirme ve ulusal mevzuatı uyumlaştırma konusuna önem vermektedir. Somali kıyılarındaki sahtekarlık operasyonları, kusurlu bir yasal çerçevenin, deniz tehditleriyle mücadelede uluslararası çabaları engelleyebileceğini göstermiş; sorunların ulusal uygulamada olduğundan uluslararası yasal çerçevede daha az yer aldığını ortaya koymuştur (Jopling, 2010).

IMO ayrıca Cibuti de olduğu gibi yüksek riskli bölgelerde kapasite geliştirme projelerini koordine etmiştir. Dünyanın diğer bölgelerinde de bölgesel inisiyatifler geliştirilmiştir ve çoğu durumda yerel denizcilik problemlerine yeterli bir cevap vermektedir. Bununla

birlikte, tehditlerin küresel doğası daha geniş bir çözüm gerektirmektedir. Gelecekte beklenen deniz güvenliğini arttırma çabalarının bölgesel ve uluslararası inisiyatiflerin entegrasyonuna bağlı olmasıdır. Örneğin hem NATO hem de AB, Somali kıyılarındaki operasyonları bağlamında IMO ile bağlantılar geliştirmiştir. Bu işbirliklerinin daha sistematik olması ve süreklilik kazanması hem NATO hem de AB'nin güvenlik sorunlarının kapsamlı bir yaklaşımla ele alınabilmesini sağlayacaktır.

Şunu da belirtmek de fayda vardır ki NATO'nun Avrupa ve Kuzey Amerika kıyılarından uzak olan ihtilaf ve krizlerden kaynaklanan güvenlik tehditlerinin ortaya çıkması, NATO kapsamında olmayan bölgelerin ve denizlerin de NATO güvenlik politikalarında yerlerini almalarını gerektirmiştir. Bu bölgeler ve denizler, jeopolitik rekabet bağlamında, NATO'nun yeni stratejik sınırlarını oluşturmaktadır. Bu yeni stratejik sınırlar, aynı zamanda yeni ortaklıklar ve işbirlikleri anlamına da gelmektedir. Bu açıdan ele aldığımızda, Akdeniz ve Karadeniz iki önemli bölge olarak karşımıza çıkmaktadır (Nordenman, 2015).

Akdeniz, NATO'nun güney kanadını oluşturur ve Akdeniz kenarı Arap Uyanışı ve Suriye, Irak ve Libya'da devam eden çatışmalar nedeniyle karmaşıklık içindedir. Doğu Akdeniz'in yeni bir enerji havzası konumuna geleceği düşünüldüğünde, yaşanan çatışmaların ve karışıklıkların artması beklenmektedir. Yeni enerji kaynaklarının bulunması bu çatışmaları artırmaktadır. Enerji talepleri üzerindeki gerilimi artırdığına dair işaretler de var. Akdeniz, NATO'nun denizcilik operasyonu olan OAE ile de görüldüğü üzere, NATO'nun deniz güvenliği ve terörle mücadele çabası ve Avrupa füze savunmasının bir parçasını oluşturan platformlar için operasyonel alandır. Avrupa, Asya ve Afrika arasında jeopolitik bir kavşak olan Akdeniz, küresel tedarik zinciri içinde önemli bir yere sahiptir. Bu bağlamda ele alındığında, karışık bir Ortadoğu ve ileride askeri teknolojileri gelişebilecek Ortadoğu ülkeleri, NATO'nun Akdeniz'de güç kullanma ve projelendirme yeteneklerini azaltabilileceği öngörülebilir (Pace, 2007, Nordenman, 2015).

Karadeniz, NATO üyeleri olan Türkiye, Bulgaristan ve Romanya Karadenizle sınır olan ülkelerdir. Rusya'nın Ukrayna'ya karşı saldırganlığı ve Kırım'ın eklenmesi, Rusya'nın

Akdeniz'e doğrudan erişimini sağlayan Sevastopol deniz üssünün kontrolü ile Karadeniz'deki Rusya kaynaklı gerilimlerin gelecekte de beklenebileceğini göstermektedir (Nordelman, 2018).

4. Kriz Yönetimi

Soğuk Savaş'ın sona ermesinden bu yana NATO, 5. Madde de yer almayan denizel alandaki problemlere karşı müdahale ve kriz yönetimi operasyonları düzenlemektedir. NATO, Ukrayna Krizi ile birlikte toplu savunma anlayışını bir kere daha ortaya koymuş olsa da kapsadığı denizel alanlar dışında operasyonlar yapmak durumunda da kalabildiği bilinmektedir. NATO'nun farklı coğrafi bölgelerde faaliyet göstermesinin temelinde bu coğrafyalardaki güvenlik tehditlerinin küresel boyut kazanma ihtimalidir ki bu bölgesel çatışmalar ve sorunlar, NATO'nun insanı yardım operasyonları ile sonuçlanmaktadır. Bu yardım operasyonları ve güvenlik tehditleri açısından riskli denizel alanlarda ticari gemilere eşlik ederek NATO önemli görevler icra etmektedir (Chaban et al., 2018).

Mevcut ulusal ve uluslararası mevzuatlar NATO üye ülkelerinin bir dizi deniz güvenliği operasyonunu üstlenmeleri için yeterli olmakla birlikte ulusal mevzuatlar ve uygulamalar arasındaki farklılıkların anlaşılması da operasyonel uyumun sağlanması için önemli bir unsurdur.

Uluslararası hukuka göre (yürürlükteki anlaşmalar ve teamül hukuku dahil) NATO üye ülkelerinin deniz operasyonlarının ve faaliyetlerinin deniz güvenliğine katkısı aşağıdaki gibi listelenebilir (Jopling, 2010):

- Kuzey Atlantik Anlaşması alanı içerisinde planlanan NATO faaliyetleri ve konuşlandırmalarının bir parçası olarak kolluk kuvvetlerini desteklemek için toplanan bilgileri paylaşmak,
- Kuzey Atlantik Antlaşması alanının içinde ya da ötesinde spesifik, onaylı bir operasyon çerçevesinde denizcilik güvenlik görevlerini yürütmek,

- NATO'nun deniz kuvvetlerinin, kolluk kuvvetlerinin desteklenmesi ve kitle imha silahlarının taşınması ve dağıtılmasının önlenmesi de dahil olmak üzere tüm denizcilik kesişme görevlerini üstlenebilme yeteneğini sürdürmek.

Ayrıca İttifakın deniz kuvvetleri, onaylanan operasyonlar kapsamında Lizbon Zirvesi'nde alınan kararlara uygun olarak kritik enerji altyapısının ve deniz hatları iletişiminin korunması da dahil olmak üzere enerji güvenliğine katkıda bulunmak üzere hazırlanmaktadır.

5. Deniz Güvenliği Operasyonlari

NATO ayrıca denizde güvenliği artırmak ve uygulamak amacıyla yapılan operasyonlarla deniz güvenliğine katkıda bulunmaktadır üzerindeki denizdeki. NATO bu nedenle hayati öneme sahip denizcilik rotaları üzerindeki yasadışı faaliyetlerle mücadelede giderek daha aktif bir rol üstlenmiş ve böylece deniz hukukunun uygulama alanına girmiştir. Son yıllarda üç tip deniz güvenliği operasyonu gerçekleştirilmiştir (Jopling, 2010, Nordelman, 2015).

- Denizcilik Tecriti/Yasağı (Maritime Interdiction) : Haziran 1992'den Ekim 1996'ya kadar İttifak'a, eski Federal Yugoslavya Cumhuriyeti'ne ve Adriyatik Denizi'ndeki tüm ticari trafikte BM'nin zorunlu kıldığı ambargoyu uygulamakla görev verildi. Haziran 1993'ten itibaren Batı Avrupa Birliği'nle (WEU) ortaklaşa yürütülen bu operasyonun süresi boyunca 74.000'den fazla gemi yargılandı, yaklaşık 6.000 uçağa bindi ve denetlendi ve yaklaşık 1.500 gemi muayene limanlarına yönlendirildi.
- Anti terörizm: Devlet kuvvetlerinin, bireylerin ve altyapıların terörizme karşı savunmasızlığını azaltmak için kullanılan saldırgan / aktif stratejileri ifade eden anti terorizm, teröristlerin yeteneklerini azaltmaya yönelik olup, çoğunlukla kısa vadeli bir hedef teşkil etmektedir. Terörle mücadele operasyonları ağırlıklı olarak NATO'nun liderlik veya destek içinde hareket edebileceği ortak operasyonlardır (Bernosconi, 2011). Aktif Faaliyet Operasyonu (Operation Active Endeovour-OAE), NATO'nun düzenlemiş olduğu terörle mücadele konusundaki tek 5. madde

operasyonudır. 9 / 11'den hemen sonra ABD'yi terör konusunda desteklediğinin bir göstergesi olan OAE, Akdeniz'deki terörist faaliyetlerin caydırılmasını ve engellenmesini sağlamayı amaçlamıştır. Toplu savunma asimetrik tehditlerin de ortaya çıkması ile birlikte kritikleşmiştir. 9/11 sonrasında Aktif Çalışma Operasyonu (OAE) tarafından denizcilik alanında yeni ittifaklar yapılmış, Akdeniz'deki terör tehditlerini tespit etmek ve önlemek amacı ile faaliyetler düzenlenmiştir. OAE, 2004 yılına kadar Akdenizin uluslararası sularını korumaktan sorumluyken, aynı zamanda ticari gemilere eşlik etmiş ve 2004 Olimpiyatlarının Güvenliği gibi ek terörle mücadele faaliyetlerinde de yer almıştır. 2004 yılından sonra OAE bilgi toplamaya ve işlemeye odaklanarak, bilgi tabanlı ve istihbarat odaklı bir anlayışla yeniden yapılandırılmıştır (Fink, M., 2018). Madde 5 operasyonu olduğu için, Aktif Faaliyet Operasyonu başlangıçta yalnızca üye ülkeleri içeriyordu. Başta Yunanistan, İtalya, İspanya ve Türkiye olmak üzere bazı NATO üyeleri, bu operasyona doğrudan katkıda bulundu. Cebelitarık Boğazı'ndaki eskort operasyonlarında Kuzey Avrupa Müttefikleri olan Danimarka, Almanya ve Norveç hızlı devriye botları ile katılım sağladı. 2004'ten itibaren ortak ve NATO üyesi olmayan ülkeler desteklerini vermeye başladı. NATO ve İsrail, Fas, Rusya, Ukrayna, Finlandiya ve İsveç, Gürcistan, İsrail ve Yeni Zelanda çeşitli kademelerde operasyonlara destek vermiştir (URL-1).

- Karşı Korsanlık Operasyonları: Birleşmiş Milletler Genel Sekreteri tarafından yapılan bir talebe cevaben NATO, NATO gemileri Dünya Gıda Programı ve Afrika Birliği konvoylarına eşlik etti ve caydırıcı devriyeler düzenledi. Operasyon, 12 Aralık 2008'de sona erdi. 2009 yılının Mart ayının başında, NATO Müttefikleri tarafından tekrar aynı bölgede koruyucu bir operasyon gerçekleştirildi. 17 Ağustos 2009'da,operasyonu uzatarak Kuzey Atlantik Konseyi Okyanus Kalkanı (Ocean Shield) Harekatını başlatmış oldu (NATO, 2014). NATO'nun tüm üyelerinin doğrudan veya direkt katılım sağladığı Okyanus Kalkanı Harekatının temel amacı NATO tarafından korsan faaliyetlerin caydırılması ve engellenmesidir. Ayrıca

operasyonda çeşitli ulusal ve çok uluslu faaliyetlerin yer alması nedeniyle, eşgüdüm ve işbirliği konusunda çok fazla tecrübe kazanılmıştır.

6. Sonuç

NATO, hem üyeleri hem de potansiyel rakipleri için askeri ve politik olarak güvenilir olmak hava, kara ve deniz harekatları için hazır olmak durumundadır. Bu bağlamda Nato, deniz güvenliği mimarisini, küresel denizcilik alanı için dört strateji üzerine kurmuştur. Bu stratejiler toplu savunma, kriz yönetimi ve güvenlik konularında üye ülkelerin işbirlikleri daha da önemli hale getirmeyi amaçlamıştır. Dünya dengelerinin her geçen gün değişmesi, Hindistan, Çin, Brezilya gibi yükselen güçlerin genişleyen ticari ve politik çıkarları, Akdeniz ve Karadeniz deki olabilecek gerilimler, NATO nun yeni güvenlik stratejileri geliştirmesine neden olması beklenmektedir. İşbirlikleri ile genişleyen NATO'nun transatlantik çıkarları korumak ve iyi normları, yapıcı davranışları ve uluslararası hukuka saygıyı savunmak için denizcilik alanındaki güvenilirliğini sürdürmesi gereklidir.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Evaluating Unmanned Vessel Through Regulatory Framework

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ABSTRACT

MUNIN - Maritime Unmanned Navigation through The Intelligence in Networks project is a European Commission-financed research project, which is designed to be a ship that is mainly driven by automated resident decision systems and is defined as a ship that can be controlled remotely by the operator at the land control station. The MUNIN project, with a total budget of EUR 3.8 million, was financed by the European Union and ended in 2016 The International Maritime Organization (IMO), the global regulatory body for international maritime transport, which was convened on 25 May 2018, was also appointed by the Maritime Safety Committee (MSC) - Safety Committee to under investigate Marine Autonomous Surface Ships (MASS) operations for their environmental and safety issues. All these progress shows us that autonomous vehicles have been arising as an important concept in the future. However the legislation and regulation issues of autonomous vehichles are in debate. In this study, it is aimed to understand the legal resonsibilities of whether the unmanned or remote control vessel in trade shipping and in case of an accident. In the commercial dimension, the size of the responsibilities of the bearer and the insurance issues are addressed.

Keywords: Autonomous Vehicles, Unmanned Vessels, Regulatory Framework

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İnsansız Gemilerin Mevzuat Açısından İncelenmesi

ÖZET

Bu çalışma, III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation (GMC2019) konferansı kapsamında bizlere rehber olması maksadıyla insansız gemilere ilişkin yasal düzenlemelerin incelenmesi üzerine yazılmıştır. MUNIN – Maritime Unmanned Navigation through Intelligence in Networks projesi ise Avrupa Komisyonu tarafından finanse edilmiş bir araştırma projesi olup, esasen otomatik yerleşik karar sistemleri tarafından yönlendirilen ve kara kontrol istasyonundaki operatör tarafından uzaktan kontrol edilebilen bir gemi olarak tanımlanan insansız gemiler için konsept geliştirmeyi ve sistemin etkinliğinin kontrolünü amaçlamaktadır. Toplam bütçesi 3.8 milyon Avro olan MUNIN projesinin 2.9 milyon Avroluk kısmı Avrupa Birliği tarafından fonlanıp 2016 yılında sonlandırılmıştır [1]. 25 Mayıs 2018 tarihinde toplanan Uluslararası deniz taşımacılığının global düzenleyici organı olan Uluslararası Denizcilik Örgütü (IMO)'nun Maritime Safety Committee(MSC)-Emniyet komitesi tarafından da; emniyetli, güvenli ve çevreye duyarlı Maritime Autonomous Surface Ships (MASS) operasyonları araştırılmaya başlanmıştır [2]. Bu durum gelecekte insansız gemilerin ne derece önem arz edeceğini göstermektedir.

Bu çalışmada farklı mevzuatlardaki tekne, gemiadamı tanımlamalarına, insansız veya uzaktan kontrol gemilerin operatörlerine yönelik sorumluluklar ve gemiadamı sınıfına dahil edilip edilememesine, bugüne kadar yapılmış olan bazı insansız gemi araştırmaları ve projelerine, insansız gemilerin Denizde Çatışmayı Önleme Tüzüğü(COLREG)'e göre uygunluğuna ve uygulanabilirliğine; ticari boyutta ise taşıyanın sorumluluklarının boyutuna ve sigorta konularına değinilmiştir.

Keywords: GMC2019, İnsansız Gemi, Mevzuat

1. Giriş

Günümüzde insansız gemi tasarımlarının ARGE çalışmaları ve testlerinin yapılması üzerine bir takım projeler yürütülmektedir. 17 Mayıs 2018 tarihinde Rolls-Royce ve Finferries şirketleri arasında imzalanan işbirliği anlaşması ile gemi operasyonlarının emniyet ve verimliliğini optimize etmek maksadıyla karar - destek sistemleri teknolojisine, uzaktan ve insansız feribot operasyonlarına ortak strateji ve çözümler geliştirilmesi amaçlanmıştır.

İşbirliğinin temel odağı, SVAN (Safer Vessel with Autonomous Navigation) adı verilen yeni bir araştırma projesine, 2017 sonlarında resmi olarak tamamlanmış olan Advanced Autonomous Waterborne Applications (AAWA) araştırma projesi bulgularının uyarlanarak insansız gemi operasyonunun gerçekleştirilmesi olmuştur [3].

Finferries şirketinin Falco isimli feribotu, Rolls-Royce Ship Intelligence teknolojisiyle 3 Kasım 2018 tarihinde Parainen ve Nauvo arasındaki seferini otonom ve uzaktan kontrol ile başarılı bir şekilde tamamlayan dünyanın ilk otonom feribotu olmuştur [4].

Proje başarılı bir şekilde tamamlanmış olmasına rağmen insansız gemilerin yasal boyutlarının; konvansiyon, kod, tüzük ve yönetmelikler bakımından sonuçlandırılmış çalışmaları bulunmamaktadır. Ancak yakın süreçte tamamlanması planlanmaktadır. Bu konudaki son IMO (Ulusararası Denizcilik Örgütü) toplantısı 25 Mayıs 2018 tarihinde biten MSC (99th Maritime Safety Committee)'dir[5].

2. İnsansız Gemilerin Mevzuat Karşısındaki Yasal Zorlukları

Bu konudaki yasal zorluklardan söz edebilmek için öncelikle insansız gemi tanımını yapmak gerekir. Günümüzde hiçbir ulusal veya uluslararası mevzuatta bu tanıma tam anlamıyla yer verilmemiştir[6]. Denizde Çatışmayı Önleme Tüzüğü(COLREG)'nde; "Tekne sözcüğü: Su üstünde kalkarak seyreden ve deniz uçakları dahil, su üzerinde taşıma aracı olarak kullanılmakta olan veya kullanılmaya elverişli bulunan her türlü deniz aracını içine alır[7]." seklinde tanımlanmıştır. Bu tanımdan yola çıkarak insansız gemi kavramını tekne olarak kabul edebiliriz. Buna benzer diğer bir tanımlama ise Salvage konvansiyonunda

yapılmıştır[8]. Ulusal mevzuata baktığımızda ise Deniz Hukukuna ilişkin tanımların yapıldığı ve kuralların konulduğu 6102 sayılı Türk Ticaret kanununun 5. Kitabı karşımıza çıkmaktadır. TTK' nın 931. ila 1400. maddelerinde düzenlenen Deniz Ticaretinin tanımlar bölümünde yer alan 931. Madde başlığı altında Tahsis edildiği amaç, suda hareket etmesini gerektiren, yüzme özelliği bulunan ve pek küçük olmayan her araç, kendiliğinden hareket etmesi imkanı bulunmasa da, bu kanun bakımından "gemi" sayılır şeklinde geminin tanımı yapılmıştır.[9] . USA (United States of America) yasasında "Su üzerinde ulaşım maksatlı kullanılan veya kullanılabilecek tüm araçlar" şeklinde düzenlenen gemi tanımına İngiltere deniz ticareti yasasında ise seyir maksadıyla kullanılan herhangi bir gemi veya tekne[10] olarak yer verilmiştir. Hollanda, Belçika ve denizcilikte önemli bir konuma sahip olan diğer ülkelere baktığımızda da benzer tanımlamaları görmek mümkündür.

Birleşmiş Milletler Deniz Hukuku Sözleşmesi UNCLOS'a göre, Bayrak devletlerinin görev ve sorumlulukları arasında bayrağının taşındığı tüm gemilerin emniyet sistemlerinin, yapı, ekipman, denize elverişlilik, minimum personel gereklilikleri, çalışma şartları ve eğitimleri de dahil olmak üzere tüm uluslararası gerekliliklerin sağlanması yer alır[11]. 1982'de yürürlüğe giren bu kurallar gereği konvansiyonel gemiler kaptan ve mürettebattan oluşmaktadır. Bayrak devletlerinin görevleri arasında da seyir için gerekli personelin tam olduğunun kontrolü vardır. İnsansız gemilerden söz edildiğinde; kaptan, zabit ve diğer personelin gemide olmaması bahsi geçen sözleşmeye bu anlamda ters düşmektedir. Bu durumda bayrak devletleri insansız gemileri yasaklamalı ya da sorunların ortadan kaldırılması için gerekli yasal düzenlemeleri yapmalıdır. Muhtemel çözüm olarak bayrak devletleri, kara kontrol merkezindeki operatör kaptanın görev ve sorumluluklarını üstlenebilir. Ancak çevre ve ortam şartlarının farklılıklarından dolayı bunu tam anlamıyla kabul etmek doğru bir yaklaşım olmaz. Bu yüzden karadaki operatör daha farklı pozisyonda konumlandırılarak kaptana nazaran daha az sorumluluk alacaktır.

Gemiadamlarının Eğitim, Belgelendirme, Vardiya Tutma Esasları Konvansiyonu(STCW)'na göre gemiadamının tanımı kaptan, zabit ya da personel olarak gemide çalışan veya çalışabilecek kişi olarak belirtilmiştir[12]. MLC (Denizcilik Çalışma

Sözleşmesi) konvansiyonunda ise gemide çalışan veya çalışabilecek kapasitede olan herhangi bir kişi olarak tanımlanmıştır[13]. SOLAS'a (Denizde Can Güvenliği Uluslararası Sözleşmesi) göre; Yolcular dışındaki, kaptan ve diğer mürettebat veya gemide herhangi bir pozisyonda gemideki işin yapılması maksadıyla çalışan kişilere gemi personeli denir[14]. Bu tanımlamalar gözönüne alındığında Kara Kontol Merkezinde(SCC) çalışan operatörü gemiadamı veya gemi personeli sınıfına dahil etmek yasa ve konvansiyonlara ters düşecektir. Ancak US Supreme Court'un yapmış olduğu gemiadamı tanımında öncelikle "gemideki bir işe katkıda bulunabilmeli veya onu tamamlamalı" ve ikincil olarak ise seyir halindeki gemi veya tanımlanabilir diğer gemi sınıfları ile bağlantısı olmalı şeklinde yer almaktadır[15]. Buradan da anlayacağımız gibi Kara Kontrol Merkezindeki operatör sadece US Supreme Court'a göre gemiadamı olarak sınıflandırılabilir.

Gemi kaptanı, yolcu ve mürettebat gemiyi terk etmeden asla gemiyi terk etmez çünkü gemiyi terk durumunda kaptan lider olarak operasyonu yönetmeli ve her bir bireyin emniyetli şekilde gemiyi terk etmesini sağlamalıdır. Personel bulunmayacağı için insansız gemilerde bu durum söz konusu olmayacaktır. Ancak insansız gemi, personeli bulunan veya bir yolcu gemisiyle çatışma yaşadığında veya çok yakınında bulunan bir gemiden tehlike mesajı(Distress) aldığında nasıl bir süreç bizi bekliyor, sorusu aklımıza gelebilir. Kara kontrol merkezi operatörü gemi kaptanı statüsünde olmadığından, yapabileceği tek şey ilgili otoritelere durum bilgisi vermek olacaktır.

Uluslararası Denizcilik Örgütü(IMO), insansız gemilerin emniyet standartları, Kara kontrol merkezi operatörlerinin eğitim, rejim ve standartlarına ek olarak da ilk etapta gerekli olabilecek regülasyonlar için gerekli çalışmayı yürütmektedir. Bu çalışmanın 2-3 sene içerisinde tamamlanarak 5 yıllık bir süreçte de yayınlanması konuşulmaktadır[16]. Bu konudaki konferans 14 Mayıs 2018 tarihinde Londra'daki IMO genel merkezinde "International Workshop on Maritime Autonomous Surface Ships and IMO regulations" (Uluslararası otonom yüzey gemileri ve uluslararası denizcilik örgütü düzenlemeleri çalıştayı) adıyla düzenlenmiştir.

Titanic faciasında 1500'den fazla kişinin yaşamını yitirmesiyle 1914 yılında yapım, ekipman ve gemi operasyonları emniyetinin minimum standartlarının belirlenmesi amacıyla 1974 yılında SOLAS (Denizde can güvenliği sözleşmesi) imzalanmıştır.

12 bölümden oluşan SOLAS'in insansız gemilere uyarlanmasında özellikle sözleşmenin 5.bölümünün seyir emniyeti kısmında düzenlenen personel donatımı, seyir planlaması, köprüüstü görüş gereklilikleri kısımlarının ve tehlike durumundaki gemilere yardım kısımlarının uyarlanması mümkün gözükmemektedir. Bayrak devletleri minimum personel dokümanını hazırlarken geminin tipi ve boyu, yapım ve gemi ekipmanları, taşıyacağı kargo olmak üzere belirli faktörleri göz önünde bulundururlar[17]. Bunu insansız gemilere uyarlamak gerekirse; gemideki teknik ekipmanlar, geminin otomasyon sınıfı(uzaktan kontrol, otomatik sistemli, sınırlı otonom ve tam otonom gemi)[18] ve karada görevli operatörün yetkinliğinin değerlendirilmesi gerekir.

Bayrak devletleri insansız gemilerin tüm emniyet gerekliliklerini sağlayarak emniyetli seyire engel teşkil etmeyeceğine kanaat getirseler dahi bunu destekleyecek atıfların; Guidelines of Safe Manning veya SOLAS gibi rehberlerde yer alması gerekmektedir.

COLREGs[19] kural 1 ve 2'ye göre vardiya zabiti çatışmayı önlemek için mümkün olduğunca erken, net ve doğru manevrayı yapmakla yükümlüdür. Kural-2(a) bendi "Bu kurallardaki hükümlerden hiçbiri, herhangi bir tekneyi veya sahibini, kaptanı veya gemi adamlarını, bu kurallara uyma veya gemicilerin her zamanki görevlerinin veya özel durum ve koşullarının gerektirdiği herhangi bir tedbirin alınması hususundaki ihmallerinin sonuçlarından kurtaramaz." , Kural-2(b) bendi ise ; "Bu kuralları yorumlarken ve uygularken ilgili teknelerin sınırlı oluşları hususu da dahil, ani bir tehlikeden kaçınırken bu kuralların hükümlerinden ayrılmayı gerektirebilecek olan hususlar dahil seyir ve çatışmanın ve herhangi bir özel şartın tüm tehlikeleri gözönünde tutulacaktır." ibareleri yer alır. Uzaktan kontrollü gemilerde karadaki operatör bu sorumluluğu üstlenebilecekken otonom gemilerde "Sorumluluk" kuralının kime uygulanacağı ? ya da herhangi bir kaza durumunda hata oranının nasıl belirleneceği ? soruları akla gelmektedir. Kural-5'de yer alan Gözcülük ise " İçinde bulunulan durum ve

koşullarda, durumun ve çatışma tehlikesinin tamamen değerlendirilmesini sağlamak üzere, elde mevcut tüm uygun araçların yanısıra her tekne her zaman tam bir görme ve işitme gözcülüğü de yapacaktır. " şeklinde düzenlenmişir. Bu kural net olarak yardımcı cihazlar da kullanılarak görsel ve işitsel bir gözcülüğü kastetmektedir. İnsansız deniz araçlarında kullanılacak günümüzün gelişmiş teknojileri ile üretilen sensor ve radar sistemleri bunu çok iyi bir şekilde başarabilirler[20]. Ancak bu cihazlarda ariza meydana gelmesi ya da karadaki operatör ile iletişimin kopması felakete varan sonuçlara yol açabilir.

3. İnsansız Gemilerin Mevzuat Karşısındaki Ticari Zorlukları

Ticari bakımdan incelediğimizde ise Kaptan, TTK'nin 1088 ila 1117 maddelerindeki yetkiler dahilinde gemisinin yönetimi ile görevli olduğu sürece donatanı temsil eder. Kaptan, gemi adamı alabilir, gemi adamlarının görevlerinde değişiklik yapabilir, navlun sözleşmeleri imzalayabilir, konşimento verebilir[21].

İnsansız gemi tanımında kaptan ve gemi adamı tabirleri yer almadığından TKK'nin bu düzenlemeleri de hüküm ifade etmeyecektir. Ancak navlun sözleşmeleri ve konşimentoların engeli blockchain ya da alternatife sistemler üretilemediği sürece devam edecektir.

Taşıyan, yükü navlun sözleşmesinde belirtildiği şekilde sağlam ve zamanında getirmekle yükümlüdür. Hasar, kaybolma ya da gecikme durumlarında da zararın tazmininden sorumludur[22]. İnsansız gemilerle yapılacak taşımalarda da taşıyanın sorumluğu değişmeyecektir. Ancak sensor, radar, IT yada diğer teknolojik kısımlardaki sistem arızalarından, yazılım hatalarından, denizde çatışmayı önleme kuralların yanlış uygulanmasından, karadaki operatörün hata yapma durumundan, siber saldırı risklerinden, korsanlık tehlikelerinden ve bunlara ek olarak insansız gemi teknolojisinin yeni olmasından dolayı uzun yıllar boyunca performanslarının ölçülememiş olmasından ötürü sigorta primlerinin çok yüksek olmaları beklenmektedir. Günümüzde ise otonom gemiler hakkındaki sigorta çalışmaları mevzuatın insansız gemilere uyarlanmamış olmasından dolayı sonuçlandırılamamıştır.

4. Sonuç

Günümüzde insansız gemi projesi ARGE çalışmaları devam etmekte ve Uluslararası Denizcilik Örgütü'nde gerekli hukuksal düzenlenmelerin üzerinde çalışılmaktadır. MUNIN proje sonuçları kapsamında yapılan araştırmada, denizcilik camiasının yüzde 70'nin insansız gemilere olumlu bakıldığı görülmektedir. "Falco" projesinin başarılması da, bu durumu etkilemektedir. Daha emniyetli, daha çevreci, daha ekonomik ve sürdürülebilir deniz taşımacılığı için insansız gemilere dair hukuksal düzenlemelerin tamamlanması için yapılan çalışmalara hız kesmeksizin devam edilmelidir. İnsansız gemiler üzerinde yapılan araştırmalar ve yatırımlar devam ettiği sürece ve yasal mevzuatın eksiklikleri giderilip karşılaşılan engeller kaldırıldıkça; insansız gemilerin 10 yıl içerisinde yaygınlaşacağı öngörülebilir.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Use of Unmanned Aerial Vehicles in Maritime Search And Rescue Operations

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ABSTRACT

During the Search-Rescue (A / C) operations, activities are carried out, such as locating persons in need of emergency assistance during any natural or man-made disaster / accident, first-aid implementation if necessary, and transporting them to a safe place where they can receive further assistance. The most important purpose of the search and rescue operations carried out at sea is to locate the survivors' place in the shortest time and reach them as the slightest delay can put the life of the victim at risk. In the search and rescue operations carried out in the sea, a lot of vehicles such as ships, helicopters, airplanes are used. Unmanned aerial vehicles; which can be defined as air vehicles that can be operated with or without air / pilot / flight personnel / crew and can be airborne and / or on the air, managed by autonomous or artificial intelligence via remote control, autopilot or navigation system or an information system. They have advantages compared to other vehicles used in search and rescue activities because of their useful loads, spills and unmanned use. It is foreseen that unmanned aerial vehicles, currently managed by direct pilots, can be used fully autonomously in the future. In this context, unmanned aerial vehicles (UAVs) are used effectively in search and rescue operations because of their effective mobilization, low reaction time and easy handling. In unmanned aerial vehicles, it is thought that unmanned aerial vehicles will have an automation capable of making decisions through artificial intelligence in the near future. As a result of the automation studies carried out with today's technology, the size of the data coming from the advanced systems and the ability of the autonomous systems to make decisions reach very large levels and can exceed the human capacity of thinking. The purpose of this research; in the scope of the measures taken to

increase the effectiveness of the search and rescue activities at sea, is to reveal the usage areas, advantages and competencies of unmanned aerial vehicles. In this context, a literature review and expert opinions were introduced and a detailed examination was conducted.

Keywords: UAVs, A/K, automation

İnsansız Hava Araçlarının Denizde Gerçekleşen Arama-Kurtarma Operasyonlarında Kullanımı

ÖZET

Denizde gerçekleşen A/K (arama ve kurtarma) operasyonlarının amaçlarından bir tanesi en kısa sürede kurtarılacak kişi ya da kişilerin yerlerini belirleyerek bu kişilere ulaşabilmektir, çünkü en ufak bir gecikme kazazedenin yaşantısını riske sokabilir. Bu kapsamda İHA'lar (insansız hava araçları) atiklikleri, taşınabilirlikleri ve havadan kısa sürede kazazedelere ulaşabilme imkânları nedeniyle bu operasyonlarda etkin bir şekilde kullanılmaktadır. İHA'lar üzerine yapılan çalışmalarla İHA'ların yakın gelecekte kendi başlarına karar alabilecekleri bir otomasyona sahip olmaları hedeflenmektedir. Bu bildiride; İHA'ların A/K operasyonlarında kullanımlarına yönelik litaratür taraması yapılmış ve elde edilen bulgulara göre bu araçların denizde gerçekleşen A/K operasyonlarında en etkili şekilde kullanılabilmeleri için sahip olmaları gereken özellikler tartışılmıştır.

Anahtar Kelimeler: İHA, A/K, Otomasyon.

1. Giriş

Bu bildiride; İHA'ların denizde gerçekleşen A/K operasyonlarında gecikme yaşanmadan kazazedelere zamanında ulaşabilmelerini sağlamak maksadıyla sahip olmaları gereken özellikler belirlenmeye çalışılmaktadır.

2. Yöntem

Denizde A/K Operasyonları ve İHA'lara ilişkin yapılan litaratür taramasında "Doküman İncelemesi" yöntemi kullanılmıştır. Araştırma kapsamında incelenen konuyla ilgili olgu ve olaylar hakkında bilgi içeren yazılı belgelerin analiz edilmesiyle veri sağlanmasına doküman incelemesi denilmektedir [1].

3. Bulgular

3.1. İnsansız Hava Aracı Sistemleri Üzerine Yapılan Otomasyon Çalışmaları

İnsansız hava araçları (İHA), diğer adıyla drone'lar ingilizcede "erkek arı" anlamına gelmektedir [2]. Literatürde İHA'lar ile ilgili çeşitli tanımlamalar mevcuttur. Ülkemizde, Sivil Havacılık Genel Müdürlüğü İHA'ları, İnsansız Hava Aracı Sisteminin bir bileşeni olarak işletilen, aerodinamik kuvvetler aracılığı ile sürekli uçuş yapma yeteneğinde olan, üzerinde pilot bulunmaksızın uzaktan İHA pilotu tarafından kontrol edilerek veya otonom operasyonu İHA pilotu tarafından planlanarak uçurulan ya da kalabilen hava aracı olarak tanımlamaktadır [3]. Halihazırda direkt olarak pilotlar tarafından kontrol edilen İHA'lar gelecekte otonom olarak görev yapabilme yeteneğine sahip olacaklardır.

Günümüzde bile otomasyon çalışmaları sonucunda gelişmiş sistemlerden gelen verilerin boyutu ve otonom sistemlerin karar verebilme yeteneği oldukça büyük seviyelere ulaşmakta ve insanoğlunun düşünme kapasitesinin üzerine çıkabilmektedir.

İHA'lar için otonomi, insan müdahalesi olmaksızın İHA'ların iniş-kalkış ve uçuş yapabilmesidir. Teknolojinin ilerlemesi ve güvenilir alt sistemlerin üretilmesi ile bu seviye çok üst düzeylere ulaşmış ve İHA'lar hareketlerini ve hatta görevlerini kendi kendilerine kararlar üreterek (hatta en uç noktada "öğrenerek") sürdürebilir hale

getirmektedirler, böylece İHA'lar uzaktan yönetilen makineler olmaktan, robotik sistem olmaya doğru yönelmişlerdir [4].

İHA; otonom, yarı otonom ya da bir operatör tarafından yönetilecek şekilde üç çeşit olabilir [5]. İHA'ların otonom olması tamamiyle İHA pilotunun, İHA'nın kullanımına yönelik ne derecede karar aldığı ve İHA'yı ne derecede kendisinin kullandığıyla alakalıdır [5].

Parasuraman Sheridan ve Wickens, otonomluk derecelerini 1'den 10'a kadar derecelendirmişlerdir [6]. İHA'ların otonomluklarına ilişkin tablo aşağıda gösterilmiştir.

Tablo 1: İHA'ların Otonomluk Dereceleri.

Derece	Otonom Sistemin Kararları/Davranışları	Otonomluk Durumu
1.	Otonomluk yoktur, pilot tüm kararları ve eylemleri kendisi gerçekleştirir.	Yok
2.	Tüm eylem seçenekler sunulur pilot hangi seçeneği seçeceğine kendisi karar verir.	Tavsiye Niteliğinde
3.	Eylem seçenekleri azaltılarak sunulur pilot içlerinden bir tanesini seçer.	Tavsiye Niteliğinde
4.	Pilot'a tek bir eylem seçeneği sunulur pilot bu eylemi ya kabul eder ya da red eder.	Tavsiye Niteliğinde
5.	Eylem otomatik olarak seçilir ancak pilot tarafından onaylanıncaya kadar uygulanmaz.	Yarı Otonom
6.	Pilot bilgilendirilir eğer pilot tarafından kısıtlı bir zaman içerisinde onaylanmazsa uygulanır.	Onaylı Otonom
7.	Eylemler otomatik olarak uygulanır ancak pilot devamlı olarak alınan kararlar ve uygulanan eylemler hakkında bilgilendirilir.	Tamamen Otonom
8.	Talep edildiği takdirde alınan kararlar ve uygulanan eylemler hakkında pilot bilgilendirilir.	Tamamen Otonom
9.	Bilgilendirmenin yapılıp yapılmayacağına sistem kendisi karar verir.	Tamamen Otonom
10.	Sistem kendisi pilot'a bilgi vermeden kararları verir eylemleri gerçekleştirir.	Tamamen Otonom

A/K operasyonlarında ilk adım kaza bölgesinin incelenmesi ve hayatta kalanların tespit edilmesidir. Geleneksel olarak bu görev özel olarak eğitilmiş arama ve kurtarma ekipleri tarafınan gerçekleştirilmektedir. Ancak son zamanlarda bu görevin çoklu robot takımları ile gerçekleştirilebilmeleri için yoğun çalışmalar yapılmaktadır ve yapılan bu çalışmalar "Kurtarma Robotiği" olarak adlandırılan yeni bir araştırma dalının ortaya çıkmasına neden olmuştur [7]. Bu dalın önemli gereksinimlerinden birisi robotlar arasındaki verimli bir iletişim ve haberleşmenin sağlanmasına olan ihtiyaçtır. İnsansız araçlardaki iletişimin faaliyetlere etkisini şu şekilde özetleyebiliriz;

Eylemlerin eş zamanlı olarak gerçekleşebilmesi; Çoklu insansız araç kullanımında, eylemler eş zamanlı, koordineli ve birbirlerini etkilemeden gerçekleşmelidir, bu husus verimli bir iletişim ile sağlanabilir [7].

İnsansız araçların kendi aralarında göreve yönelik anlaşmaya varmaları; Görev paylaşımı açısından insansız araçlar arasında hangi görevin hangi İHA tarafından gerçekleşmesine yönelik kararlar alınmalıdır, bu sebeple insansız araçlar kendi aralarında etkili iletişim kurabilmelidirler [7].

Çeşitlilik içeren bilgilerin iletiminin sağlanması; Farklı insansız araçlar bulundukları konum, geçmiş deneyimleri sebebiyle farklı çevresel bilgiler edinmiş olabilirler, ayrıca eğer robotlar aynı tür sensörler ile donatılmamışlarsa herhangi bir İHA'nın kendi sensörleriyle elde ettiği bir bilgiyi bir başka İHA ile paylaşması gerekebilir [7].

İnsansız hava araçlarının, toplu halde kullanımı, tek ve gelişmiş bir İHA'nın kullanımına göre çeşitli avantajları haizdir, İHA'ların toplu olarak kullanımlarıyla aşağıdaki kazanımlar elde edilebilir.

- Bir ya da daha fazla İHA'nın kaybı durumunda bile kalanlar görevi yerine getirebilirler,
- Daha esnek şekilde görev gerçekleşebilir (görevin koşullarına göre İHA grubu kendisini daha kolay adapte edebilir.)
- Görevin amacına uygun olarak İHA'lar kendi aralarında gruplanabilirler,

- Basit tasarıma sahip İHA'lar karmaşık sistemlere sahip İHA'lara nazaran daha ucuza imal edilebilir ve bu sayede maliyetten tasarruf sağlanabilir [7].

Otonomi sonucunda İHA'ların çoklu olarak emniyetli ve güvenli bir şekilde görev gerçekleştirebilmeleri için bir çok çalışma yapılmıştır bunlardan birtanesi de 2014 yılı içerisinde ABD'de DARPA tarafından İHA'ların çoklu olarak görev yapmalarına yönelik "Collaborative Operations in Denied Environments (CODE)" isimli Ar-ge çalışmasıdır, bu çalışma sadece bir pilot tarafından birden fazla İHA'nın kontrol edilerek görev yapabilmesini, İHA'ların kendi aralarında iletişim kurabilmelerini, sensör ve mesafe kısıtlamalarının azaltılmasını sağlamak üzerinedir [8].

İHA'ların otonom kullanım çalışmalarından farklı olarak sensörlere, sensörlerin tespit ettiği bilgileri İHA pilotuna ileten sistemlere ve İHA'nın navigasyon sistemlerine yönelik çalışmalar yapılmaktadır [9]. İHA pilotlarına gelişen teknolojiyede bağlı olarak İHA'nın sensörlerinden birçok bilgi gelmektedir. Pilotlar için zaman çok değerli olduğundan pilotlara o an için ihtiyaç duydukları bilgilerin iletilmesi ve bu bilgilerinde pilotları çok yormayacak ekranlar üzerinden okunabilmesi, takip edilebilmesi çok önemlidir [9].

İHA'nın emniyetli ve güvenli bir şekilde uçuşunu gerçekleştirebilmesi için navigasyon sistemi büyük önem taşımaktadır, uçuş 3 boyutlu bir ortamda tüm engel ve tehditlere karşın en emniyetli ve güvenli şekilde gerçekleştirilebilmeli ve bu esnada İHA'nın sensörlerinden de kayıt işlemleri yapılabilmelidir [9].

3.2. İnsansız Hava Araçlarının Denizde Gerçekleşen Arama ve Kurtarma Faaliyetlerinde Kullanımı

A/K operasyonlarının ana amaçlarından bir tanesi en kısa sürede kurtarılacak kişi ya da kişileri belirleyebilmektir çünkü en ufak bir gecikme kazazedenin yaşantısını riske sokabilir. Bu kapsamda hava araçları atiklikleri, taşınabilirlikleri ve havadan kısa sürede kazazedelere ulaşabilme imkânları nedeniyle A/K operasyonlarında etkin bir şekilde kullanılmaktadır.

İHA'lar sahip oldukları aygıt ve sensörler vasıtasıyla operasyon bölgesini tarayarak gözlem yapabilmekte elde ettikleri bilgileri yer istasyonlarına iletebilmektedirler [10].

İHA'ların sensörlerinin kullanımı çok önemlidir, sensörler vasıtasıyla kazazedeler takip edilerek yerleri belirlenmekte ya da en son kayboldukları nokta kayıt edilebilmektedir [10].

Waharte ve Trigoni tarafından İHA'ların A/K operasyonlarında kullanımlarına ilişkin yapılan bir çalışmada İHA'ların A/K operasyonlarında en optimum faydayı sağlayacak şekilde kullanılabilmeleri için dikkate alınması gereken birkaç faktör olduğu ifade edilmiş bunlar "sensör bilgisi kalitesi", "enerji kısıtlamaları", "çevresel tehlikeler", "bilgi paylaşımı" olarak belirlenmiştir [11].

Sensör Bilgisi Kalitesi: A/K operasyonlarında, kurtarma ekibine iletilen bilgiler çok önemlidir, İHA'lar tarafından kazazedenin yerine ilişkin bilgilerin yanlış iletilmesi, kurtarma ekibinin, kazazedenin olmadığı bir yerde faaliyet göstermesine neden olabilir. Ayrıca bilgilerin zamanında iletilmesi gerekmektedir, geç gelen bilgi kazazedenin hayatını kaybetmesine neden olabilir. Bunun dışında İHA'lar A/K faaliyetleri süresince kazazedelerden takibi kesmemeli ve kazazedelerin yerlerini kaybetmemelidir [11].

Enerji Kısıtlamaları: İHA'ların kullanımlarında dikkat edilmesi gereken bir diğer faktör İHA'ların enerji kısıtlamalarıdır. İHA'lar SAR faaliyetlerinde kaza mahaline intikallerinin yanında askıda (hover) kalma, süratli yer değiştirme gibi yakıt sarfiyatına neden olan birçok manevra gerçekleştirmektedir. Dolayısıyla İHA'ların A/K faaliyetlerinde kullanımlarında enerji kısıtlamalarının göz önünde bulundurulmasına ayrıca gelişen teknolojiye'de bağlı olarak bu araçların daha az yakıt sarf etmelerini sağlayacak motorların kullanılmasına özen gösterilmelidir [11].

Çevresel Faktörler: İHA'lar uçarlarken, ağaçlar, binalar vb. engellere çarpabilirler ayrıca aynı anda faaliyet gösteren birden fazla İHA birbirine çarpabilir, bu yüzen İHA'ların intikal edecekleri rotalar dikkatli planlanmalı bu tür tehlikelere bağlı oluşabilecek gecikmelerin önüne geçilmelidir [11].

Bilgi Paylaşımı: İHA'ların A/K operasyonlarında kullanımındaki veri paylaşımını "veri birleştirme" ve "iletişim bağlantısı" olmak üzere iki açıdan ele almak gerekmektedir [11].

Veri Birleştirme: Birçok İHA'nın kullanıldığı A/K operasyonlarında, İHA'lardan gelen bilgilerin toplanması ve A/K operasyonunun resmini gösterecek şekilde bilgilerin kullanılması gerekmektedir. Bu husus A/K operasyonunun taktiksel olarak doğru şekilde yönetilebilmesi için önem arz etmektedir. Ayrıca veri birleştirmek için gerekli alt yapıların (verilerin işlenmesi, hafızada kalma süresi, sensörlerin birbirlerine uyumu, enerji tüketimi vb.) iyi planlanması gerekmektedir [11].

İletişim Bağlantısı: İHA ile İHA'nın yer kontrol istasyonu arasındaki bağlantı çok önemlidir. Bu bağlantının istenildiği zaman mı yoksa belirli periyotlarla mı yapılacağı A/K operasyonuna göre değişiklik gösterebilir ancak bilgi alış verişi istenildiği şekilde yapılmalıdır. Gerekli bilgiler yer kontrol istasyonuna mutlaka doğru şekilde iletilmelidir.

Bunların dışında İHA'ların (İHA pilotlarının) birbirleri arasında iletişim kurmaları sağlanabilir. Ayrıca İHA'ların yer kontrol istasyonlarıyla iletişimlerine ilave olarak kurtarma faaliyetlerindeki görevlerine ilişkin yer kontrol istasyonlarına düzenli periyotlarla rapor göndermeleri sağlanabilir [11].

Molina ve diğerleri İHA'ların kayıp insanları bulması üzerine yaptıkları çalışmada, A/K'da İHA kullanımındaki en kritik unsurun İHA'nın intikalini sağlayan navigasyon sisteminin güvenilirliği (emniyet açısından) olduğunu belirtmişlerdir [12].

Belçika'da Kraliyet Askeri Akademisi denizde arama ve kurtarma faaliyetlerine yardımcı olacak ICARUS (Integrated Components for Assisted Rescue and Unmanned Search) isimli, İHA'lardan yerde ve suda gidebilen robotlardan (insansız sistemlerden) oluşan bir projeyi hayata geçirdi [10]. Bu sistemde İHA'lar kazazedeleri tespit ederek, yerlerini belirleyebilmektedir. Ayrıca bu sistem vasıtasıyla, kurtarma ekibinin erişme imkanı olmadığı kazazedelere ilk yardım malzemesi vb. faydalı malzemeler ulaştırılabilmekte kurtarma ekibinin ihtiyacı olan malzemeler de kurtarma ekibine ulaştırılabilmektedir. İHA'lar gemilerin manevra yapmak için ihtiyaç duydukları zamandan daha kısa sürede kazazedelere ulaşabilmektedir. Kurtarma ekibi yer kontrol istasyonu ile doğrudan iletişime geçemez ise İHA'lar üzerinden (İHA'ları role istasyonu olarak kullanarak) iletişime geçebilmektedir [10].

İHA'lar denize yakın mesafede yüzen insanları kurtarmakta da bir çok avantaj sağlamaktadır. Örnek vermek gerekirse İran labaratuarlarında geliştirilen "Pars" isimli kıyıya yakın mesafelerde kurtarma amaçlı kullanılan bir İHA sahilden 75 mt mesafedeki bir kazazedeye 22 sn'de ulaşabilmektedir. Can kurtaranlar ise aynı mesafedeki bir kazazedeye 90 sn'de ulaşabilmektedir [10].

Ayrıca bu İHA'lar bir uçuşta üç can simidini farklı kazazedelere ulaştırabilmektedir. Can simitleri vasıtasıyla da kazazedeler su üzerinde kalabilmektedir, böylelikle can kurtaran sayısından tasarruf edilerek bir can kurtaran ile sırayla üç kazazedenin kurtarılması sağlanmaktadır [10].

Drone üretiminde Avrupa'da ve Dünya'da önemli bir konumda olan Altigator Aerial Viev Aircrafts firması arama kurtarma operasyonları da dahil olmak üzere bir çok alanda insansız hava aracı üretmektedir [13]. Bir insansız hava aracı üreticisi olan ve ürünlerini çok geniş bir pazara sunan bu firma İHA'ların A/K operasyonlarında kullanımlarında sağladıkları avantajları şu şekilde belirtmektedir [13].

- Gerçek zamanlı görsel bilgileri iletebilmek, böylelikle kazazedelerin konumlarını kurtarıcalara ulaştırabilmek,
- Karar vericilere durumsal farkındalık sağlamak böylelikle kaza bölgesine ait riskler, tehditler ve ihtiyaçlar düşük maliyetle belirlenebilir,
- Personeli risk'e atmadan müdahale edebilmek,
- Kısa sürede kazazedelere ilk yardım malzemelerini ulaştırmak.

Termal kamera ve diğer gece görüş sistemleri ile İHA'lar hem gündüz hem de gece A/K operasyonlarında kullanılabilmektedir. Kullanıcılara sağladıkları kolaylıklar ile kaynakların etkin kullanımı açısından tasarruf sağlamaktadır [13].

4. Sonuç

Denize gerçekleşen kazalarda kazazedelerin kurtarılabilmesi için hızlı karar alınması çok önemlidir. İHA'lar tüm araçlar içerisinde kaza yerine en hızlı ulaşan araçlardır ve bu araçların insan hayatının kurtarılmasında en etkin şekilde kullanılmaları gerekmektedir.

Karar destek sistemlerindeki teknolojiden her alanda olduğu gibi denizcilik alanında da istifade edilmelidir. Günümüzde doğrudan pilot kontrolünde görev yapan İHA'lar geleceğin operasyonlarında tam otonom olarak görev yapacaklardır.

Çevre denizlerimizde geniş bir alanı içeren Arama ve Kurtarma Bölgemiz göz önüne alındığında, ulusal arama kurtarma planlarımızı, İHA'ların kullanımlarını da ele alacak şekilde güncelememiz gerekmektedir. Özellikle İHA'ların sürü halinde toplu kullanımıyla deniz ulaştırmasının emniyetini sağlamanın yanında İHA'lar deniz ulaştırmasının ve deniz alanlarının güvenliğini sağlamak maksadıyla da kullanılabilecektir.

Günümüz karar destek sistemlerinde özellikle yapay zeka alanındaki çalışmalar sebebiyle çok hızlı şekilde ilerleme kaydedilmektedir. Otonom işletim sistemleriyle insan zekasına özgü olan, düşünme, algılama, öğrenme, kavramları ilişkilendirme, fikir yürütme, sorun çözme, iletişim kurma, çıkarım yapma ve karar verme gibi bilişsel fonksiyonlar yerine getirilebilmektedir. Akdeniz ve Karadeniz Deniz Havzasının önemli bir ülkesi olan Türkiye'nin bu deniz alanlarında gerçekleşecek deniz kazalarında kendi başına ya da diğer çevre ülkeler ile ortak olarak gereken süratli reaksiyonu gösterecek şekilde bir A/K operasyonu gerçekleştirebilme kabiliyetine sahip olabilmesi için İHA'lar üzerine yapılan otomasyon çalışmalarına önem verilmesi gerekmektedir.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Energy Efficiency and Environmental Aspects of Refrigerated Containers in Maritime Transport Towards Intelligent Systems

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ABSTRACT

More than 80% of world trade in volume is carried by sea transport and approximately 16% of this volume is through containers. In the year 2016, the volume of maritime container transport exceeded 140 million TEU. Nowadays, the variety of cargo has increased with respect to the development of technology. Refrigerated cargo transport is gaining importance, particularly in developing countries, as it is necessary to protect the cold chain in the trade of cargos such as meat, fruit, vegetables and fish. This situation is supported by the fact that approximately one third of the world food supply chain is carried by refrigerated transport. In the year 2000, refrigerated bulk cargo and refrigerated container shares were almost equal in the cold chain maritime transport. However, due to the lack of intermodal connectivity and the reliability of refrigerated bulk transport, the use of refrigerated containers has increased, particularly in the case of perishable food transport in recent years. It has been observed that technological improvements are required in refrigerated containers in the light of the information that one third of the food products are spoilt before reaching the end consumer, energy is highly used for the containers and the carbon footprint of the products carried is relatively large. In this study, due to the continuously increasing usage of refrigerated containers, improvement potential analysis of the efficient use of energy and the reduction of the effects on the environment was carried out. In this respect, the importance and benefits of integration of innovative refrigerated containers and intelligent systems are also considered. According to the results of the analysis, it has been evaluated that there is a room for improvement with respect to a more efficient and environmentally friendly system. Moreover, the concept of intelligent container could

help to spot unwanted ripening or spoil in the container. It has been concluded that, optimization methods with the knowledge assisted by the intelligent container could lower not only the energy usage, but also emissions.

Keywords*:* Refrigerated Container, Maritime Transport, Energy Usage, Intelligent Systems, Cold Chain

1. Introduction

Global maritime shipping trade is in a good condition with respect to the growing of world economy in 2017. Moreover, container shipping, which is the 17.1 % of total seaborne trade, expanded by 6.4% with handling 42.3 million TEUs more, along with profit reaching to $7billion [1]. It has been stated that cargoes are shifted to containers [2], thus, it could be easily said that containerization continuously keeps growing wave by wave since its first introduction around 60 years ago along with gross domestic product (GDP) [3]. Furthermore, containerization enhanced the intermodal transportation due to its performance and competitive advantages over the other types of shipping as it leaded new distribution techniques that revolutionized supply chain management and logistics [4].

Seaborne trade includes carrying of temperature sensitive products, perishable goods, mostly foods. The quality and shelf life of the goods depends on the temperature of the postharvest cold chain [5, 6], and the temperature sensitivity phenomenon could be explained as to stop or to reduce the microbiological growth, physical and physiological degradation of the perishable goods [7]. Hence, to maintain the required temperature, refrigerated containers or reefers are introduced and widely used in the transport of foods [8]. They are responsible for transport of the almost one-third of the global food supply in the global cold food chain [8]. Refrigerated containers consist of an insulated box, namely container, and a cooling system. Most of the reefers have vapor compression refrigeration (VCR) system that requires either electrical or mechanical drive to remove heat from the container, that is controlled by a control unit [9]. The vapor compression system basically consists of a compressor, an evaporator, a condenser and an (thermostatic or electronic) expansion (throttling) valve [8, 10, 11]. As auxiliary, condenser and evaporator fans are within the system [9]. When they all work in harmony, the evaporator cools down the container or keeps the cargo cool at the required temperature, while excessive heat is rejected by the condenser into the ambient with the aid of compressor that receives electricity as external source [12]. It is expected from a

reefer that it should have a good cooling capacity to decrease the temperature of the goods rapidly, be environmentally friendly, energy efficient, and rapid responder to the changes of the environment as well as the cargo conditions [7, 8, 12].

There are several studies on VCR to analyze in the framework of different perspectives. Energy analysis is the one perspective that is heavily used to evaluate the performance of the VCR systems. However, it has been seen that it has shortcomings on determination of the performance degradation as where, how and how much it occurs [13]. Exergy analysis is a tool to overcome aforementioned degradation by determining the exergy destruction of each component in the system separately as well as overall system [14]. The exergy destruction is the measure of the system inefficiency and environmental impact. Hence the aim is to decrease the exergy destruction within the components as well as the overall system. The methods are applied to experimental and modeled VCR systems in the literature [13, 15, 16].

Another perspective to analyze and understand the behavior of the VCR systems of reefer containers is controlling the system. It is actually the first step towards intelligence. Mostly, the control systems of containers control the superheat temperature as well as the compressor for a fast and optimal respond, which are based on either experiments [10, 11] or simulation models [9].

As last perspective, it has been observed by the researches who are looking on the other side of the problem that one third of all produced foods are turn into inedible conditions from farm to fork [7, 17]. Hence, cold chain management gains more importance proportionally with the engineering solutions. For example, low temperature can cause freezing damage on the fresh fruits and vegetables while high temperature can reduce the shelf life and both will harm the quality of the transported food [18]. Therefore, only engineering improvements, which ignores the temperature dynamics of the cargo, is not an adequate approach. "Intelligent container" concept is based on four pillars, namely, (i) wireless sensor network that are installed inside of the food pallets to monitor the parameters, (ii) a supervision unit to evaluate the data and determine the shelf life, (iii)

an external communication system and (iv) an integration into the company database [5]. There have been a bunch of studies on the subject in the literature focusing particularly on the cold chain logistics management [5, 7, 18]. Here, monitored parameters carry crucial importance on the connection of three aforementioned perspectives, to determine the parameter changes, to evaluate the effect and control the optimized VCR system for a rapid reflex while with providing minimum or no damage on the transported perishable goods. In this paper, a simple refrigerated container system is investigated *in silico* while considering a perishable food is kept at a constant temperature and the ambient temperature is changing. Potential improvements and real sources of the exergy degradations are revealed. Effect of the system on the environment is evaluated with respect to the results.

2. Materials and Methods

The main aim is the refrigerated container is to keep the temperature of the precooled goods stable, hence temperature pull down is not an aim [19]. The analyzed reefer is 40-foot-equivalent-unit (FEU) that has an insulated box and a VCR system with condenser and evaporator fan as seen in Figure 1.

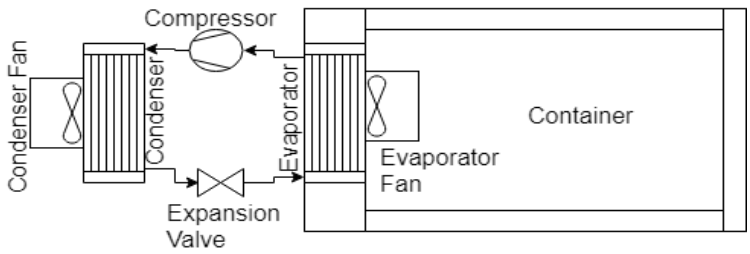

Figure 1: General Layout of the Investigated System.

The cooling load is determined due to the inlet temperature of the box and the ambient temperature. Moreover, the respiration of the perishable food is another source of cooling load. The cooling load is transferred by the circulated air inside the box through the

evaporator and refrigerant in the evaporator gains the heat until it reaches to the saturated vapor condition. The vapor then enters the compressor, where its pressure and temperature rises before entering the condenser. The electricity is required in the all system by the compressor due to pressurizing the refrigerant (except auxiliary fans). Thus, determination of the power consumption depends on both evaporator and condenser pressures. Condenser is used to cool down the refrigerant by releasing heat in to the ambient environment and then pressurized refrigerant becomes saturated liquid. Lastly, it passes through the expansion valve for depressurizing and entering the evaporator to complete the cycle. The system is modeled with respect to the thermodynamic relations of the processes [20] as shown on the Figure 2. Condenser and evaporator fans are modeled with the information based on literature [9]. Then exergy analysis is applied with respect to the "fuel - product" approach via the equations given below [14, 21]:

$$\dot{E}_j \cong \dot{m}_j ex_j \qquad and \qquad ex_j = \left[\left(h_j - h_0\right) - T_0\left(s_j - s_0\right)\right] \tag{1a,b}$$

$$\dot{E}_{F,k} = \dot{E}_{P,k} + \dot{E}_{D,k} \tag{2}$$

$$\dot{E}_{F,tot} = \dot{E}_{P,tot} + \dot{E}_{D,tot} + \dot{E}_{L,tot} \tag{3}$$

$$\varepsilon_k = \frac{\dot{E}_{P,k}}{\dot{E}_{F,k}} \tag{4}$$

$$y^*_{D,k} = \frac{\dot{E}_{D,k}}{\dot{E}_{D,tot}} \tag{5}$$

The exergy of a stream *j* is denoted with $\dot{E}$ where *ex*, $\dot{m}$, *h, s,* T_0 represent specific exergy, mass flow rate, enthalpy, entropy and ambient temperature respectively. It is obvious that exergy of a stream is directly related to ambient temperature. Moreover, Eq (2) and (4) are the component-wise (subscript *k*) and system-wise (subscript *tot*) exergy balance equations, respectively. Subscripts *F, P, D, L* are for the fuel, product, destruction and loss

of exergy, respectively, while ε_k is the exergy efficiency and $y^*_{D,k}$ is the exergy destruction ratio of the investigated component.

The temperature sensitive product in the container is selected as banana that is shipped from central America to Europe, where investigated container includes 16 pallets with 88o kg of bananas each has 48 boxes [22]. The cargo temperature is 15 ℃ while air supply temperature in the container is 13 ℃ and respiration rate of the banana in the controlled atmosphere (4.5% CO2, 3% O2) is 32.5 W/t [23]. Moreover, ambient air temperature effect is also investigated with respect to 20 and 30 ℃ as assumed mean temperatures on the voyage.

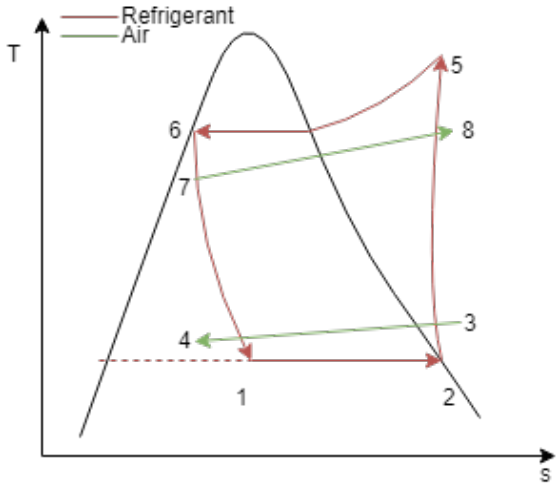

Figure 2: T-s Diagram of the System.

The system is analyzed starting with the cooling load. Then, evaporator temperature and pressure are determined with the minimum temperature between cooled air and refrigerant, which is selected as R134a, as 10 ℃. Afterwards, inlet pressure of the expansion valve is calculated due to the thermodynamic relations and the assumption of saturated liquid on the inlet side. When the upper pressure is obtained, the compressor power consumption and the temperature eat the compressor outlet is determined with

80% compressor efficiency. Lastly, with the 10℃ minimal temperature difference between condensed refrigerant and the ambient air is used to determine the released heat to the atmosphere.

3. Results and Discussion

The properties of each pipe stream that belongs to the modeled system is given on the Table 1. Exergy balance equations are applied for all system components with respect to the values on the Table 1 and the results are given in Table 2 and Figure 3. As it can be observed minimum required power to drive the compressor is calculated as 260W while the cooling load of the system is 1,61 kW in terms of energy and 99 W in terms of exergy. The difference between the energy and exergy loads are due to being close to the ambient temperature, hence the quality of the energy is lower. It could be also said that the exergy destruction of the overall system is 82% of the fuel exergy of the overall system while the exergy efficiency is only 13.5%. The rest is exergy loss to the environment.

Table 1: Properties of Streams (kg/s, ℃, bar, kJ/kg).

stream	$\dot{m}$	T	P	ex
1	0.01049	3	3.259849	36.96333
2	0.01049	3	3.259849	27.50003
3	1.088774	14.47236	1	0.053096
4	1.088774	13	1	0.085438
5	0.01049	41.51488	8.475657	47.63003
6	0.01049	33.37096	8.475657	39.73542
7	0.536714	20	1	0
8	0.536714	23.46754	1	0.020474

The highest exergy of fuel belongs to the expansion valve due to throttling the refrigerant from the inlet as its fuel exergy, and it is followed by the compressor. Moreover, it still has the highest exergy of product among the components. The exergy change on the condenser is the lowest as it can be observed from Table 2 due to small temperature

change on the air side and small amount of mass flow rate on the refrigerant side. The evaporator has an acceptable result compared to others with respect to the small temperature change.

Table 2: Results of The Analysis for Ambient Temperature, 20℃ (W).

Component	$\dot{E}_F$	$\dot{E}_P$	$\dot{E}_D$	ε_k%
Evaporator	99.27286	35.21279	64.06007	35.47071
Compressor	259.9745	211.1698	48.80471	81.22712
Condenser	82.81686	10.98855	71.82831	13.26849
Expansion Valve	416.8365	387.7564	29.08007	93.02363
TOTAL	259.9745	35.21279	213.7732	13.54471

On the inefficiency and environmental impact perspective, condenser has the highest exergy destruction that destroys the usable energy of the refrigerant by releasing it to the ambient temperature. Exergy destruction of the condenser is 71 W. The reason for that is simply the temperature difference between the two flows on both sides. The ambient air starts to gain the heat at 20℃, while outlet temperature of the refrigerant is relatively higher. The heat that is thrown into the ambient is 1.87 kW and it is a relatively high impact on the environment. Heat exchange is the main source of all exergy destructions in the system. Evaporator has a high exergy destruction and it is because of heat transfer in finite time. The exergy destruction in the compressor is directly a function of its isentropic efficiency, hence it can be said that better the compressor efficiency, smaller the exergy destruction. Expansion valve has lower exergy destruction due to the fact that the pressure ratio is small.

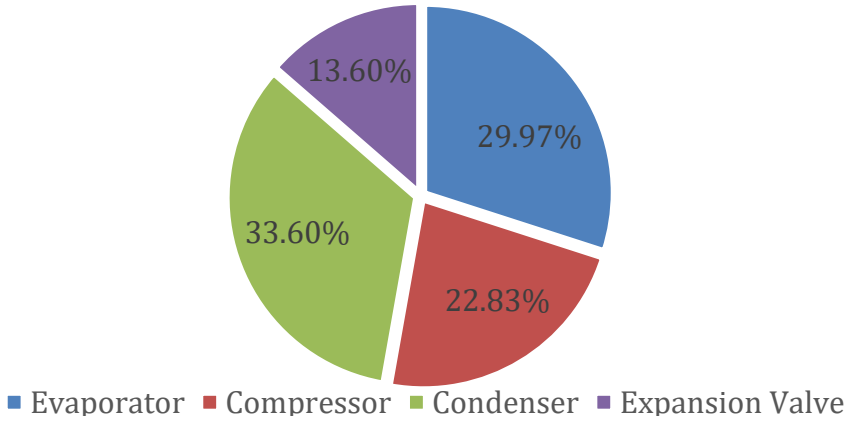

Figure 3: Exergy Destruction Ratios of the Investigated Components at 20°C.

As shown in Figure 3, condenser has the highest exergy destruction ratio, which is one-third of the exergy destruction, which belongs to system. The smallest ratio occurred in the expansion valve as expected with respect to the pressure it expands. Evaporator is slightly lower than the condenser, the heat load that it deals with is smaller than the condenser. Compressor has almost the one-fourth share of the exergy destruction. The results have shown that the highest irreversibility occurred in the condenser, therefore the first place to look for improvement must be this component. Decreasing the temperature difference between the flows at two sides would improve the efficiency of the component and recover some exergy destruction. Moreover, it might be possible to evaluate the released heat for a different purpose instead of polluting the environment. Then focus should be on the evaporator. Improvement on the evaporator could be achieved by decreasing the temperature difference between the refrigerant and container air. It is followed by the compressor. As mentioned before, increasing the isentropic efficiency of the compressor would help to regain some exergy destruction, and this will lead to decrease the power consumption and hence the fuel consumption to produce that power and lower the environmental pollution of greenhouse gases due to the combustion of fuel. This can be achieved to decrease the friction losses with a better lubricating of the compressor, and improving the volumetric efficiency. Lastly, if it is possible to improve expansion valve by replacing with another component that could produce energy or

efficiently throttle the flow with different approaches, it should be applied.When the ambient temperature change, the heat load, condenser conditions and the stream exergy changes. This reflects to the compressor as the pressure change of the outlet. Table 3 shows the results of the analysis for ambient temperature of 30℃.

Table 3: Results of The Analysis for Ambient Temperature, 30℃ (W).

Component	$\dot{E}_F$	$\dot{E}_P$	$\dot{E}_D$	ε_k%
Evaporator	199.711	114.3284	85.38264	57.24691
Compressor	477.354	388.1053	89.24871	81.30345
Condenser	113.2748	18.56259	94.7122	16.38722
Expansion Valve	707.9144	632.7949	75.11949	89.38862
TOTAL	477.354	114.3284	344.4631	23.95044

As it can be observed easily, the heat load on the evaporator is increased, due to increase of the ambient temperature and increase of the heat flow. The heat load of the evaporator is calculated as 2.04 kW. Moreover, the power requirement of the compressor, which is the exergy of fuel for the compressor, is increased. The reason for that is compressor should compress the refrigerant until the condenser pressure, which is determined by the temperature difference between the ambient air and the refrigerant. It unveils that more fuel is required by the compressor, that means more impact on the environment. Similarly, condenser pressure leads the temperature rise, therefore the fuel and product exergies increase. Furthermore, the exergy efficiency of the overall system is increased, which is a good sign that it approaches to the design conditions. On the other hand, all exergy destructions of the system components as well as the overall system are increased. Even in this situation, it has been observed that the 72% of the fuel exergy is destructed for the system. This can be accounted as the environmental effect of the investigated system, which is lower than the working conditions at 20℃ ambient temperature. In contrast, the heat that released to the environment is 2.52 kW is higher than the 20℃

ambient conditions. The exergy destruction shares off the investigated components are shown in Figure 4.

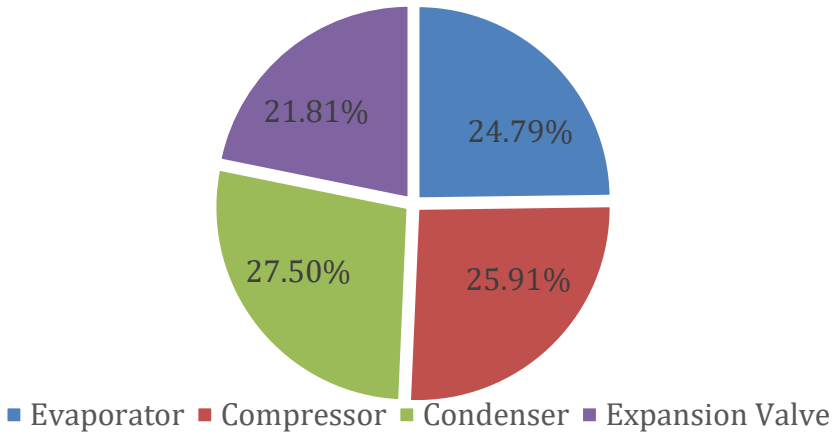

Figure 4: Exergy Destruction Ratios of the Investigated Components at 30°C.

The shares have been changed with respect to the ambient temperature. Distribution is almost equal around all components. Still, condenser has the highest share and the highest importance with respect to the room for improvement. On the other hand, evaporator and compressor have almost the same exergy destruction ratio that shows, they should be treated equal while improving the system. Lastly, the share of the exergy destruction which belongs to throttling valve is increased due to increase of the compression ratio.

The results showed that, the system is sensitive to the temperature and heat load changes. Therefore, obtaining temperatures of the pellets and air in the box from different points in the intelligent container will help to improve the system operations and efficiency. Moreover, the results of the analyses and the impact on the environment would be better.

4. Conclusion

In this study, an introduction for intelligent container is presented and a refrigerated container system, which transports bananas overseas is analysed. Results are shown that minimum effect on the environment could be achieved at relatively low ambient temperatures in terms of heat release to the atmosphere and exergy destruction of the

system. On the other hand, at high ambient temperature exergy efficiency of the system has increased. Moreover, the exergy destruction values are also presented that improvement efforts focusing on components could change with respect to the ambient temperature. The respiration rate of the transported bananas is included in the analysis as a part of evaporator cooling load, and it has been seen that one-fourth and one-fifth of the cooling load is due to the respiration for ambient temperatures 20 and 30, respectively.

Transient system conditions in between the change of ambient temperature would also increase the environmental effects with respect to the fuel consumption, hence a fast and flexible system and control would also help to improve the system efficiency and lower the harmful effects. With an intelligent container, the temperature data of each box, and each pallet will be stored as log. Although it is hard to determine the temperature hotspots from the circulating air in the container until it is too late for the shelf life of the transported perishable goods, the data are easily used to determine the system operating conditions and adjust the system either automatically or remotely from the company. Moreover, using the log data would help to improve the system efficiency due to responding exact need of the container.

5. Acknowledgement

This work was supported by Scientific Research Projects Coordination Unit of Bandırma Onyedi Eylül University. Project Number: BAP-19-1009-008.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Investigation of Issues in Tank Cleaning Operations and a Proposal of an Automated System for Improvement in Tank Cleaning System

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ABSTRACT

Loading operations are performed in accordance with the pre-defined sequences after the remnants of previous cargo is cleaned. Presently, cleaning operations are carried out by manual tank cleaning systems. Tank cleaning operation is a time consuming process, which is performed by ship crew, thus, eventually leading to fatigue. Shortening this operation further emphasizes the importance of discharging and inspection of the wastes in compliance with the international regulations. Additionally, this paper shows that total number of personnel work hours spent during a 5-day tank wahing operation generally exceeds the work hour limitations per IMO STCW requirement. This study identifies problems associated with the tank cleaning operations, propose an automated system, and explains benefits to the operators. Existing methods of tank cleaning operation is discussed and the effects of the intended and modernised tank cleaning system is evaluated. Controlling and supervision of waste disposal using an automated system with a database is introduced. Data submission over internet would be beneficial to the port authorities as well as to flag states for monitoring. Additionally, by preventing the ship crew from being exposed to chemicals and lessening the probability of accidents or near misses due to fatigue, an automated tank cleaning system would provide a more efficient operation and improve both environmental and labor safety.

Key words: Maritime safety, automated ship systems, automated tank washing system, human fatigue and failure, pollution of sea and environmental safety

1. Introduction

Significant amount of chemical and petroleum product is carried over by means of maritime transportation and the volume of this trade is escalating rapidly over time. Additionally, total number of tankers carrying these products are in an increasing trend. Chemical and crude oil tankers carry these chemical and petroleum derived products in their tanks. They load cargo in compliance with the directions from the owner or the charterer.

Presently, more than 80 percent of import and export of world's goods transported by means of maritime transportation and the volume of trade is rapidly increasing over time. In 2017, ships carried 293 million tons of liquid cargo between world's marine ports [14]. There were totally 5418 chemical tankers worldwide in 2017. Figure 1. Shows statistics related to the total number of ships on a global scale [27].

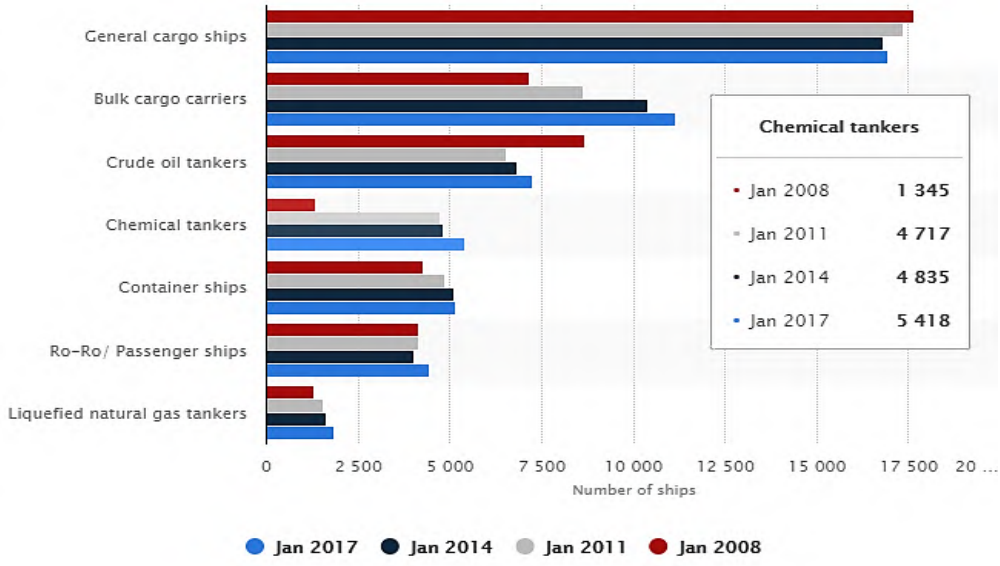

Figure 1: Total Number of Chemical Tankers Between 2008 and 2017 [27].

Chemical tankers carry products by storing them into their tanks [2]. There are many operations in relation with chemical tankers such as loading, discharging, tank cleaning

and inerting the tanks [1]. There are many risks involved in these maritime operations due to the large number of different types of operations and the dangerous cargoes that are being carried [5]. There are 20 accident reports of fire and explosion in chemical tankers which is obtained by the web page of IMO GISIS (International Maritime Organisation Global Integrated Shipping Information System): Marine Casualties. Eight of these incidents occured during tank cleaning process and Table 1. Shows some of the significant incidents that took place in tanker operations.

Table 1: IMO GISIS – Incidents of Fire & Explosion In Chemical Tankers

YEAR	LOCATION	SHIP NAME	INCIDENT	RESULT
2003	Fransa – Gulf of Biscay	Chassiron	Mogas – Fire and Explosion during tank cleaning operation	1 Death , Substantial Damage
2004	A.B.D - Virgina	Bow Mariner	MTBE (Methyl Tert Butyl Ether) Explosion and Consequent Fire	21 Death ,6 injury, Substantial Damage
2005	Fransa- Lavera	Metanol	Fire and Explosion during Methanol Discharging Opr.	Substantial Damage
2006	Offshore South Korea	Gunsul	Fire and Explosion during tank cleaning operation of Jet Fuel	1 Death, Substantial Damage
2012	S.Arabia – Jubail 25 miles offshore	Stolt Valor	Fire and Explosion during tank cleaning operation of Benzene	1 Death , Substantial Damage
2012	Maleyza,Labuan,PML Terminal	Bunga Alpinia	Fire and Explosion during loading operation of Methanol	5 death , Oil Leakage and Substantial Damage

ISM (International Safety Management) regulations, introduced in 1998 as a chapter of SOLAS, requires planned maintenance performed by operators. However, despite the implementation of ISM regulations, there are still many ship accidents and machinery failures caused by human error at a rate of more than 80 percent, which indicates that

there is a necessity for new methodologies or techniques [4]. In this context, computerized systems could be effective to reduce human errors [7].

There are both material and nonmaterial damages in the face of these accidents. Operational precautions are the most significant items in chemical tanker operations and the human factor is the obvious potential threat to this process [5]. To minimise human related accidents on ships, many systems and processes are transformed into automation to reduce human interaction [9]. For instance, main engine and other auxiliary parts are fully integrated and automated to optimise cost effectiveness and to reduce the potential risks in the engine room of commercial ships. In recent years, bridges and engine rooms are mostly priotirized for integrating and automating the systems and equipment.

To the author's knowledge, there is no study about the automation of cargo operations in tankers in literature. Previous studies investigate and report mostly the integration of loading and discharging systems in shore side particularly in marine ports. In the next section, the information about the existing tank cleaning operation methods and the intended integrated tank cleaning system has been given and the advantages and disadvantages of the proposed automated system is compared with the present applications.

2. Definition of Existing Tank Cleaning Operations in Chemical Tankers

Chemical tankers are designed to carry different types of cargoes in their tanks [3]. Chemical tankers are divided into three groups according to the IBC code issued by IMO (International Maritime Organization) in terms of their construction categories as Type 1, Type 2 and Type 3. Type 1 chemical tankers are designed to carry highly dangerous substances. Type 2 and 3 chemical tankers are designed to carry relatively less dangerous materials in contrast with the type 1 [15]. The difference between the types is in their tank designs. Usually, all chemical tankers share similar equipment and systems. MARPOL Appendix-2 categorizes cargo types under the following four sections [16] [11].

- **Category X**: Noxious Liquid Substances, which, if discharged into the sea from tank cleaning or discharging ballast operations, are deemed to present a major hazard to

either marine resources or human health and, therefore, justify the prohibition of the discharge into the marine environment [16].

- **Category Y:** Noxious Liquid Substances which, if discharged into the sea from tank cleaning or discharging ballast operations, are deemed to present a hazard to either marine resources or human health or cause harm to amenities or other legitimate uses of the sea and therefore justify a limitation on the quality and quantity of the discharge into the marine environment [16].
- **Category Z:** Noxious Liquid Substances which, if discharged into the sea from tank cleaning or discharging ballast operations, are deemed to present a minor hazard to either marine resources or human health and therefore justify less stringent restrictions on the quality and quantity of the discharge into the marine environment [16].
- **OS (Other Substances):** Substances which have been evaluated and found to fall outside Category X, Y or Z because they are considered to present no harm to marine resources, human health, amenities or other legitimate uses of the sea when discharged into the sea from tank cleaning of discharging ballast operations. The discharge of bilge or ballast water or other residues or mixtures containing these substances are not subject to any requirements of MARPOL Annex II [16].

A ship operator should chase the freight fee in return for the carried goods to sustain the economic cycle of the company [3]. Otherwise, a company can go bankrupt or may need to sell their ships. The most important point that the tanker ships used for commercial purposes to make money is the goods they carry. Tankers carry liquid substances in their tanks [8]. To carry over these products, the equipment and tanks must be fit in accordance with IBC, MARPOL and the ship must hold a fitness certificate. However, the fitness of the equipment is not enough to carry these products. After discharging their cargo, tankers must carry out a proper tank cleaning operation in accordance with the MARPOL Annex-II and P&A manual [16]. Figure 2. and Table 2. shows the flow diagram of tank cleaning and disposal of tank washings procedures [17].

Table 2. Indicates the disposal procedures of tank washings with regard to the categories of different chemicals in accordance with the flow diagram described in MEPC 2014 (Figure 2) [17]. The remnants of tank washings could be disposed as long as the conditions meet the MARPOL regulation. Otherwise, this disposal water must be kept in slop tanks, which are particularly designed for this purpose [11]. These regulations are international rules and must be adopted by all companies globally [16]. However, tank cleaning operation does not merely consist of procedures and disposal of the waste water under correct circumstances. To be able to carry out these procedures systematically, firstly there need to be a wastewater formed after a proper tank washing operation [11]. Currently, these methods are not introduced in MARPOL. Because of the different types of products transported in tanks, tank-washing methods to be applied with respect to the new product for loading also differ from each other. Upcoming section introduces the information about the tank washing methods.

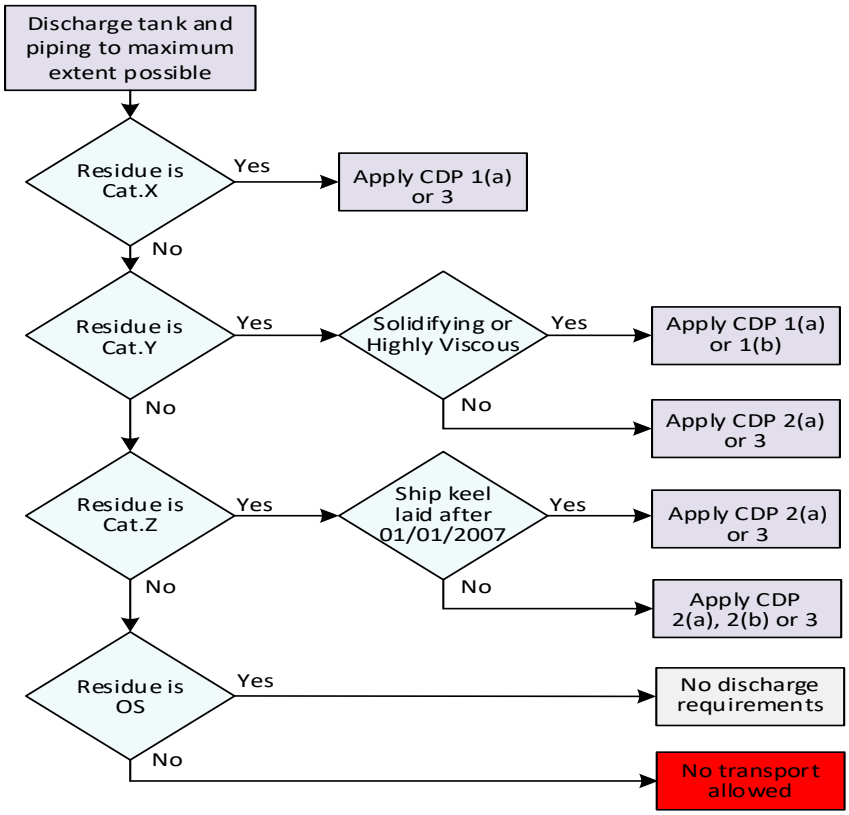

Figure 2: Cleaning of Cargo Tanks and Disposal of Tank Washings [17].

Table 2: Cleaning and Disposal Procedures (CDP) [17].

No	Operation	Procedure Number				
		1(a)	1(b)	2(a)	2(b)	3
1	Strip tank and piping to maximum extent, at least in compliance with the procedures in section 3 of this Manual	X	X	X	X	X
2	Apply prewash in accordance with Addendum B of this Manual and discharge residue to reception facility	X	X			
3	Apply subsequent wash, additional to the prewash, with: a complete cycle of the cleaning machine(s) *for ships built before 1 July 1994* a water quantity not less than calculated with "k" 1.0 *for ships built on or after 1 July 1994*		X			
4	Apply ventilation procedure in accordance with Addendum C of this Manual					X
5	Ballast tanks or wash tank to commercial standards	X		X	X	X
6	Ballast added to tank		X			
7	Conditions for discharge of ballast/residue/water mixtures other than prewash:					
	.1 *distance from land > 12 nautical miles*	X		X	X	
	.2 *ship's speed > 7 knots*	X		X	X	
	.3 *water depth > 25 metres*	X		X	X	
	.4 *Using underwater discharge (not exceeding permissible discharge rate)*	X		X		
8	Conditions for discharge of ballast:					
	.1 *distance from land > 12 nautical miles*		X			
	.2 *water depth > 25 metres*		X			
9	Any water subsequently introduced into a tank may be discharged into the sea without restrictions	X	X	X	X	X

2.1. The Role of Ship's Crew in Tank Washing Operations

In chemical tankers, there is a booklet containing the procedures of tank washing operation in accordance with the ISM code. This booklet consists of the responsible staff member of tank washing operation, step by step operation guide, procedures, common risks and evaluation criteria. The person in charge of the tank washing operation is primarily the ship captain. His supervisor and co-operator is Chief Officer. Flag state sets the minimum number of crewmembers and equipment criteria to effective operate the ship. Establishing these standards are based on working and resting hours of ship's crew, safe staffing and watchkeeping criteria [19], [18]. By considering all of these issues, SAFE MANNING CERTIFICATE is issued by the flag state, which indicates the minimum number of crew and their minimum competence levels for safe operation of a particular ship. Table 3. shows, as example, Malta Flag State Authority' minimum manning requirement for a 12.000 DWT chemical.

Table 3: Number of Crewmembers in A 12.000 Dwt Chemical Tanker In Safe Manning Certificate Issued By Malta Flag State Authority.

Personnel Grade /Capacity	Minimum STCW Reg.	Number of Persons
Master	II/2	1
Chief Mate	II/2	1
OOW (Bridge)	II/1	2
Chief Engineer	III/2	1
Second Engineer	III/2	1
OOW (Engine Room)	III/1	1
Deck Rating	II/4	3
Deck Rating	VI/1	2
Engine Rating	III/1	3
Engine Rating	VI/1	1

Shipping companies create operating manuals for tank cleaning operations. Selecting the suitable staff and plannnig the work schedule is the responsibility of Chief Officer and the Ship's Master. The operation plans and the necessary preparations are highlighted before the actual operation and key points are explained to the staff [21]. Table 4. Shows working hours of crewmembers in a 12000 DWT chemical tanker for tank cleaning operation. This watchkeeping schedule is based on the total number of crewmembers as shown in Table 3. & Table 5. Shows working hours of crewmembers who are not take part in tank cleaning operation. The tank washing operation is carried out at the time of the ship's navigation and main engine is usually operated by the remote system. Because the duration the operation may differ and considering the crew working hours, the cleaning operation is carried out by two teams.

Table 4: Shift Plan for Crewmembers Attending Tank Cleaning Operation.

TEAM NO	RANK	RESPONSIBILITY IN TANK CLEANING OP.		WORKING HOURS
1	Ship's Master	Person in charge for tank cleaning operation.		1200-2400
1	2nd. Eng.	Responsible for cleaning equipment and system in tank cleaning operation.		1200-2400
1	Boatswain	Assistant of washing operation supervisor		1200-2400
1	Oiler-1	Assists 2nd Eng. in engine room		1200-2400
2	Chf. Off.	Washing operation supervisor		0000-1200
2	3rd. Eng.	Responsible for cleaning equipment and system in tank cleaning operation.		0000-1200
2	Pumpman	Assistant of washing operation supervisor		0000-1200
2	Oiler-2	Assists 2nd Eng. in engine room		0000-1200

Table 5. Working Schedule for Crew Memebers Not Attending Tank Washing Operation.

RANK	DUTY	WORKING HOURS
2nd. Off.	Bridge watchkeeping	1200-2400
3rd. Off.	Bridge watchkeeping	0000-1200
Chf. Eng.	Engine room supervisor	0800-1200 / 1300-1700
AB-1	Bridge lookout and assist in tank cleaning operation	Bridge Watchkeeping 0000-0400; 1200-1600 Assist in Tank Cleaning Op. 0400-0800
AB-2	Bridge lookout and assist in tank cleaning operation	Bridge Watchkeeping 0400-0800; 1600-2000 Assist in Tank Cleaning Op. 0800-1200
AB-3	Bridge lookout and assist in tank cleaning operation	Bridge Watchkeeping 0800-1200; 2000-2400 Assist in Tank Cleaning Op. 1200-1600
Fitter	Assist in engine room supervisor	0800-1200 / 1300-1700
Oiler-3	Assist in engine room supervisor	0800-1200 / 1300-1700

After discharging operation is complete, tanks must be cleaned from the remnants of the previous cargo for readiness to load the next freightage [1]. For tank washing operations, there are reference booklets and approved programs that explain and clarify tank cleaning methods. Staff member, responsible from the cleaning operation, can use these reference materials [24]. Examples of principle sources of information are Tank Cleaning Guide, Milbros and Miracle. These sources are advisory and include tank-washing methods. Table 6. Shows a sample tank washing method, in which discharging product is Palm Oil and the product to be loaded after cleaning operation is Methanol. This Washing methodology is taken from Milbros [24].

Table 6: Sample Tank Washing Methodology (From palm oil to methanol)

From Palm Oil To Methanol for Cleaning Steps				
No	**Description**	**Time**	**Temperature (°C)**	**Notes**
1	Machine wash sea water	1.5 Hours	50	-
2	Machine wash sea water	1.0 -2.0 Hours	75	Use wash water temp up to maximum allowed for tank coating or by class
3	Inject or Recirculate cleaning chemical	2.0 -3.0 Hours	-	Temperature and concentration asper manufactures recommendations.
4	Machine wash sea water	2.0 -3.0 Hours	75	-
5	Fresh water rinse	0.3 -0.5 Hours	-	Ensure all tank surfaces are rinsed.
6	Gasfree	Gasfreeing each tanks till no remain any gase in tank		
7	Eject and Mop Dry	No remain any water or residue each tank.		
8	Inspect and check wallwash results to determine if further cleaning is required	Checking of each tank for Wall wash specs. are suitable for load.		

The total duration of tank washing operation in the proposed methods varies with different cargo types. Washing procedures and necessary specifications may also vary according to the usage area of a specific cargo [10]. These specifications are usually identified in reference sources. Nevertheless, these may can change based on the request of the charterer or the recipient. Necessary specifications of a cargo transition is declared to the ship as a chapter of the campaign plan. **Table 7.** shows sample specifications

needed for a cargo transition [26], [12]. For this example, tank washing operation continues by ship crew until the cargo specifications fully meet the required criteria. A designated ship personnel reports to the charterer, recipient and the ship owner for readiness to cargo loading operation according to requested specifications. Subsequently, independent surveyors check the tanks by taking samples from each tank and confirm whether the tanks are ready to load the cargo and, if not, the ship is refused to better prepare the tanks for the cargo [10].

Table 7: Required Specs for Loading Methanol [26]

Wall Wash Specifications					
Test	**Unit**	**Method**	**WW Spec**	**Sales Spec**	**Sabic Spec (Wwash)**
Appearance	Visual	IMPCA 003-98	Clear & Free from suspended matter.	Clear & Free from suspended matter.	Clear & Free from suspended matter.
Colour	PT-CO	ASTM D 1209-00	Max 10 (APHA)	Max 5 (APHA)	Max 10 (APHA)
Hydrocarbon	Visual	ASTM D 1722-98	Pass	Pass	Pass
Chloride as Cl	mg/kg (ppm)	IMPCA 002-98	Max 2	Max 0.5	Max 2
PFT @ 15C	Minutes	ASTM D 1363-01	Min 50	Min 50	Min 50

2.2. Current System Used in Tank Washing Operations

There are many systems and equipment used in tank washing operations. The order of use of these equipment and components vary according to the preferred method. Figure 3. Shows a generalized diagram of current systems used in tank washing operations of a chemical tanker.

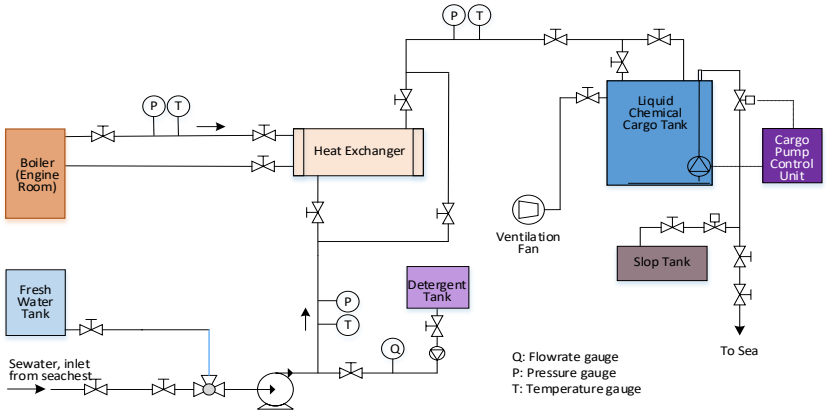

Figure 3: Generalized System and Equipment Used in Tank Washing Operations of A Chemical Tanker

In Figure 3. Equipment and instruments is shown. Operational work flow and use of the current system in tank washing operation is briefly explained as follows:

There are both portable and fixed tank washing equipment in chemical tankers. Seawater or freshwater is pumped through a tank washing pump with a certain pressure. Remnants of a cargo or the washing water is stored in sludge tanks or directly pumped over the sea according to Marpol Annex 2 [16]. If the tank to be washed with sea water or fresh water, the water is pumped through a nominated pump (Tank Cleaning Pump) to tank washing equipment with certain pressure. If there is a need for hot water, heating system (boiler and heat exchanger) is used. After the washing operation, tanks are ventilated with "Tank Ventilation System" [6].

2.3. Role of Ship's Crew in Use of Equipment in Tank Washing Operations

Current tank washing systems in chemical tankers includes all aforementioned equipment in tank washing operations. Each equipment itself constitutes a separate system for washing operation and these systems are operated via human interaction. The role of ship's crew in use of equipment in tank washing operation could be listed as:

- Checking up the tank washing system (whether they are active or not)
- Connecting hoses to tank washing equipment (if they are portable)

- Starting up the Boiler, make settings and regularly monitoring them during the operation
- Starting up the Heat Exchanger, make settings and regularly monitoring them during the operation
- Waste water must be pumped out during the washing operation thus regular monitoring is necessary
- Tank washing equipment need a pressurized water to rotate and this water is supplied by freshwater tanks or the seawater. The transfer of water to the tank is enabled by sea water pumps and these pumps need to be activated and regularly checked during tank washing operation
- Tank ventilation system must be run and blowers should be attached. This operation should continue until the tank gets dry
- Ship's staff should measure the gas inside the tank. This operation could be done with the portable gas detector.

Each stage in tank washing operation must be performed by way of human interaction, as there is no system integration. There may be alarm devices in each of the systems and these devices provide both visual and audio signals. Tank washing process is a serious event and must proceed uninterruptedly. Interruptions may affect the active progression of the method, which may end up with undesired results.

2.4. Example Calculation for Time Spent in Tank Washing Operations

A chemical tanker is selected for calculation of durations using the timings occurring in a sample tank washing operation. The selected chemical tanker consists of 16 individual cargo tanks. These tanks are named as CT 1,2,3,4,5,6,7 and Slop (Port) / S (Starboard) as shown below. There are 14 ballast tanks in total. These ballast tanks are also entitled as CT 1,2,3,4,5,6,7 and P (Port) / S (Starboard) as shown in Figure 4. Each cargo tank has two tank washing systems and are able to pump out the water 24 cm^3/hr at 10 bar. Total amount of water that can be discharged to sea is specified in Marpol Annex-2 [16]. The relevant information can be found in ship's P&A (Procudere & Arrangement) Manual,

which is created in accordance with Marpol Annex-2 [16]. The total hourly amount of dischargeable waste water is 98 m^3/hr which means there can be maximum of 4 tank washing systems operated at the same time.

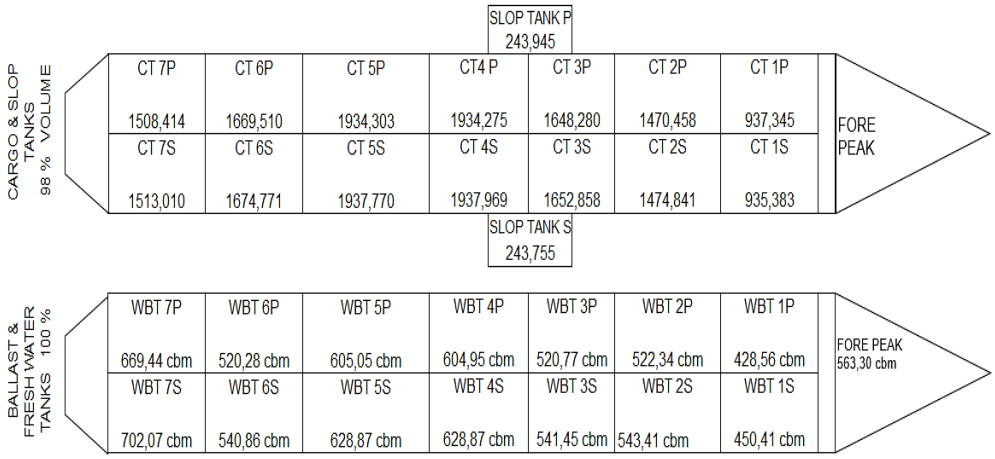

Figure 4: General Arrangement Plan of Tanks in A Chemical Tanker, Selected As Example.

Examining the voyages of the sample chemical tanker, it is realized that the vessel has Palm Oil in all of her 16 tanks and after the discharge operation and the next load will be Methanol. Soon after the discharge operation of Palm Oil, the crew have immediately started to wash out ship's tanks and the ship has directly came alongside to port of loading without delay. Table 6. Shows the selected method for this tank washing operation. In Table 8. Total hours of tank cleaning operation is shown in details and Table 9. Shows working hours of ship's crew during this tank washing process.

Table 8: Total Tank Washing Hours

No	Washing Method	Duration	Washed Tanks (1 or 2 Two tanks washed at the same time)	Time Spent (hours)
1	Machine wash Sea water at 50^{0}C with Tank Cleaning Machine (Simultaneously 2 Tanks 4 T.C.Machines)	1,5	1P/S,2P/S,3P/S, 4P/S,5P/S,6P/S, 7P/S,SLOP P/S TOTAL : 16 Tanks Simultaneously:8 Tanks	1,5 x 8 = 12 Hours
2	Machine wash Sea water at 750C with Tank Cleaning Machine (Simultaneously 2 Tanks 4 T.C.Machines)	2,0	1P/S,2P/S,3P/S, 4P/S,5P/S,6P/S, 7P/S,SLOP P/S TOTAL : 16 Tanks Simultaneously:8 Tanks	2,0 x 8 = 16 Hours
3	Injection Cleaning with Tank Cleaning Machine (Simultaneously 2 Tanks 4 T.C.Machines)	3,0	1P/S,2P/S,3P/S, 4P/S,5P/S,6P/S, 7P/S,SLOP P/S TOTAL : 16 Tanks Simultaneously:8 Tanks	3,0 x 8 = 24 Hours
4	Machine wash Sea water at 750C with Tank Cleaning Machine (Simultaneously 2 Tanks 4 T.C.Machines)	3,0	1P/S,2P/S,3P/S, 4P/S,5P/S,6P/S, 7P/S,SLOP P/S TOTAL : 16 Tanks Simultaneously:8 Tanks	3,0 x 8 = 24 Hours
5	Fresh Water Rinse with Tank Cleaning Machine (Simultaneously 2 Tanks 4 T.C.Machines)	0,5	1P/S,2P/S,3P/S, 4P/S,5P/S,6P/S, 7P/S,SLOP P/S TOTAL : 16 Tanks Simultaneously:8 Tanks	0,5 x 8 = 4 Hours
6	Gasfree Operation of Tanks & Mop Dry (Simultaneously 2 Tanks)	4	1P/S,2P/S,3P/S, 4P/S,5P/S,6P/S, 7P/S,SLOP P/S TOTAL : 16 Tanks Simultaneously:8 Tanks	4 x 8 = 32 Hours

No	Washing Method	Duration	Washed Tanks (1 or 2 Two tanks washed at the same time)	Time Spent (hours)
7	Inspect and Check wall Wash result to Determine if further cleaning reguired (Each Tank)	0,5	1P/S,2P/S,3P/S, 4P/S,5P/S,6P/S, 7P/S,SLOP P/S TOTAL : 16 Tanks	0,5 x 16 = 8 Hours
Total Tank Cleaning Complete:				**120 Hours (5 Days)**

Table 9: Total Working Hours of Ship's Crew During A 5-Day Tank Washing Operation (Using Existing Manual System)

Rank	Participated Tank Washing Method	Total Working Hours In Tank Washing Op.	Other Duties if the Member Not Attended Tank Washing Op.	Working Hours Other Than Tank Washing Op.	Total Work Hours During Operation
Ship's Master	1,2,3,4,5,6,7	60	Executive Acts	2 hours x 5 days during op. =10 Hours	70
Chief Officer	1,2,3,4,5,6,7	60	Executive Acts	2 hours x 5 days during op. =10 Hours	70
2nd. Off.	-	-	Bridge Watchkeeping + External Duties & Responsibilities	60 hours Watchkeeping + 2 hours x 5 days during op. =10 Hours	70
3rd. Off.	-	-	Bridge Watchkeeping + External Duties &	60 hours Watchkeeping + 2 hours x 5 days	70

			Responsibilities	during op. =10 Hours	
Chief Eng..	-	-	Executive Acts	8 hours administrative x 5 days during op. =40 Hours	40
2nd Eng.	1,2,3,4,5	40	External Duties & Responsibilities	4 hours x 5 days during op. =20 Hours	60
3rd Eng.	1,2,3,4,5	40	External Duties & Responsibilities	4 hours x 5 days during op. =20 Hours	60
Boats wain	1,2,3,4,5,6,7	60	Deck Maintenance	2 hours x 5 days during op. =10 Hours	70
Pump man	1,2,3,4,5,6,7	60	Deck Maintenance	2 hours x 5 days during op. =10 Hours	70
AB-1	Assisting in Tank Washing Op. Supervisor	4 hours x 5 days during op. =20 Hours	Bridge Lookout	8 hours x 5 days during op. =40 Hours	60
AB-2	Assisting in Tank Washing Op. Supervisor	4 hours x 5 days during op. =20 Hours	Bridge Lookout	8 hours x 5 days during op. =40 Hours	60
AB-3	Assisting in Tank Washing Op. Supervisor	4 hours x 5 days during op. =20 Hours	Bridge Lookout	8 hours x 5 days during op. =40 Hours	60
Fitter	-	-	Executive Acts	8 hours administrative x 5 days during op. =40 Hours (Assisting in Engine Room Supervisor)	40

Oiler-1	1,2,3,4,5	40	External Duties & Responsibilities	4 hours x 5 days during op. =20 Hours	60
Oiler-2	1,2,3,4,5	40	External Duties & Responsibilities	4 hours x 5 days during op. =20 Hours	60
Oiler-3	-	-	Executive Acts	8 hours administrative x 5 days during op. =40 Hours (Assisting in Engine Room Supervisor)	40

Total hours spent for tank wahing operation in this example indicate an intensive tank washing operation is carried out and the ship's crew worked with an average of 14 hours a day to successfully complete the operation. In STCW convention it is indicated that weekly maximum working hour of a ship's crew can not exceed 77 hours in total and daily maximum working limit is 14 hours while daily minimum resting hour must not be under 6 hours without any interruptions [20].

In this context, the key staff, such as Ship's Master, Chief Officer etc. Has reached up to 70 hours of total working hours during this 5 days of tank washing operation. This tank washing operation was completed as normal; however, the tanks would have been re-cleaned if they did not meet the conditions stated in Table 6**.** In Section 7 [10] and such situation would dramatically increase the total time spent. Other than such occurences, weather conditions, equipment failures and enclosed space entry practices are also among the main factors that could increase the total time spent so as the total working hours of ship's crew.

Ship crew's working hours are inspected by authorities. As of 2014, Port State Officers inspect crew's working-resting hours according to Paris & Tokyo MOU CIC (Concentrated

Inspection Campaign) "Results of CIC Hours of Rest 2014" and if they find any noncomformity, they penalize the ship [25].

Ship staff conducts tank cleaning operations under fatigue both mentally and physically. As a consequence, there is a potential risk to a serious accident to occur. These accidents are to occur regardless of how many new procedures and regulations are introduced by companies and international authorities unless they encourage and motivate their staff both physically and mentally. These figures, shown in this paper, therefore provide evidential value on this important matter. Checking the web page of "IMO Marine Casualties and Incidents" sample accident report, submitted as a consequence of forementioned case, can be displayed. Figure 5. Shows the details etails of this accident [23].

Name	Flag Administration	Ship type	Gross tonnage
BOW MARINER (IMO 7923512)	Singapore	Chemical Tanker	22587

Incident time and location

Time of incident (local onboard):

Date:	2004-02-28
Time:	18:05

Location:

Place/area name:	50 miles E. of Chincoteague, Virginia, United States
Latitude:	37° 53.00' N
Longitude:	74° 15.00' W

Coastal Administration(s):

United States

Type of casualty:

Very Serious Casualties

Initial event:

Fire or explosion

Summary of events:

At 18.05 on Saturday 28 February 2004, the Singaporean chemical tanker M/V BOW MARINER caught fire and exploded while the crew was engaged in cleaning residual Methyl Tert Butyl Ether (MTBE) from cargo tank number eight starboard The ship sank by the bow at 19.37 about 45 nautical miles east of Virginia. Of the 27 crewmembers aboard, six abandon ship and were able to make it to an inflatable life raft and were rescued by the Coast Guard. 18 crewmembers remained missing and are presumed dead, three died before reaching the hospital.
The Singaporean vessel's cargo of ethyl alcohol (3.188.711 gallons) was released, along with the vessel's heavy fuel oil (192.904 gallons), diesel fuel (48.266 gallons) and slops (quantity unknown).
The cause of this casualty was the ignition of a fuel/air mixture, either on deck or in the cargo tanks, that was within its flammable limits.

Figure 5: Sample Accident Report Of Chemical Tanker "Bow Mariner" During Tank Washing Operation [25].

Tank washing operations in a chemical tanker must be recorded to Cargo Record Book in accordance with the Marpol Annex-2 [16]. Nevertheless, these recordings are not kept in a digital platform so sometimes there may be false declarations by ship's staff. For instance, there is no digital proofs of aforementioned tank washing operation and crew working hours, which may potentially lead the ship's staff to head towards violation of regulations.

Moreover, cleaning water from tank washings is discharged by means of underwater discharge pumps in compliance with Marpol Annex-II [16]. The valves are manually operated by ship's crew, thus, crew may discharge the wastewater into sea unintentionally which can lead to a significant marine pollution. One of the main ideas behind this project is digitally record the whole operation, hereby, provide the necessary information for authorities as proof to prevent these violations.

3. Proposed Integration and Use of Automated Tank Washing Systems

Instruments and equipment that are used in tank cleaning operation are described in section 2. Operating sequence of these equipment and instruments are provided before Figure 3. As these systems must be operated manually, except the cargo pump with a control unit, the checks and inspections are carried out by designated staff members. However, all available instruments can connect to each other via Profinet (Process Field Net) and both Cargo Control Room and Bridge stations can control the system remotely. With a reliable design, a fully automated and integrated system can operate the whole system and its components and equipment with much less human involvement.

Profinet is the ethernet based web protocol, which adapts real time requirements of industrial automation by Ethernet hardwares and protocols. Moreover, it is a profibus arrangement that is based on Ethernet substructure as an IT (Information and Technology) standard. Equipment that are connected to the system (Sensors, Subsystems,

Instruments etc.), Programmable Logic Controllers (PLC) and Distributed Control Systems (DCS) etc, are industrial ethernet solutions to establish connection between automation devices [22]. Considering all hazards, all systems should be designed and assembled as ex-proof and realiable. Systems should be installed redundantly for additional realiability and support the user as emergency back up. With integration of such automation, existing tank washing systems becomes digitally operated and they could provide real time data to companies and authorities. Furthermore, logs of processes and operations can be monitored in real time over internet.

3.1. Advantages and Disadvantages of Automated Tank Washing Systems

The main income of tankers is loading the cargo with desired specs and intended ports, then, safely discharging soon after the safe voyage. To be able to load the cargo, tanks must be ready for that intended cargo. This process is prone to many types of accidents and risks and the underlying cause is often the human factor. The main causative factor for human defect is generally fatigue and negligence. The frequency of human based accidents is calculated as $0{,}1x10^{-1}$ incidents/year [13].

With this envisaged tank washing system, whole process will be able to be controlled from cargo control room and ship's bridge. Also, a planned tank washing method can be selected from a panel and system will be controlled via automation. Tank washing systems, pumps, boilers, heat exchangers and ventilation systems will be integrated as a unified system and they will be automated.

The main advantage of utilizing an automated system is to reduce crewmember's number of work hours spent to operate the manual system. Table 10. Shows an analysis made based on the operational experience of the authors working onboard such chemical tankers and performing tank cleaning operations.

Table 10: Total Working Hours Of Ship's Crew During A 5-Day Tank Washing Operation (Using An Automated System)

Rank	Work Hours for a 5-day Tank Cleaning Operation (Existing Manual System)	Work Hours for a 5-day Tank Cleaning Operation (Using an Automated System)	Remarks
Ship's Master	70	40 (Regular watchkeeping , Daily eight hours work)	He/She would need to attend regular watchkeeping duties meanwhile he/she monitors the tank cleaning operation using the Bridge Control/Monitoring system.
Chief Officer	70	40 (Regular watchkeeping , Daily eight hours work) + 10 (2 hours x 5 days during op. Planned Maintenance and Paper work) Total : 50 Hours	He/She would need to attend regular watchkeeping duties meanwhile he/she monitors the tank cleaning operation using the Bridge Control/Monitoring system.
2nd. Off.	70	40 (Regular watchkeeping , Daily eight hours work) + 10 (2 hours x 5 days during op. Planned Maintenance and Paper work) Total : 50 Hours	He/She would need to attend regular watchkeeping duties meanwhile he/she monitors the tank cleaning operation using the Bridge Control/Monitoring system.
3rd. Off.	70	40 (Regular watchkeeping , Daily eight hours work) + 10 (2 hours x 5 days during op. Planned Maintenance and Paper work) Total : 50 Hours	He/She would need to attend regular watchkeeping duties meanwhile he/she monitors the tank cleaning operation using the Bridge Control/Monitoring system.
Chief Eng.	40	40	-
2nd Eng.	60	40 (Regular watchkeeping , Daily eight hours work)	He/She would need to attend regular watchkeeping duties meanwhile he/she monitors the tank cleaning operation using the ECR Control/Monitoring system.
3rd Eng.	60	40 (Regular watchkeeping , Daily eight hours work)	He/She would need to attend regular watchkeeping duties meanwhile he/she monitors the tank cleaning operation using the ECR Control/Monitoring system.
Boatswain	70	70	He/She monitors the tank cleaning operation.

Rank	Work Hours for a 5-day Tank Cleaning Operation (Existing Manual System)	Work Hours for a 5-day Tank Cleaning Operation (Using an Automated System)	Remarks
Pumpman	70	70	He/She monitors the tank cleaning operation.
AB-1	60	60	He/She would need to attend regular watchkeeping duties meanwhile he/she monitors the tank cleaning operation.
AB-2	60	60	He/She would need to attend regular watchkeeping duties meanwhile he/she monitors the tank cleaning operation.
AB-3	60	60	He/She would need to attend regular watchkeeping duties meanwhile he/she monitors the tank cleaning operation.
Fitter	40	40	-
Oiler-1	60	40 (Regular watchkeeping , Daily eight hours work)	He/She would need to attend regular watchkeeping duties meanwhile he/she monitors the tank cleaning operation using the ECR Control/Monitoring system.
Oiler-2	60	40 (Regular watchkeeping , Daily eight hours work)	He/She would need to attend regular watchkeeping duties meanwhile he/she monitors the tank cleaning operation using the ECR Control/Monitoring system.
Oiler-3	40	40	-
Total time spent (h)	**960**	**790**	

Other advantages and disadvantages of integrating and using such an automated system may be summarized as follows:

Advantages

- Preventing both mental and physical fatigue due to long periods of tank washing operation.
- Reducing the frequency of potential hazards and accidents by minimizing human interaction.
- Lessening the numbers of probable incidents in latter stages such as watchkeeping, loading – discharging operations etc. which stems from long hours of tank cleaning operation and subsequent negligance or carelessness by fatigue.
- Preventing miss-usage of tank cleaning equipment, devices or items such as chemical detergents by ineligible crewmembers.
- As the system is sensitive to any faults, it will be capable of shutting down the operation to prevent any damage to equipment and instruments. For instance, damaging the heat exchanger due to open wrong valve and consequent increase in oil temperature.
- The integrated and automated system will be beneficial particularly for tankers that have short voyage periods where arrangement of work-rest hours of crewmembers is difficult.
- Each process on the system is going to be recorded.
- Inspectors from international organizations will be able to establish remote connection and monitor the records live.
- Wastewater could be controlled when discharging to sea so it will minimise the environmental pollution and consequent death of sea creatures.
- Minimizing the exposure of ship's crew to several bunch of chemical substances.
- Repairs and revisions to the system could be made via remote connection.
- On the advancing time, system architecture will be organised such that, other devices and equipment would be easily integrated.
- System would be equipped with redundant and duplicate devices in case of any emergency.
- Additional costs such that stem from re-cleaning operations would be minimised by reducing oil and washing water usage.

- Downsizing and optimising the numbers of crewmembers may also be possible considering the processing times.
- Since necessary equipment and instruments already exists in ships, long processes, high costs and new design arrangements will not be required for the integration of systems.

Disadvantages

- Installing costs for adding the automated system, software, and parts
- System could be prone to syber attacks due to remote connection options.
- There need to be an arrangement of additional equipment in case of any breakdowns such as sensors or system cards etc.

4. Conclusion

Eight out of 20 chemical tanker accidents occured during the tank cleaning operations. Increasing the number of personnel is usually limited due to the ship's safe manning capacity and therefore may not be possible due to the safety and life saving equipment as well as capacity of comodities onboard ship. Therefore, planning of staff work hours exceeds what is specified as maximum in IMO STCW, in practice. This paper proposes an automated tank wahing system as for the solution to these issues. An operational scenario of a tank washing system indicated 960 hours spent whereas with existing manual system this is 790 hours. This indicates 170 hours saving from personnel work hours during tank a 5-day tank cleaning operation. The main benefit of using such automated system, therefore, is to meet the limitations in the IMO STCW's staff work hours requirements. Working within the requirements, personnel's fatigue would be less. This integrated washing system would minimize the accidents and risks during tank cleaning operation by eliminating carelessness, fatigue, and violation of procedures and loss of motivation that stems from physical and mental conditions of crewmembers.

Other benefits of using an automated system are also important. Each process on the system would be recorded, which eliminates the potential issue of unrecorded discharges to the sea. Environmental pollution and consequent harm to sea creatures would be

lessen by reducing these unrecorded events. Moreover, these unrecorded violations cause significant amount of penalties for both ship's crew and companies which could be prevented by the proposed method.

Furthermore, system would be designed as open to proactive developments. Recently, one of the main subject in maritime sciences is autonomous ships and integrating the systems and equipment in one combined cluster would be a significant step towards this issue.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

The Investigation of Improvement with Tall Oil Fatty Acid of Negative Effects Through Diesel Oil Mixed with Lubricating Oil in Marine Diesel Generators

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ABSTRACT

It is inevitable in time that the lubrication oils used in the marine diesel generators are contaminated with fuel leakages from the combustion chamber, injector, fuel pumps. Due to this contamination, the lubricating properties of the lubricating oil will decrease, resulting in friction losses and wear in the piston ring-cylinder liner area on the engine. In such cases, it will not be easy to change or clean (separate) the lubricating oil, which will cause an additional cost.

For this purpose, in this study, friction forces of %10, %20, %30 diesel fuel mixed in the lubricating oil are determined in the piston ring-cylinder liner area. Improvement of these negative effects with tall oil fatty acid in different ratios was investigated by using Taguchi design method.

Keywords: Friction, Diesel Engine, Diesel Oil, Tall oil, Taguchi.

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Gemi Dizel Jeneratörlerinde, Yağlama Yağına Karışan Dizel Yakıtının Olumsuz Etkilerinin Tall Yağı Asidi ile İyileştirilmesinin Araştırılması

ÖZET

Gemi Dizel Jeneratörlerinde kullanılan yağlama yağlarının zaman içerisinde, gerek yanma odasından, gerekse enjektör, yakıt pompaları gibi ekipmanlardan kaynaklı yakıt sızıntıları ile kirlenmesi kaçınılmazdır. Bu kirlenme ile yağlama yağının yağlayıcılık özelliği azalacak, motor üzerinde segman-silindir gömleği bölgesinde sürtünme kayıplarına ve aşınmalara neden olacaktır. Bu gibi durumlarda yağlama yağının tümüyle değiştirilmesi veya temizlenmesi (ayrıştırılması) kolay bir işlem olmayacağı gibi, yağlama yağı değişimi ilave bir gider oluşumuna neden olacaktır.

Bu amaçla bu çalışmada, yağlama yağına karışan %10, %20 ve %30 oranındaki dizel yakıtın, segman-silindir gömleği bölgesinde neden olduğu sürtünme kuvvetleri tayin edilmiş ve bu olumsuzlukların değişik oranlarda tall yağı asidi ile iyileştirilmesi, Taguchi Dizayn metodu kullanılarak araştırılmıştır.

Keywords*:* Sürtünme, Dizel Motor, Dizel yakıtı, Tall yağı, Taguchi.

1. Giriş

İçten yanmalı motorlarda sürtünme işi, yüke bağlı olarak indike işin %10'undan daha fazladır [1]. Sürtünme kuvvetlerinin %20'sinden fazlası ise segmanlardan kaynaklanmaktadır [2]. Bu yüzden segman-silindir gömleği arasında meydana gelen sürtünme, motor performansı ve emisyonları açısından büyük önem arz etmektedir.

Motorlarda kullanılan yağlama yağı, zamanla meydana gelen kirlenmeler sonucunda özelliğini kaybetmekte ve sürtünme kayıplarının ortaya çıkmasına sebep olmaktadır. Kirlenme, özellikle yanma odasına püskürtülen yakıtın bir kısmının yağlama yağına karışması ile yağın kimyasal özelliklerinin bozulmasına sebep olmaktadır. Atmosfere salınan SOx emisyonlarının azaltılması amacıyla, IMO Marpol Ek 6 hükümlerinde yapılan düzenlemeler düşük sülfürlü yakıt kullanımını arttırmıştır. Hidrodesülfürizasyon prosesinin kullanımı ile sülfür, oksijen ve nitrojen bazlı bileşenler uzaklaştırılmaktadır [3-5]. Bu durum hem yakıtın hem de yağa karışan yakıt ile birlikte yağın yağlama özelliklerinin düşmesine sebep olmaktadır. Bu amaçla literatürde yapılan çalışmalara bakıldığında, malzeme ve geometrik özelliklerin iyileştirilmesiyle ilgili çalışmaların [6-9] yanı sıra, yağlayıcı özelliklerinin geliştirilmesi ile ilgili çalışmalar da önem kazanmıştır. Cesur ve ark. tarafından yapılan çalışmada, segman-silindir düzeneğinde yağlayıcı olarak normal makine yağı, dizel yakıt, yağ-dizel ve biyodizel seçilip aşınma ve sürtünme kayıpları ölçülmüştür. En kötü sonucu dizel yakıt verirken en iyi sonucu makine yağı vermiştir. Biyodizel ise dizel yakıtına göre aşınmaları azaltmıştır [10]. Aydın ve ark. segman-silindir düzeneğinde yağlama yağına %5 ve %10 oranlarda deniz suyu veya tatlı su karıştırıp sürtünme kayıplarını ölçmüşlerdir. %5 oranında deniz suyu karışımı sonucunda sürtünme kuvvetlerinin azaldığı fakat artan su miktarı ile sürtünme kuvvetlerinin arttığı gözlemlenmiştir. Yapılan Taguchi ve varyans analizleri sonucunda ise sıcaklık ve hızın sürtünme kuvveti üzerinde en etkili parametreler olduğu belirlenmiştir [11]. Savaş ve ark. segman-silindir düzeneğinde yağa yakıt karışımının sürtünme kuvvetine etkilerini araştırmışlar, kirletici cinsi ve yağlayıcı tipinin kritik öneme sahip olduğunu belirtilmişlerdir. Ayrıca yağa IFO 380 yakıtının karışması

yağlamayı iyileştirirken, MDO yakıtının karışması en kötü sonuçları vermiştir [12]. Kirlenen yağlama yağının özellikleri yağ içerisine katkı maddesi ilave edilerek iyileştirilebilmektedir. Özellikle son zamanlarda yağ asitleri, katkı maddesi olarak kirlenen yağ içerisine katılmakta ve sürtünme, aşınma performansları incelenmektedir [13]. Kirlenen yağ içerisine ilave edilen yağ asidi, karbon zincir uzunluğuna bağlı olarak sürtünme miktarının azalmasına sebep olmaktadır. Bu durum Van der Waals etkileşimi ile açıklanmaktadır. Aynı zamanda yağ asidinin doymamışlık derecesindeki artış veya hidroksil grubu ilavesi elektrostatik etkileşimin artmasına ve yüzeyde bir koruyucu film tabakasının oluşmasına sebep olmaktadır [14]. Hu ve Li yaptıkları çalışmada, tall yağ asidinin düşük sülfürlü dizelle karışımının aşınmaları ve sürtünmeyi azalttığını, dizel yakıtının fiziksel ve kimyasal özelliklerinde herhangi bir negatif değişim yaratmadığını tespit etmişlerdir [15]. Tall yağı ve türevlerinin dizel motorlarda da performans ve emisyon açısından test edilmektedir [16-19].

Denizcilik sektöründe SOx emisyonunun azaltılması amacıyla 2020' de uygulanacak olan regülasyon ile düşük sülfürlü yakıt kullanımına geçilecektir. Bu durumda gerek yakıt, gerekse yağlama yağının yağlayıcılığı konusu önem kazanmaktadır. Bu soruna çözüm getirebilmek amacıyla bu çalışmada, segman-silindir düzeneğinde yağlama yağına farklı oranlarda dizel yakıt karıştırılmış, farklı sıcaklık ve devirlerde kullanılan tall yağ asidinin sürtünme kuvvetleri üzerindeki etkisi araştırılmıştır. Katkı maddesi olarak kullanılan tall yağ asidinin sürtünme kuvvetlerinde iyileşme gerçekleştirmesi amaçlanmıştır. Deney verilerinin analizinde Taguchi L18 deney planı ve varyans analizi (ANOVA) kullanılmıştır.

2. Materyal ve Metot

Deneysel çalışmalarda kullanılan katkı maddelerinin sürtünme katsayısı üzerindeki etkisini belirleyebilmek amacıyla, Taguchi tarafından geliştirilen L18 ortogonal deney planı kullanılmıştır. Sıcaklık, devir, kirletici oranı ve katkı (tall yağ asidi) miktarı deneysel çalışma parametreleri olarak seçilmiştir. Sıcaklık 2 seviye ve diğer parametreler 3 seviye olacak şekilde deney planı hazırlanmıştır. Seçilen parametreler ve aralıkları Tablo 1'de verilmiştir.

Tablo 1: Seçilen Parametre Ve Aralıkları

Parametre		Seviye		
		1	2	3
A	Sıcaklık (°C)	80	120	-
B	Devir (rpm)	100	150	200
C (%)	Kirletici oranı	10	20	30
D	Katkı miktarı (%)	0	10	15

Taguchi deney tasarımında deney sonuçları sinyal-gürültü (S/N) oranı kullanılarak değerlendirilmektedir. Sinyal değeri sistem tarafından ölçülmek istenen gerçek değeri, gürültü faktörü ölçülen değer içerisindeki istenmeyen faktörlerin payını temsil etmektedir. Bu çalışmada minimum sürtünme katsayısına ulaşabilmek amacıyla en küçük-en iyi yöntemi tercih edilmiştir. Bu yönteme göre S/N oranını hesaplayabilmek amacıyla Denklem 1 kullanılmıştır. Deneysel çalışmalarda kullanılan deney planı ve elde edilen S/N çıktıları Tablo 2'de gösterilmiştir.

$$S/N = -10\log\frac{1}{n}\left(\sum y^2\right) \quad (1)$$

Tablo 2: L18 Taguchi Deney Planı ve S/N Sonuçları

Deney No	A	B	C	D	Sürtünme Kuvveti (N)	S/N
1	1	1	1	1	26,96	-28,61
2	1	1	2	2	21,77	-26,76

3	1	1	3	3	32,41	-30,21
4	1	2	1	1	18,63	-25,40
5	1	2	2	2	12,28	-21,78
6	1	2	3	3	19,51	-25,80
7	1	3	1	2	10,16	-20,14
8	1	3	2	3	12,41	-21,88
9	1	3	3	1	21,07	-26,47
10	2	1	1	3	26,81	-28,57
11	2	1	2	1	44,85	-33,03
12	2	1	3	2	44,74	-33,01
13	2	2	1	2	26,80	-28,56
14	2	2	2	3	29,70	-29,46
15	2	2	3	1	35,53	-31,01
16	2	3	1	3	11,97	-21,56
17	2	3	2	1	27,23	-28,70
18	2	3	3	2	26,29	-28,40

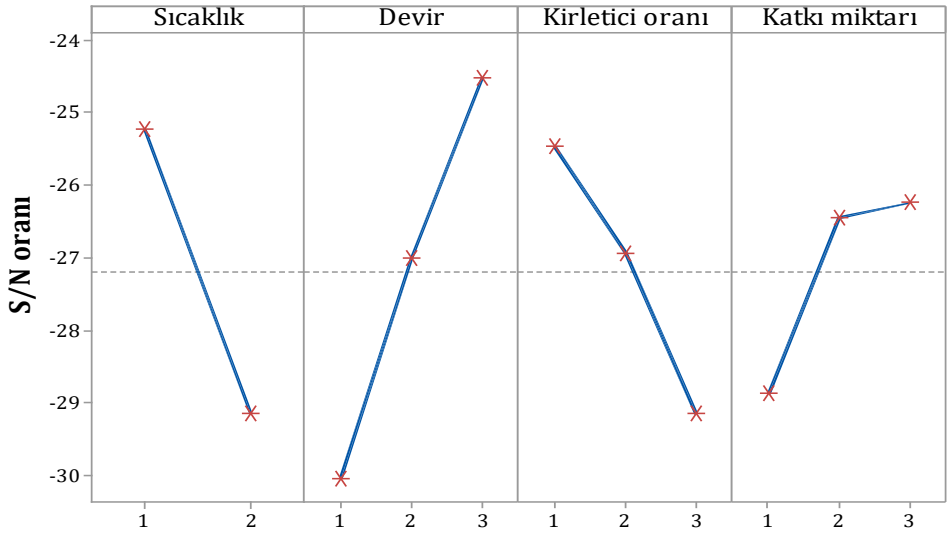
3. Sonuç ve Tartışma

Bu çalışmada Taguchi L18 ortogonal deney planı kullanılarak, sürtünme katsayısı üzerine; sıcaklık, devir, kirletici oranı ve katkı miktarının etkileri ve seçilen deney şartları içerisindeki optimum çalışma şartları belirlenmiştir. Aynı zamanda parametrelerin etkinlikleri, varyans analizi (ANOVA) yapılarak belirlenmiştir. Optimum sürtünme katsayısının S/N oranlarının belirlenmesinde, Taguchi tarafından önerilen en küçük-en iyi yöntemi kullanılmıştır. Elde edilen veriler Tablo 2'de verilmiştir.

Elde edilen bu verilerin her bir parametreye göre etkisi Şekil 1'de gösterilmiştir. Şekilden de görüldüğü gibi, sıcaklık ve kirletici oranının artmasıyla sürtünme katsayısının arttığı, devir ve katkı miktarının artmasıyla ise azaldığı belirlenmiştir. Şekilden görüldüğü gibi,

minimum sürtünme katsayısı; sıcaklık 80 °C, devir 200 rpm, kirletici oranı %10 ve katkı oranı %15 iken elde edilmiştir. Bu veriler belirlenen çalışma şartları içerisindeki optimum seviye olarak kabul edilmektedir.

Şekil 1'de ayrıca kirlenen yakıt içerisine ilave edilen katkı miktarının sürtünme katsayısını önemli ölçüde azalttığı görülmektedir. Yakıt ile kirlenen yağlama yağı içerisine ilave edilen yağ asitlerinde bulunan -COOH grupları ve -CH2- uzun karbon zincirlerinin polar bileşenlerine bağlanırlar. Katkı maddesi içerisindeki hidrojen bağlarının yüzey ile olan etkileşiminde yüzeyde koruyucu bir film tabakası oluşmaktadır [15]. Oluşan bu film tabakası sürtünme katsayısının azalmasına katkı sağlamıştır. Ancak katkı oranının %10 oranından % 15 oranına çıkarılmasıyla sürtünme katsayısında önemli ölçüde azalma meydana gelmediği görülmüştür.



Şekil 1: Kulanılan Parametrelerin Sürtünme Katsayısı Üzerine Etkileri.

Deneysel çalışmalarda belirlenen her bir parametrenin sürtünme katsayısı üzerine etki oranlarının belirlenebilmesi amacıyla %95 güven aralığında varyans analizi (ANOVA) gerçekleştirilmiştir.

Varyans analizi sonuçları Tablo 3'de verilmiştir. Varyans analizi sonuçlarına göre tüm çalışma parametrelerinin istatistiki olarak anlamlı olduğu tespit edilmiştir.

Parametrelerin sürtünme katsayısı üzerindeki etkinlik sırasının; devir, sıcaklık, kirletici oranı ve katkı miktarı şeklinde olduğu görülmektedir. Aynı zamanda bu parametreler; devir %37,01, sıcaklık %30,16, kirletici oranı %15,76 ve katkı miktarı %5,32 oranında bir katkıya sahiptir.

Tablo 3: Varyans Analizi (ANOVA) Sonuçları

Parametre	DOF	SS	MS	Fc	Fden	Etki (%)
Sıcaklık	1	541,4	541,4	4.96	36,45	30,16
Devir	2	664,5	332,3	4.10	22,37	37,01
Kirletici oranı	2	283	141,5	4,10	9,53	15,76
Katkı miktarı	2	157,9	79,00	4.10	5,32	8,80
Hata	10	148,5	14,85			
Toplam	17	1795,4				

R-sq:91.73

Ayrıca doğrusal regresyon analizi kullanılarak, sürtünme katsayısının, sıcaklık, devir, kirletici oranı ve katkı miktarına bağlı eşitlik (Denklem 2) elde edilmiştir.

$$\begin{aligned} \textit{Sürtünme katsayısı} = {} & 24,95 - 5,48 \times A_1 + 5,48 \times A_2 + 7,97 \times B_1 - 1,21 \times B_2 \\ & - 5,76 \times B_3 - 4,73 \times C_1 - 0,24 \times C_2 + 4,97 \times C_3 \\ & + 4,09 \times D_1 - 1,28 \times D_2 - 2,82 \times D_3 \end{aligned} \qquad (2)$$

Çalışmanın güven aralığını ve Taguchi deney planı kullanılarak elde edilen modelin yeterli olup olmadığını belirleyebilmek amacıyla doğrulama deneyleri yapılmıştır. Optimum şartlarda ve farklı parametre seviyelerinden elde edilen deney sonuçları Tablo 4'te verilmiştir.

Tablo 4: Tahmin Sonucu İle Deney Sonucunun Karşılaştırılması

Parametre	Optimum şartlar	1. Deneme	2.Deneme	3. Deneme
Sıcaklık (°C)	80	80	120	120
Devir (rpm)	200	150	100	200
Kirletici oranı (%)	10	10	30	20
Katkı miktarı (%)	30	10	10	0
Tahmin sonucu	5,16	12,25	42,10	27,52
Deney sonucu	6,74	12,57	44,74	27,24
Güven aralığı	0-15,48	1,93-22,57	31,78-52,42	17,20-37,84

Tahmin ile deneysel sonuçlar arasında %1 ila %6 aralığında hata olduğu görülmektedir. Doğrulama deney sonuçlarının, Taguchi deney planı kullanılarak elde edilen değerler ile uyumlu olduğu ve sonuçların güven aralığı içerisinde bulunduğu gözlemlenmiştir. Bu durum, parametre seçiminin doğru olduğunu ve parametrelerin iç etkileşimlerinin ihmal edilebilir seviyede olduğunu göstermektedir.

4. Sonuç

Bu çalışmada sürtünme katsayısı üzerine; sıcaklık, devir, kirletici oranı ve katkı miktarının etkileri Taguchi optimizasyon yöntemi kullanılarak belirlenmiştir. Deneysel çalışmalarda L18 ortogonal deney planı kullanılmıştır. Ayrıca katkı maddesi olarak tall yağ asidi kullanılmış ve etkileri araştırılmıştır. Elde edilen sonuçlar aşağıdaki gibi sıralanmıştır.

Yapılan optimizasyon çalışmaları neticesinde incelenen parametrelerin etkinlikleri belirlenmiştir. Parametrelerin etkinliği; devir, sıcaklık, kirletici oranı ve katkı miktarı şeklinde sıralanmaktadır. Devir %37,01, sıcaklık %30,16, kirletici oranı %15,76 ve katkı miktarı %5,32 oranında bir katkıya sahiptir.

Optimum deney şartları için parametre seviyeleri; sıcaklık 80 °C, devir 200 rpm, kirletici oranı %10 ve katkı oranı %15 olarak belirlenmiştir.

Aynı zamanda yakıt ile kirlenen yağlama yağının içerisine ilave edilen tall yağ asidinin sürtünme kuvvetlerini önemli ölçüde azalttığı tespit edilmiştir.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

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Criteria Comparison of Companies Which Have Different Tonnage of Vessels for BWTS Selection

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ABSTRACT

In February 2004, IMO adopted International Convention on the Control and Management of Ballast Water and Sediments of Ships - BWM Convention to regulate the environment from the ballast water of the ships. In D Section of this convention, discharged ballast water standards have been defined. While D1 standards means "Ballast water Exchange Standards", D2 means "Ballast water performance standards". Although, IMO issued a deadline for conformity of D1 & D2 standards for vessels in convention, due to delayed entry in force date of convention, this time line has been updated in MPEC 71. There are a wide variety of treatment options and manufacturers. The choice of appropriate methods & manufacturers will depend upon several factors, including vessel sailing area, vessel tonnage, age, the length of voyages, costs of systems, OPEX etc. Moreover, systems shall have a type/approval certificate which must be issued according to IMO G8 & G9 guidelines. However, an IMO approved BWTS is not enough to discharge ballast water in U.S. waters. USCG has its own specific test and approval procedures for BWTS. In the light of above information, some owners, whose vessels do not sail to US waters, do not request a USCG approval certificate for BWTS. On the contrary, USCG certificate is essential for some owners. This research is to compare these owners BWTS choice depending on trade area, vessel size & age. For this purpose, a decision making questionnaire has been prepared and filled by companies which have different size & age of vessels.

Keywords: Ballast Water Treatment Systems, Ballast Water Management Systems, BWT.

1. Introduction

IMO has started to take measures to minimize the spread of invasive species with ships' ballast water. For this reason, International Convention for the Control and Management of Ships' Ballast Water and Sediments (the Ballast Water Management Convention) have been accepted at 13 February 2004 [1].

As per Article 18 of Convention; it shall enter into force twelve months after the date on which not less than thirty States, the combined merchant fleets of which constitute not less than thirty-five percent of the gross tonnage of the worlds merchant shipping, have either signed it without reservation as to ratification, acceptance or approval, or have deposited the requisite instrument of ratification, acceptance, approval or accession in accordance with Article 17.

According to Convention; ships 400 gross tons and more, Ballast Water Management Plan and Ballast Water Records shall be on board. Vessels shall perform ballast water management according to D-1 (Ballast water exchange) and / or comply with D-2 (Ballast water performance) standards [2].

An accession by Finland has triggered the entry into force of convention which will contribute to the protection of the environment by preventing the spread of potentially harmful aquatic organisms in the ballast waters. It became an important turning point in terms of stopping the spread of invasive aquatic species [3].

According to convention, ships must follow a Ballast Water Management System. The ship's time line to implementation was varied according to the ship's construction year and ballast capacity. However, this time line has been updated for the existing ships (Existing vessel) as per the decision taken on IMO MEPC No. 71 because of postponed entry into force date of convention and preventing the accumulation of vessels in the shipyards. According to MEPC No 71, Lloyd's Register announced and prepared a time line (Table 1) for its costumer in order to help companies understand time line better [4].

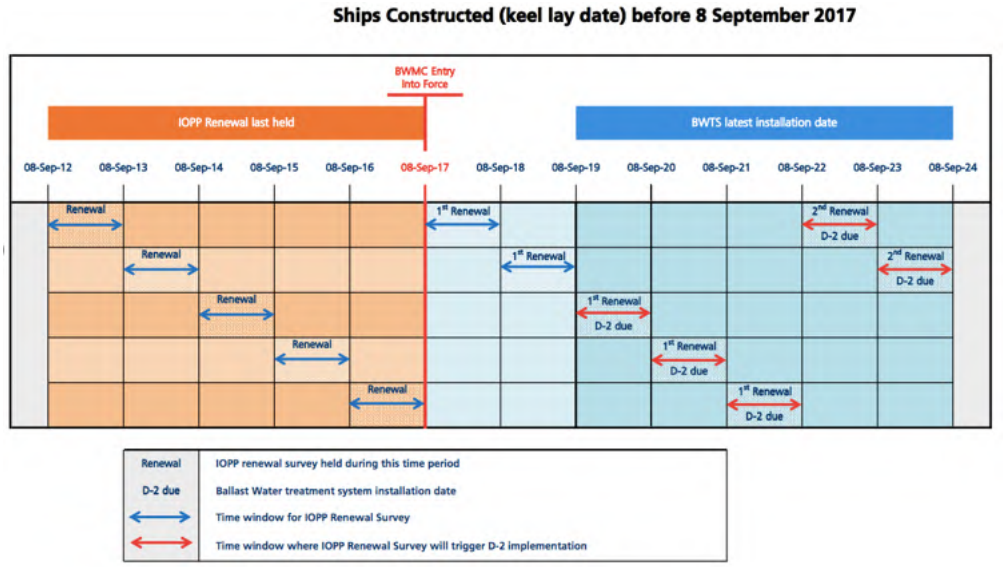

Figure 1: Timeline Issued by LR as per MEPC No:71 for Existing Vessel

As can be seen in the table, all vessels must meet the D-2 standard as per the latest IOPP certificate renewal date, but not later than 08 September 2024.

a. D-1 Standard

Today, the recommended method for controlling the spread of harmful aquatic organisms is ballast water exchange. This change is carried out in open sea water (200 miles and 200 m depth from the nearest land, if 200 miles is not possible, it must be minimum 50 miles). With empty and refill or flow through dilution method [5].

According to the D-1 regulation of the ballast water management convention, a vessel applying this method must replace at least 95% volume of the ballast water in tank.

In order to meet D-1 standard with the ballast water change, a vessel that selects flow through method must pump in sea water to the tank up to 3 times the volume of the tank. However, pumping with less than three times the volume can also be accepted if the ship proves that the volume change is at least 95% volumetric.

As known; especially in Black Sea ports, ships are strictly controlled whether they have made this change before they arrive at the port after entering the Black Sea, in some cases

ship/shipowner find themselves in very difficult situations. B-4 Ballast Water Exchange Article of Convention states that the ship does not change its course for this change or cause any delay, but it is known that ballast water which has not been changed before ports which are on Black Sea coast cause big problems.

b. D-2 Standard

The D-2 standard specifies the bacterial / virus types, sizes and amounts that can be included in the ballast water to be discharged, unlike ballast exchange. A ship must have ballast water treatment system (BWTS) in order to meet these requirements.

Table 2: D-2 Standard

Organism	**Regulation of discharge ballast water**
Phytoplankton/zooplankton ≥ 50µm	<10 viable organisms per m3
Phytoplankton/zooplankton 10-50µm	<10 viable organisms per ml
Toxicogenic Vibrio cholera (O1 and O139)	< 1 cfu per 100 ml
Escherichia coli	< 250 cfu per 100 ml
Intestinal enterococci	< cfu per 100 ml
Cfu : colony forming unit	

In order for BWTS to prove that the water they will discharge is in compliance with the D-2 standard, BWTS must complete the test procedures specified in the IMO's G8 and / or G9 guidelines. After receiving the type/approval certificates through the procedures specified in these guidelines, then BWTS obtain the IMO approval (Class Type Approval Certificate) [6].

However, USCG has its own ballast water standard, test procedure for BWTS and USCG approval for these systems. Although the water standard to be evacuated is very similar to IMO, "viable" term was used in IMO rule, while "living" term is used in USCG. USCG

states that it is very difficult to test the viability of organisms. However, due to differences in test procedures, many systems approved by IMO have not received USCG approval [7].

Table 3: Differences in Test Procedures

	IMO G8/G9	USCG
Discharge standars	<10 viable / m^3	<10 living / m^3
Shipboard testing	3 test cycles	5 test cycles
Holding time	>5 days	>24 hours
Component / Environmental	2 h vibration endurance test	4 h vibration endurance test

USCG issued an AMS (Alternate Management System) certificate for 5 years to the systems approved by IMO and authorized the use of these systems for 5 years in US waters. However, within 5 years if this system does not receive a USCG certificate, the ship will not be able to discharge ballast by using this system in the US Waters [6].

When the ship sailing area is considered for choosing a system, a shipowner can choose a system which hold only IMO approval, Hereby, system installation cost will significantly reduce. In addition, certain vessels sailing between certain ports, are discussed in the convention A-4 Exemptions article. According to this rule vessels meeting the following conditions, can get an exemption [2].

1. "Granted to a ship or ships on a voyage or voyages between specified ports or locations; or to a ship which operates exclusively between specified ports or locations;
2. Effective for a period of no more than five years' subject to intermediate review;

3. Granted to ships that do not mix Ballast Water or Sediments other than between the ports or locations specified in paragraph 1.1; and
4. Granted based on the Guidelines on risk assessment developed by the Organization. "

When the conditions of exemption above are considered, only a ship that sails within same area (For example Marmara Sea) may not install BWTS with the exemption. However, as it is seen, this exemption is given for 5 years and every 5 years, it will be decided by the Administration whether the exemption will be continued.

A shipowner whose vessel operates between different regions / ports may not be exempted, so he must install BWTS on his ship in accordance with the time limit given in Table 1 regardless of the tonnage and age of his ship.

2. Dominant BWTS Technologies in Market

Currently on market, there are BWTSs using different methods offered to the shipowners, and during the shipowner selection phase, it is necessary to make a selection by evaluating the parameters of the sailing area, ports, installation cost, the advantages / disadvantages of the systems, maintenance period cost..etc.

Nowadays, there are many technologies in ballast water treatment in the world market. However, the choice of technology for aquatic organisms is very important. For example, a filter system is recommended to prevent the ingestion of large organisms into ballast tanks, while a chemical or physical treatment system is required to prevent the microscopic size of organisms. However, a system using a single method is not suitable for environments that operate under different conditions, such as ships. Therefore, many BWTS uses another method selected with filtering. Thus, each stage targets different types.

Unfortunately BWTS assembly (retrofit) on an existing ship is a more complex and costly operation, , due to reasons such as limited space and increased works. In this respect, ship

owners purchase consultancy services from some companies for 3D scanning, plans drawings..etc. [6]

The strengths and weaknesses of the methods used by manufacturers who are dominant in the market nowadays and who have received the necessary certificates will be discussed. It should be noted that almost all of the manufacturers using these methods have 40-50 μm filters with automatic back flushing.

a. UV Technology

UV method is used to prevent the growth of these organisms by damaging or killing organisms such as phytoplankton, zooplankton, human pathogens and bacteria. The efficiency of the system depends on the turbidity and conductivity of the water.

Limitations and advantages of the UV method are listed as follow.

Limitations;

- Additional system is needed to more effectively treat ballast water.
- Ballast water, that is treated, should have a quality to able to pass UV light. A high turbidity will reduce the effect of UV. UV systems in fuzzy waters may not work effectively.
- Some antioxidants in the water may prevent the killing of harmful aquatic organisms. The high amount of chemical oxidants used may have the same effect.
- Heavy metal ions (less than 10mg / l), oil and grease in the water to be treated may cause deterioration of the UV lamps or crystals.
- Large amounts of energy are required to obtain UV light. Some ships may even require an additional generator.
- Change of UV lamps in case of problem is high cost.
- UV systems have to be used during both ballasting & deballasting.
- Repair and maintenance by ship personnel is not known at present.
- If the system uses oxidized chemicals, they must be kept on board and secured.

Advantages;

- The UV system does not corrode or cause any corrosion
- The UV system does not need to store any harmful materials, chemicals for operation.
- There is no overdose in the UV system.
- Organisms do not show resistance to UV system.
- UV does not require dilution of water.
- UV system is not effected from ph, salt, temperature of water.
- UV is a system without side effects.

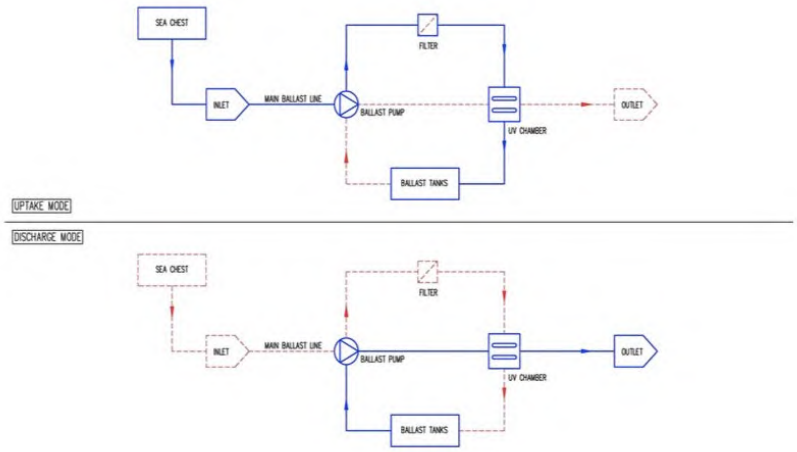

Figure 2: Aquarius UV BWTS Line Plan [9]

b. Electrochemical / Chemical Injection Technologies

Ballast water can be treated with chemicals, active substances or electrochemical methods. Caution should be exercised when using active substance. Because the active substance, can harm human health as well as the living organisms in the water. Sodium hypochlorite, chlor dioxide, hypochlorous acid, ozone and hydrogen peroxide are generally used as active substances. [8] In chemical Injection method, active substance can inject main ballast line directly. In electrochemical method, this active substance can produce in a generator by using sea water on board with sufficient salinity. If necessary, the active substance must be neutralized before the ballast water is discharged into the

environment. The proportions of the active substance and the neutralizing agent (if any) should be specified in the type approval certificate of the BWMS. [6]

While in some systems, all water which pass inside main ballast line is treated, in some systems a side streaming line is used to direct the water into the generator. After active substance is produced in generator, the water with active substance is injected into main ballast line.

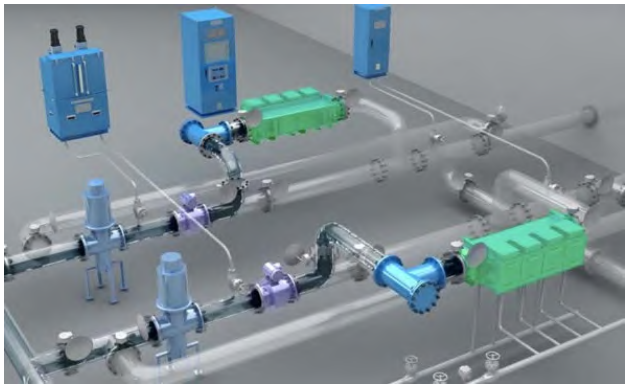

Figure 3: Techcross BWTS That Treated Water in Main Ballast Line [10]

Figure 4: SunRui Balclor BWTS with a Stream Line [11]

Limitations;

- Chemicals have toxic effects on humans and the environment in which they are released.

- Chemicals have a burning effect on people.
- Chemicals cause wear on the ship's metal body over time.
- Different levels of toxic chemicals can react with each other.
- Undesired gases may occur.
- Systems with a time limit in USCG approval are not suitable for ships operating with short voyages in the US waters.
- Advantages;
- The system using chemical injection method can be easily installed with a feed pump attached to main ballast line. No major changes are needed in the main ballast circuit.
- Maintenance costs are low.
- Most of the chemicals have been tested and found to be effective.
- Chemical injection method consist of a tank and feeding pump. That's why, energy consumption is very low.
- Only the neutralization pump is activated during ballasting if active substance is not within the limits.
- Chemical injection method has been used for many years in pool water, public water treatment [6].

3. Method

In this study, it will be compared the companies' criteria for choosing the right BWTS for their fleet. One group consists of companies which have vessel fleet of 6000 DWT and more, while the other group consists of companies which have vessel fleet of less than 6000 DWT.

For this purpose, a questionnaire has been prepared and filled by inspectors of companies (Mainly technical department inspectors & owners). The company representatives have been asked to mark how important related criteria is in "1-9" scale. A criteria which has a value between 1-4 will be considered as "Slightly important". While criterias with value

between 5-7 can be seen "Important", criterias with more than 8 point can be considered as "Very important".

The criterias were mainly about installation & operating costs, using periods of system, energy consumption, temp&salinity effects.

4. Findings

For all companies, installation cost, OPEX, energy consumption, nott using system during both ballasting & deballasting, turbidity effects criterias and corrosion effect are most important factor for choosing BWTS.

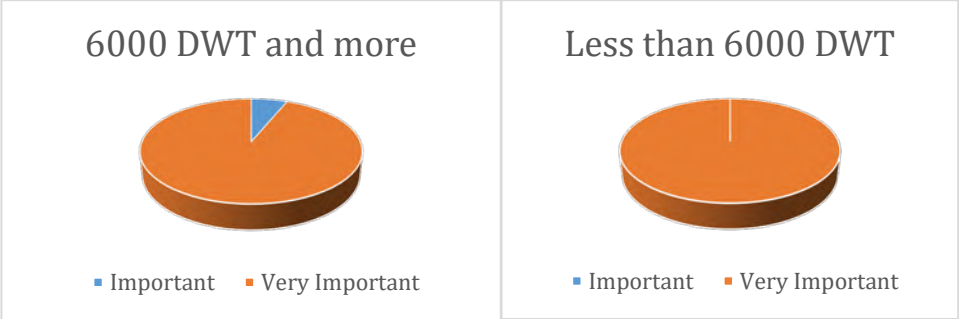

Figure 5: Installation Cost Criteria Values for Companies

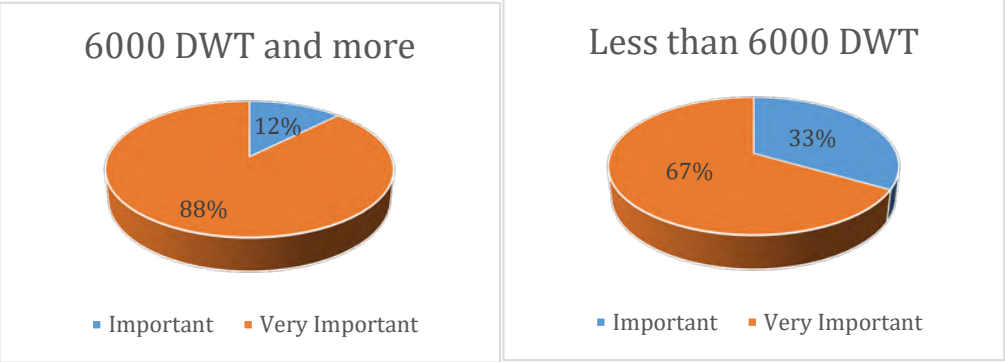

Figure 6: OPEX Criteria Values

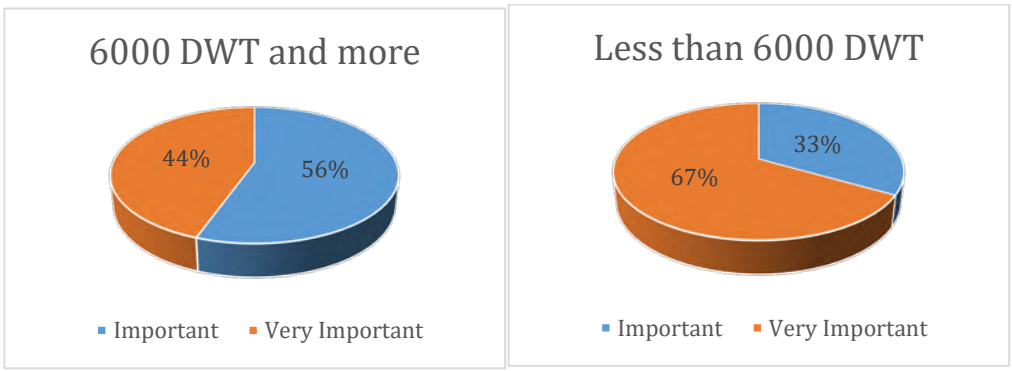

Figure 7: Energy Consumption Criteria Values

Main difference between companies which have different sizes of vessel is to request USCG approval of system. The average USCG requisition value of companies (Less than 6000 DWT and sailing areas are out of US water) is around 20%. On the other hand, the average value of companies (6000 DWT more and sailing areas are US water or there is a possibility of sailing US waters) is more than 85% which can be evaluated as an essential criteria.

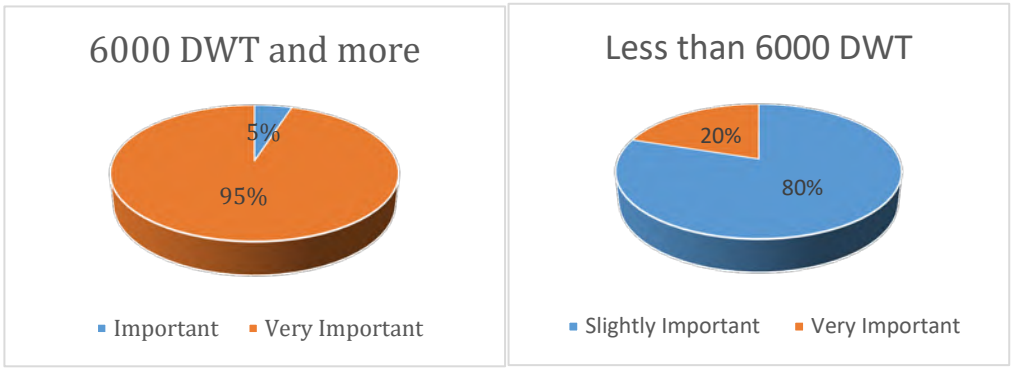

Figure 8: USCG Requisition Criteria Values

The other difference is manufacturer reputation. 62% of companies which have fleet 6000 DWT and more considered this criteria as very important, while manufacturer reputation is not important for 67% of coaster companies participants.

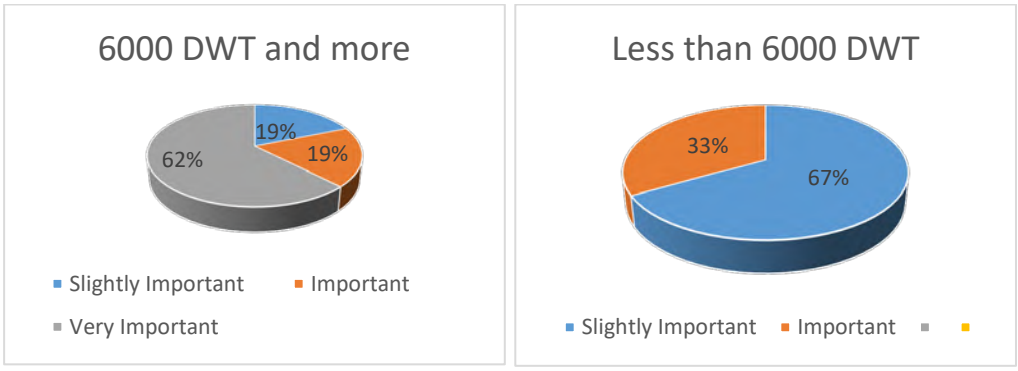

Figure 9. Manufacturer Reputation Criteria Values

5. Conclusion

Choosing most correct BWTS for a vessel is a very challenging process. For this purpose, companies must consider their criteria. Different manufacturer & different methods have their own strength and weaknesses. As a result of questionnaire which have been filled by companies having different sizes of vessel, it is seen that priorities can vary as per vessel size and sailing area.

Table 4: The Most Important Criteria's

6000 DWT and more	Less than 6000 DWT
• Energy consumption, • System using during ballasting&deballasting, • Warranty, • Installation cost (Including system price), • Service after sale, • Spare parts quality and availability, • USCG approval,	• Payment conditions, • Warranty, • Installation cost (Including system price) • Line updates, • Service after sale, • Spare parts quality and availability, • Working effective under turbidity condition,

• Working effective under turbidity condition, • User friendly during operation and maintenance, • OPEX. • Corrosion effect of BWTS	• OPEX. • Corrosion effect of BWTS

Cost is main common criteria for both group of companies. Cost means not only installation cost but also OPEX, warranty, spare parts prices ..etc. While the company with large vessel has an intention to use original spare parts at all times, coaster owners want to have a chance to use sub-industry parts for reducing OPEX.

Corrosion effect of BWTS is an unwanted side effects for all companies. This criteria is leading most of owners to UV technologies, despite UV systems energy consumption is high and they must be used during both ballasting & deballasting.

Main difference between companies which have different sizes of vessel is to request USCG approval of system. Companies which have fleet 6000 DWT or less does not need (even does not request) USCG approval for BWTS. Because if a system has a USCG approval, installation cost becomes quite higher.

Moreover, companies with large vessel prefers the system of manufacturers which are known on maritime sector for years. However, coaster companies are ready to try a new brand production with an acceptable price.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

A Comprehensive Study On Assessment of Safety Climate Based On Theory of Planned Behaviour in Maritime Domain

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ABSTRACT

An understanding of risk concepts has become rather important for determining the causes of work accidents and preventing possible losses, especially within the maritime domain. Earlier researches in the area have commonly based on organizational culture and the analysis of relations among dimensions of safety climate. The focus must therefore shift towards the human factor, seafarers as well as their perceptions of safety and risk behaviour. This study aims to clarify the sub-factors of risk behaviour and safety violations with an innovative approach. In this respect, besides the assessment of safety climate, the factors that affects the individual's attitudes, perceptions of the risk and risk behaviours has been contextualized in the scope of the study. As a pre-study of a large-scale research project, a comprehensive model based on the Theory of Planned Behavior for assessing attitudes and behaviours has been developed as a safety climate assessment tool. Information gathered through the literature review indicates that the model is a functional tool giving an overall measure linked with occupational risk behaviour and safety climate. The model highlighted that the management's attitude to safety directly affects seafarers' occupational risk behaviours. In sum, the purpose of the study is to identify the factors that contribute to a better safety climate on board ships. Results of the study provide supportive information on occupational risk behaviour management especially for maritime organizations as well as safety climate assessment. Then again,

the study contributes to organizations for enhancing their behaviour based safety training programme for seafarers.

Keywords: Human factor, Risk Behaviour, Theory of Planned Behaviour, Safety Climate

1. Introduction

Shipping is an international and one of the most dangerous industry including high-level risks in the World. The concept of safety and risk therefore become more important in the Maritime domain. IMO (International Maritime Organization), as a global standard setting authority for the safety, security and environmental performance of international shipping, emphasized that at least 80% of shipping casualties are related to the human element [1,2]. Accordingly, the role of the human element should entirely be considered in the development of maritime safety and reducing marine accident and their unintended consequences.

Safety culture, is an integral part of an organization's safety management system that consists of values, beliefs and attitudes [3]. Therefore, an assessment of safety climate being as distinguished from the perceptions, attitudes and behaviors of seafarers will lead to an insufficient detection. An important goal of an organization's positive safety climate is to reduce incidents and accidents by affecting safety behavior [7]. Many studies have demonstrated that safety climate is an early warning indicator of safety issues and significant predictor of safety performances for organizations [18].

This study investigates the relationship between safety climate and safety behaviors of seafarers. The main objective of the study is to develop a comprehensive measurement model assessing the attitudes, behaviors and perception of seafarers about safety as an indicator of the safety culture of maritime organizations. The model highlights that both shipping company's and ship management's attitude to safety have a profound effect on seafarers' attitudes to safety and occupational risk behaviors [2].

2. Safety Culture and Safety Climate

The term safety culture first appeared in the IAEA's (International Atomic Energy Agency) accident report after the Chernobyl nuclear power plant disaster in 1986 [8]. Safety culture and the concept of Safety Climate, which was firstly asserted by Zohar [12], are generally considered as the comprehension, internalization and implementation of the

safety for each member in an organization [9]. Nevertheless, these related terms have differences in certain points.

Zohar [12] defines the safety climate as a summary of the beliefs and perceptions that employees share about their work environments [8]. Safety climate can be considered as a surface characteristics of the safety culture distinguished from the attitudes and perceptions of the workforce at any given time [10]. It is a superficial concept that describes the current state of the organization related to safety issues. Accordingly, safety culture is comprehensive term including safety policies and safety climate assessments.

Measurement of the safety climate is a crucial step to raise an awareness toward safety and make work environments safer on board ships and in the maritime organizations. Therefore, assessment of safety climate is a core activity for organizations besides other internal audits [19]. Hofman and Stetzer [13], identify the employees' attitudes and behaviors as a micro elements of an organizations. The level of safety priority within the organizations will influence both ship management's and seafarers' safety behaviors, accordingly. That's why safety climate assessment that comprise of attitudes and perceptions of seafarers is such crucial as a guide for maritime organizations.

3. The Key Components of the Safety Climate

The safety climate assessment process that is developed from the relevant literature on organizational safety culture and safety climate includes three key components. The components are examined as a three separate stages of the safety climate assessment process in the study; Risk perception variables, safety climate attitude dimensions and occupational risk behavior variables.

3.1. Risk Perception

Risk perception is a subjective assessment of the likelihood of occurrence of a specific accident or incident and to what extent we are concerned [11]. Researches on risk perception basically examines how individuals assess the risk, how they make their own decisions related to risk and the consistence between the current risk level and the risk perceptions of individuals.

The maritime industry has a history of considerable amount of tragic events and seafarers are continuously exposed to a high-level risks due to nature of the work. Therefore, the contribution of the risk perception level cannot be underestimated in determining the seafarers risk behaviors and safety attitudes onboard. Berg emphasized that the risk perceptions and safety behaviors of seafarers are highly important for organizations to better understand their approach to safety management and to improve safety culture level [20]. Additionally, Rundmo [14] stated that there has been a shift from psychological descriptions to sociological and organizational frameworks for understanding risk perception and safety behavior in the risk studies. For this reason, evaluations of employees' risk perceptions and safety behaviors without involving organizations safety climate assessment will not be significant enough. In the study, factors influencing the risk perception of seafarers will be examined under the two main heading that also indirectly influence the safety behaviors and safety climate assessments.

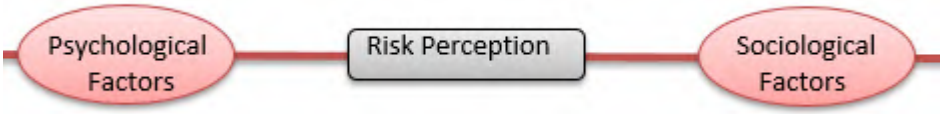

Figure 1: Factors Affecting İndividuals' Risk Perception.

3.2. Attitude to Safety

Attitudes of seafarers are important indicator to explore the link between behavior, attitude and safety climate. When provide training to change attitudes it is important that the safety culture of ship management is consistent and congruent so that seafarers can form a single attitude about safety. Management should be in co-operation focusing on improvements, rather than asking seafarers to change their attitudes directly.

Within the work group, seafarers' attitudes and safety related behaviors can be intensely affected by organizations attitude to safety. The flow of impact of organization related to safety is observed clearly in the figure 2.

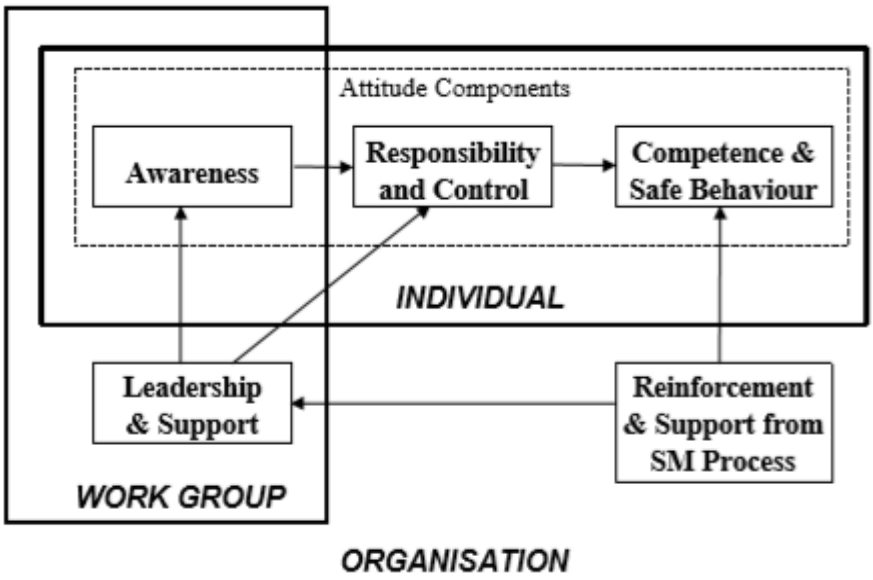

Figure 2: The Impact of Organization On Indıvıduals' Safety Attitudes [16].

Attitude measurements are obtained from seafarers regarding their views on and feelings about safety on board, using attitude measurement questionnaire. The questionnaire covers four main area [16] that are given below;

- Organizational Context,
- Social Environment,
- Individual Appreciation,
- Work Environment.

Each area comprise of related dimensions. According to Organization's Specific Structure description of each dimension under the related area is determined properly.

a. Occupational Risk Behaviors

Examination of occupational risk behaviors is the other stage of the safety climate assessment process in the study. Behavioral indicators of safety climate help organizations to identify the major factors in accidents and incidents as well as enabling

yet another route for continuous improvement [16]. Therefore, risk behaviors of seafarers are provide an insight to managers of how the company is behaving related to safety issues and to what extend safety culture of management influence seafarers.

In this stage of the assessment process, occupational risk behaviors are examined. Assessments are achieved both using a questionnaire that comprise of occupational risk behavior variables and through observing accident and near-miss incident reports and safety inspections of the shipping companies.

4. Interaction Between the Components of Safety Climate

The Theory of Planned Behavior is the most widely used and empirically tested social psychology theory that measures the relationship between attitude and behavior [5]. The theory of planned behavior offers that behavior is dependent on individual's intention to perform the behavior [6].

Ajzen hypothesized that attitudes frequently fail to display strong correlations with behavior due to the large number of factors [17]. These factors are captured under the main components of the Theory that are shown in the Figure 3.

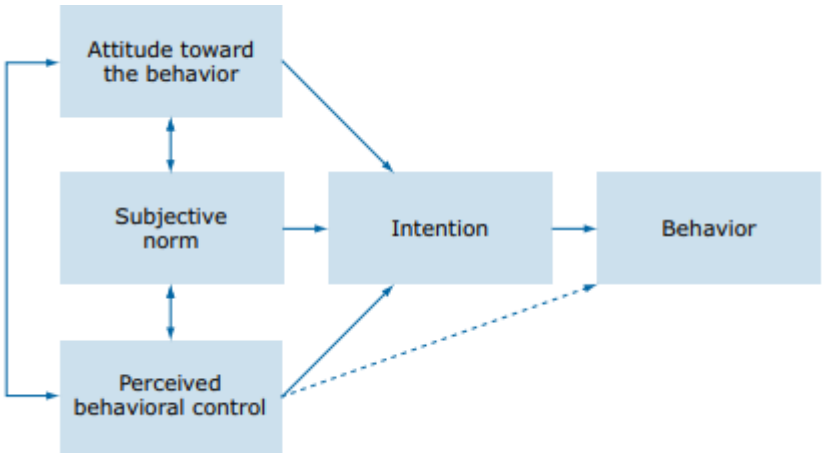

Figure 3: Model of Theory of Planned Behavior [4].

According to the Model of Theory of Planned Behavior, it is observed that any change of the attitude toward the behavior firstly affects the intention and then turns into permanent behavior over time.

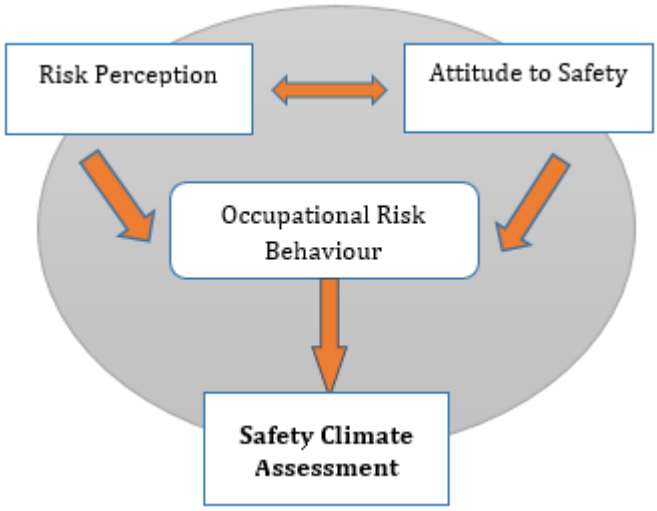

Figure 4: A Comprehensive Assessment Model Based on the Theory of Planned Behavior.

The comprehensive assessment model derived from the Theory of Planned Behavior is developed to improve the effectiveness of the study. Safety attitudes and the safety climate have been found to be associated with risk perception as well as risk behavior of employees in the previous researches [14, 15]. In this context, model in the study intends to measure the relationship between attitude, behavior and perception as a comprehensive safety climate assessment.

5. Conclusion

In determining the safety culture level of the maritime organization and in understanding the safety climate on board the ship, risk perceptions, attitudes and the behaviors of seafarers are crucial factors in assessing safety needs.

The study highlights that safety policy should be continuously underlined and improved in the organization and the resources should be allocated to directing the seafarers'

behaviors effectually. As it is seen in the study, the primary factor that affects the seafarers' attitude to safety and risk behaviors is a better safety climate on board ships. Safety awareness and risk perception level can be promoted within the ship through ship management safety policy and training programs. Awareness shapes individual attitudes to safety and perceptions of responsibility and safety behaviors.

This study provides a supportive information on comprehensive safety climate assessment. The method based on the Theory of Planned Behavior generates the safety climate profile of an organization and produce tangible outputs for correcting any deficiencies within the organization. Accordingly, it is believed that the study will contribute to maritime organizations for enhancing their risk and safety management system besides their behaviour based safety training programme for seafarers. In the future studies, safety climate should be evaluated with an involvement of different organizations in maritime industry and safety climate assessment of different transportation industries should be taken in consideration to make comparison. Furthermore, occupational risk behaviours of seafarers should be evaluated by both direct and indirect observation besides survey method.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

A Review on Practicality of Cognitive Performance Tests in Deck Officer Selection

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ABSTRACT

In the globalizing World, the importance and frequency of maritime transportation have increased drastically. As a result of these increase, seafarers onboard ships have been put in a situation where their working environment have become more compelling than it was before with the increased working hours, lesser rest times, more frequent operational periods and lesser employment. These factors may transform into stressor factors on top of the psychological toll of working onboard ships. Therefore, seafarers' certain abilities may deteriorate which may become the main cause of maritime incidents. This occurrence has been defined as human factor. IMO (International Maritime Organization) has stated that the majority of the accidents harmful to economy, environment and well-being of humans are based on human errors. One of the deteriorating ability types are the cognitive abilities. Cognitive performances are affected by factors causing stress and anxiety on human beings. Ship being a complex and compelling working environment, creates these stressor factors naturally. Therefore, a cognitive performance evaluation prior going onboard ships, may help on choosing the competent seafarers for such working environment. In this study, cognitive performance

concepts, criteria and utilization of cognitive performance tests has been described. Applicability of cognitive performance tests in maritime officer selection is reviewed and suggestions have been made for developing such test specified to the maritime sector.

Keywords: Maritime Transportation, Cognitive Performance Test, Maritime Officer Selection

1. Introduction

In the wake of globalization, with the development of new transportation nodes, new technologies and improvements in present utilized models and technologies, the requirement for maritime industry have been increased. Because of the competitive environment that has emerged related to the requirement for maritime industry has created a threat for both maritime safety and safety of navigation. In the light of the events with severe consequences in maritime sector (i.e. Titanic, Exxon Valdez, and Torrey Canyon) has resulted in the emerging of new regulations and has caused the revision of the existing ones. These revised and new regulations comprise of technical standards and economic planning mainly, although human factor is the primary cause of the major accidents that was damaging World economy, environment and humanity [1].

Human element is very crucial in the shipping's systematic design and its operations. Human element is relevant beginning from the design, idea and building process throughout a ship's life [2]. In maritime sector, the awareness of human element dates back to 1550s but had come forth more in the 1970s when ships started going missing. Besides the technical issues that caused the incidents in maritime transportation, concepts such as exhaustion, inattention etc. are found to be causes of incidents regarding human element framework [3]. Additionally, psychological and physiological stressor factors occur because of onboard working environment and sea conditions [4].

In a discipline such as maritime transportation which environmental effects such as noise and ship motion on sea and organizational and operational factors such as working hours, number of onboard personnel and consistency of port of calls on top off the effects of psychologic restraints may not only cause accidents with severe consequences, also impacts the well-being of people in negatively, human element or human factor is a very top-line subject in consideration with maritime industry and maritime studies.

Humans, as a functional element of a structure, can make mistakes. The severity of the consequences and the types of mistakes are both a function of a task's parameters meaning that the severity of consequences and the type of a mistake defined by the

working environment, workload and physiologic and psychologic condition of a worker. Considering these parameters, errors based on human element originate from the loss or disconnection during perception, processing of external data and responding after its transformation to information. Dialectic and task completion is actually the capacity needed for purposive information processing and this capacity is defined as cognitive ability [5, 6].

Cognitive science investigates the structure and elements of a system. Stress, regarding biology and behavioral sciences, is defined as physical, biological and psychological state of living beings that cannot be controlled by themselves while causing adaptation issues. Since shipboard environment is a close and complex system, stressor factors this environment causes affect cognitive processes involving seafarers' information cycle directly. This is one of the reasons human element based errors widely emphasized on maritime studies [7].

Considering the involvement of cognitive skills onboard environment and their effects on safe shipping practice, maritime transportation industry and cognitive evaluation should be in correlation. Although there has not been a standard for cognitive performance evaluation set for the maritime industry, for other occupations related to transportation such as pilots, astronauts, drivers, a various cognitive performance tests with approved reliability-validity have been performed currently.

This study is intended to be informative and descriptive regarding concept of cognitive performance tests in maritime transportation field and utilization in deck officer selection. In the study, criteria for cognitive performance evaluation have been evaluated according to the literature and terms such as cognition, cognitive sciences and cognitive performance tests explained. After that cognitive performance tests' application in various fields regarding transportation is explained and cognitive performance tests' and maritime transportation relation is stated in accordance with the literature. Following that, cognitive performance tests are suggested as a deck officer selection criteria with

further suggestions for a framework of a cognitive performance test specialized for maritime sector.

2. Cognitive Performance Test Criteria

Cognition, as a term, has been defined many times but in its simplest definition, cognition is the ability to process the information through perception or everything an individual perceives or knows. Accordingly, cognition is the system composed of these capabilities. Cognitive abilities is defined as the capability of generating information, processing information and transformation of the results in order to receive input from external context [8]. Cognitive abilities are coded into the memories of humans and are related to the previous experiences [9, 10].

Cognitive abilities described with four capabilities:

- Ability to obtain information
- Fast learning ability
- Ability to adapt to unknown situations
- Ability to structure information for future use [11].

Due to environmental, mental and physiological differences; the cognitive abilities stated above would also influence cognitive processes.

Cognitive processes enable information transferring from sensory recordings to short term memory, information storage in the short term memory and information transfer from the storage to long term memory. These processes can be listed as; attention, perception, coding, repetition [12]. Neuropsychological tests enables cognitive screening. These tests are composed of basic queries that assess specific cognitive skills.

Cognitive tests originate from neuropsychological evaluation. Neuropsychological evaluation can be defined as the activities composed of disorders emerging in the brain with psychological and behavioral situations with the inclusion of evaluation of memory, attention, managerial functions, visual and spatial functions and language. In such tests, cognitive disorders occurring because of functional disorders that is developing in the

brain is given a weight or a score [13]. With neuropsychological tests examining regions located outside the movement and sensory function of the brain is enabled by measuring changes in cognitive functions' performance [14].

For proper evaluation of cognitive abilities, considerable amount of studies have been carried out to design questions. Cognitive tests had emerged from paper and pencil tests. These test considered advantageous for being user friendly regarding the age of participants; but, variety of questions was restricted due to using paper. With computerization, cognitive tests were able to be digitalized. Computerization improved the spectrum of questions by utilization of multimedia components and evaluations results were able to be stored on digital media, causing analyzing and re-utilizing the data to be easier. However, with computerization, user friendly and age friendly aspect of paper and pencil tests diminished. Such tests was found difficult on application to elderly individuals which resulted in computerized neuropsychological tests' application to become limited. Some of the widely used cognitive performance tests are given in Table 1 [14] below.

Table 1: Cognitive Performance Tests and Evaluation Criteria.

Cognitive Performance Tests	**Evaluation Criteria**
Automated Neuropsychological Assessment Metrics	Memory, attention, psychomotor speed, language, reaction time.
Computer Administered Neuropsychological Screen for Mild Cognitive Impairment	Memory, language, executive functions.
Cambridge Neuropsychological Test Automated Battery	Working memory, attention, visuo-spatial memory.
CNS Vital Signs	Memory, psychomotor speed, processing speed, cognitive flexibility, sustained attention.
Computerized Neuropsychological Test Battery-CNTB	Language, information-processing, motor speed, attention, spatial, memory.

CogState-CGS	Working memory, executive function, attention, reaction time.
Cognitive Stability Index-CSI	Memory, attention, response speed, processing speed.
Mild Cognitive Impairment Screen-MCIS	Memory, executive function, language.
MicroCog	Memory, attention, reaction time, spatial ability, reasoning/calculation.

Accordingly, cognitive performance tests have been found to be utilized in evaluation of following criteria in their intersection:

- Attention
- Concentration
- Reaction time
- Memory
- Processing
- Decision making
- Executive Functions
- Language
- Arithmetic ability.

Cognitive performance evaluation practices have been utilized in transportation discipline in the fields of maritime transportation, land transportation, aviation and space.

3. Cognitive Performance Tests' Application

In 1995, under the name of Euro-NATO Aircrew Human Factors Group (AHFWG), a group of aviation psychologists and pilots had gathered for the purpose of developing flight personnel selection techniques and methods while establishing 12 skill and 8 personality tests for fighter pilots. The skills had been determined as; situational awareness, memory, decision making, perception speed, timing, reaction time and spatial orientation and the personality criteria had been determined as; success motivation, violence, tolerance to

stress, risky behavior, cooperation, assertiveness, leadership and determination [15]. The most basic criteria that determines a pilot's performance was stated as; intelligence, personality and psychomotor abilities [16]. Regarding general cognitive skills and occupational knowledge on pilots' performance, it was found out that intelligence is the most impactful criteria among all excluding psychomotor capabilities and personality [17].

Air Force Officer Qualifying Test, which is a test carried out by pencil-paper, was used for evaluation of civil or military pilots' navigation skill. In this test qualitative, quantitative, academic, pilotage and navigation criteria was evaluated as well as verbal, analytic, perception speed and comprehension skills [18]. Although the relation between cognitive capabilities and flight performance has been known, in aviation, problems such as complications in psychomotor tests' application, various reliability issues, cost and equipment's calibrations caused these types of tests to be seen as non-applicable. Because of these reasons combined with the developments in computer technologies, computer based cognitive tests have become an evaluation criteria for their objectivity, standardization, calculation, cost effectiveness, re-applicability and caused the development of Basic Attributes Test that evaluates psychomotor and cognitive capabilities of pilots [16, 18].

Cognitive functions have been found to be affected by stressor factors such as fatigue, sleep depravity and compelling working environments. Studies on ship pilots, drivers and astronauts have been carried out and in accordance, in the intersection of these studies, long shifted working hours has serious psychophysiological effects on workers and heavy workload did not only cause fatigue but also affected cognitive performance in a negative way. Monotonous tasks cause numbness and loss of attention, hence affecting cognitive performance [19, 20, 21, 22].

4. Cognitive Performance Tests and Maritime Transportation

Using cognitive abilities under stressor factors for seafarers result in the acquisition of information at various levels according to the individual mental models they have. The reason for this variety is caused by the information structures of seafarers' mental models

containing vehicle information, task information and information of the organization they are in. The losses and disconnections occurring during the creation of these three types of information will directly affect the operational processes [23]. Cognitive skills are closely in relation to the development of knowledge about learning and work [11]. The high level of cognitive abilities of the seafarers at the individual level will enable them to understand complex tasks and to achieve efficiency in operational processes. In maritime transportation discipline, studies focus on stressor factors in general which defines the origin for stressful environment and individual stress. In the literature, fatigue has been found as the one of the main reason for human error related incidents and main stressor factor [1, 24].

Cognitive processes have also been tried to be modeled. For example, a work load model based on cognition has been developed which is called "Climate", for evaluation of maritime accidents in cognitive processing point of view [25]. Also a study on cognition-safety relationship has been carried out under Horizon project in 2012 [26] and as a part of a study, effects of fatigue and stressor factors on cognitive performance changes have been mentioned [1], while in another study a proposal for the utilization of a developed cognitive performance test on seafarers' evaluation has been made [27].

In the literature, psychophysiological and cognitive studies on seafarers mostly have been performed using simulated environment. There have not been many studies that have been carried out in dynamic natural environments. Experimental stressors have been found temporary, limited and most of the time have not been found satisfactory for analyzing long-term effects. Real-time, realistic environment stressor have been found more effective, spontaneous and to have long-term effects on individuals. Cognition related studies have usually been carried out in simulated environment and a few have been analyzed in real-time environment [28]. Measuring cognitive processes in real world are getting harder to practice also costing much more than expected. Therefore, in order to practice studies as realistic as possible, scenarios designed for such studies have to be long and close-to-real.

5. Maritime Officer Selection Criteria

Ships are by their nature complex environments that require the individuals onboard to have more psychological and physical endurance than average humans which means that their cognitive capabilities must also be above a standard. Considering complexity also occurs because of the high risks, cognitive capabilities of deck officers working onboard plays a great role on safety of life at sea and environment as well as economical security and safety.

Watch keeping officers has been acknowledged as one of the most crucial members of onboard crew [29]. Officers are liable for successfully completing training and certification to qualify for serving as officers onboard ships. These trainings and certifications are standardized and controlled by the STCW Convention (Convention on Standards of Training, Certification and Watch keeping). In STCW, deck officer cadets ought to successfully complete A-II/1 training of the STCW Convention to be eligible for working freely on merchant navy, without any restrictions of ship type [30].

Watch keeping officers' duty is to ensure safety of the ship, her crew and her cargo operations, navigational watch keeping, her maintenance, drills, tests and controls, supply operations etc. Safety attitude, ranging from risk perception to approach to safety equipment and search and rescue activities, ought to always be a crucial aspect in maritime industry [31]. During onboard operations, watch keeping officers may encounter less than optimal and compelling occurrences such as adverse weather conditions, unsafe working environment, insufficient rest hours and/or exhausting work hours, dense traffic, pressure from the management company and/or charterer, vettings and safety risks of life at sea. [32, 33].

For cognitive performance, following evaluation criteria is found to be appropriate for utilization as mentioned in chapter 2; attention, concentration, reaction time, memory, processing, decision making, executive functions, language skills, arithmetic ability regarding the variety of utilized test for cognitive performance evaluation that had their reliability and validity tests been carried out. These criteria have been structured

according to intersection set of the utilized tests and job description, standards and day-to-day duties of the deck officers.

In accordance with the duties of officer's onboard ships, these criteria would help to determine an officer's fitness for duty from the cognitive point of view since working in a compelling environment would deteriorate cognitive capabilities by causing and generating stressor factors.

Considering the incidents based on human errors, human factor, evaluating the cognitive criteria beforehand can be used as a reference point for an officer's tendency of making errors based on cognitive performance decrease, which is mainly affected by an individual's psychological and physiological endurance to his environment.

For applicability or practicality of a cognitive performance test in maritime industry for maritime officer selection criteria, it is necessary to consider each rank onboard ships. Although certain computer skills have been normalized because of everyday usage of personal computers, as an individual ages, their understanding of such skills deteriorate [27]. In order to nullify this and to apply cognitive performance tests to each rank of maritime officers, it is suggested to utilize touch screens and mobile devices. By utilizing touch screens and mobile devices, older seafarers would be able to perform as intended since mouse, keyboard or joysticks are not used, resulting in seafarers to use their fingers and natural instincts as well as being more user friendly [34].

To increase the practicality and tests' being more user friendly in maritime sector, questions and tests is suggested to be prepared with maritime related icons, images, sounds and terminology and also to be selected from a test pool which would prevent learning questions and answers and using them in the re-application of the test in the future utilization.

6. Conclusion and Future Works

The psychological toll of onboard working environment have always been known. As a results of globalising World and developments and improvements in technologies, the requirement for faster transportation systems has improved the need for maritime transportation. In the light of these developments and requirements, harsh and

compelling working environments for seafarers have emerged considering the improved need for maritime transportation and profiting resulting in more voyages, less personnel employment and improper working hours on top of the daily challenges of living on a ship.

Regarding the psychological and physiological challenges of onboard environment and ship being a complex working place, comprising of various stressor factors that affects seafarers' psychophysiology, cognitive capabilities of seafarers deteriorate. In contrast, to perform tasks with high economic, environmental and health consequences such as, ship handling and cargo handling, seafarers' cognitive performance has to be high.

In such working environment, managers of shipping companies must rely on onboard personnel's individual capabilities and endurance. Cognitive tests offers a reference point for measuring officers' possible onboard behavior and operational tendencies. For practicality of a cognitive performance test in maritime industry for maritime officer selection criteria, it is necessary to consider each rank onboard ships as well as the age of the user. To make the cognitive performance tests more user friendly in such manner, it is suggested to utilize touch screens and mobile devices. By utilizing touch screens and mobile devices, older seafarers would be able to perform as intended since mouse, keyboard or joysticks are not used, resulting in seafarers to use their fingers and natural instincts as well as being more user friendly while establishing the design of the questions and queries using maritime terminology and icons.

In the future works, a mobile application based cognitive performance test will be developed for utilization in the maritime sector while it is intended to evaluate the tests with cooperation of maritime organizations.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Investigation of Seafarer Employment in Turkey

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ABSTRACT

Transportation is a service sector and an economic activity that creates an added value through the relocation of substances and products. The maritime transport within the transportation sector has become more and more important from the first ages to the today. While there are markets for goods and services produced in the economy, there are also labor markets composed of workers and employers. The changes in supply and demand experienced after the economic crises in the world directly affect the sea transportation. The efficient and efficient use of human capital, which is called as the seafarer in maritime transport, is important in order to achieve optimum results both in global and in our country. On the one hand, due to changes in the world economy and other factors affecting the seafarers 'market, the seafarers' market is undergoing changes dynamically. Considering the fact that seafaring is an international sector, seafarers' training is subject to international rules, and seafarers are employed in ships of different countries, the seafarer's supply and demand should be followed carefully and dynamically. It should also be taken into account that it will take some times for the training of the people to be employed. In this study, the seafarer profile in our country's maritime sector will be examined, the areas that may be needed for the next years in terms of employment and the necessary steps to be taken will be evaluated.

Keywords: Maritime, Employment, Seafarer, STCW.

Türkiye'de Gemiadamı İstihdamının İncelenmesi

ÖZET

Taşımacılık bir hizmet sektörü olup, madde ve ürünlerin yer değiştirme yoluyla bir katma değer oluşturan ekonomik bir faaliyettir. Taşımacılık sektörü içindeki deniz taşımacılığı ise ilk çağlardan günümüze önemini gün geçtikçe hissettirmektedir.

Ekonomide üretilen mal ve hizmetler için piyasalar bulunuyorken, aynı zamanda işçi ve işverenlerden oluşan işgücü piyasaları da mevcuttur. Dünyada meydana gelen ekonomik krizler sonrasında yaşanan arz ve talep değişimleri deniz taşımacılığını doğrudan etkilemektedir. Deniz taşımacılığında gemiadamı olarak adlandırılan beşerî sermayenin etkin ve verimli kullanımı gerek küresel gerekse ülkemiz açısından optimum sonuçlara ulaşmak adına önem arz etmektedir. Bir taraftan dünya ekonomisindeki değişimler, diğer taraftan gemiadamı piyasasına etki eden diğer faktörler nedeniyle gemiadamı piyasası dinamik bir şekilde değişimlere uğramaktadır.

Denizciliğin uluslararası bir sektör oluşu, gemiadamları eğitimlerinin uluslararası kurallara tabi olması, farklı ülkelerin gemilerinde farklı tabiyete bağlı gemiadamlarının istihdam edilmesi konuları dikkate alındığında, gemiadamı arz ve talebinin dikkatli ve dinamik olarak takip edilmesi gereklidir. Ayrıca istihdam edilecek kişilerin eğitimlerinin sonuç vermesinin belli bir zaman alacağı da hesaba katılmalıdır. Bu çalışmada ülkemiz denizcilik sektöründeki gemiadamı profili incelenerek, istihdam açısından gelecek yıllar için ihtiyaç duyulabilecek alanlar ve atılması gerekli adımlar değerlendirilecektir.

Anahtar Kelimeler: Denizcilik, İstihdam, Gemiadamı, STCW.

1. Giriş

Deniz yolu taşımacılığı diğer taşımacılık türleriyle karşılaştırıldığında bütün taşımacılık türleri içerisinde en büyük paya sahip taşımacılık türüdür. Hem daha ucuz hem de daha güvenli olmasından dolayı dünya üzerinde taşınan yük miktarının yaklaşık yüzde 90'a yakını deniz yolu ile taşınmaktadır. Lojistik sektöründe payı bu kadar büyük iken en çok personel çalıştırılan taşımacılık sektörü de deniz yolu taşımacılığıdır. Bimco (Baltık ve Uluslarası Denizcilik Örgütü) ve ICS (Uluslararası Denizcilik Konferansı) tarafından 5 yılda bir hazırlanan Manpower Report (İşgücü Raporuna) göre 2020 yılında dünyada öngörülen tahmini işgücü arzı 790.000 civarı olacak iken talep edilen işgücü miktarının sunulan arza göre 90.000 daha fazla gerçekleşerek 880.000 civarı olması öngörülmektedir. Ortaya çıkan bu ihtiyacı karşılamaya yönelik gemiadamı yetiştirmek deniz ticaretinin önem arz ettiği toplumlar için öncelikli hedef haline gelmiştir. Ülkemizde üç tarafı denizlerle çevrili olan ve deniz ticaretine önem veren toplumlardan bir tanesi olduğu için, ülkemizde de her geçen gün gemiadamı yetiştirmeye yönelik eğitim veren kurumların sayısı artmaktadır. Açılan bu kurumlarda yetiştirilen gemiadamlarının uluslararası arenada kolay istihdam edilebilmesi için uluslararası standart ve beklentilere uygun olarak yetiştirilmeleri önem arz etmektedir.

Uluslararası standart ve gerekliliklere uygun gemiadamı nasıl olur anlayabilmek için önce; gemiadamı türlerinden ve gemilerde hangi görevlerde çalıştıklarından, hangi belgeleri nereden temin edip, bulundurmaları gerektiğinden ve nitelikli gemiadamı olabilmek için sahip olması gereken kriterleri anlamak gerekir. Gerekli nitelikleri edindikten sonra iş arama aşamasına geçer. Bu aşamada doğru arama kanallarını uygun şekilde kullanmak önem arz etmektedir. Çünkü gemiadamlığı mesleğinde iyi iş imkanları olduğu kadar, insanlara yalan vaatlerde bulunarak dolandırma amacında olanlarda çoktur. Hem iyi bir işi kısa bir sürede bulabilmek hem de, yalan vaatlerle kandırılıp mağdur olmamak adına güvenilir iş arama kanallarını doğru bir şekilde kullanmak önem

arz etmektedir. Burada da Deniz Ticaret Odası gibi İşkur gibi resmi ve güvenilir iş arama kanallarını kullanmak ya da, sektörde faaliyet gösteren iş yerlerine bizzat özgeçmiş hazırlayarak müracaat etmek önemlidir.

2. Gemiadamı Temel Kavramları

2.1 Gemiadamı Nedir?

Bir gemide hizmet akdine bağlı olarak çalışan bütün zabitlere, tayfalara, stajyer ve yardımcı hizmet personeline Gemiadamı denir. [1]

2.2 Gemiadamı Olabilme Koşulları

Her gemi adamının, yaptığı işe göre bir ünvanı ve bu ünvanın gerekliliği olan bir yeterliliği vardır. Bu yeterliliğe de sahip olabilmek için kanunlarla belirlenmiş bir takım koşulları yerine getirmek gerekmektedir. Bu yeterlilikler şunlardır;

a.) Türkiye Cumhuriyeti veya Kuzey Kıbrıs Türk Cumhuriyeti (KKTC) vatandaşı olmak ve bu ülkelerde denizcilikle alakalı bir eğitim görmek veya mezuniyeti olmak ve 25.09.1981 yılı 2527 sayılı yönetmek uyarınca Türkiye'de çalışabilme yeterliliğine sahip Türk soylu yabancılar bu alanda çalışabileceklerdir.

b.) Gemi adamı olabilmek için gerekli öğrenim derecesi, yaş, deniz hizmet süresi ve diğer şartları gemiadamları yönetmeliğine uygun olarak taşıyor olmak.

c.) Denizde çalışmaya uygun olduğuna dair sağlık durumunu belgelendirmek

d.) Taksir hükmündeki suçlar ile 1918 sayılı kaçakçılığın men ve takibine yönelik kanunun 25nci maddesinden hüküm giyilen suçlar hariç; 1 yıldan uzun süreli hüküm giyilmiş suçlar ile, sahtecilik, hırsızlık, dolandırıcılık, rüşvet, ihtilas, zimmet, inancı kötüye kullanmak, resmi evrakta sahtecilik ve kaçakçılık gibi suçların herhangi birinden ceza almamış olmak.

e.) Devlete ve bekasına karşı işlenmiş herhangi bir suçtan hükmü bulunmamak.

f.) T.C.K. 313üncü madde hükmüne giren suçlar ile 4422 sayılı Çıkar Amaçlı Suç Örgütleri ile Mücadele kanun uyarınca hükmü bulunmamak. [2]

2.3 STCW Nedir?

İngilizce, açılımı **S**tandards of **T**raining, **C**ertification and **W**atchkeeping for seafarers olup, denizciler için eğitim, sertifikasyon ve gözetim standartları olan uluslararası bir denizcilik standardıdır.

Bu belgenin amacı denizcilik eğitiminde uluslararası bir standart oluşturarak denizciler için gerekli olan bütün eğitimleri belirleyip bu eğitimleri almasını sağlamaktır.

Bu standarda göre gemiadamı olmak isteyenler bir takım eğitimler alırlar ve bu eğitim sonucu da STCW belgesi denen uluslararası geçerliliği olan belgeleri alarak uluslararası sularda görev yapabilir hale gelirler.

Gemilerde çalışan her gemiadamı yaptığı göreve göre uygun eğitimleri görmek zorundadır.

2.4 STCW Belgeleri ve Eğitimleri

Stcw sözleşmesi uyarınca tüm gemi adamlarının almakta zorunlu olduğu eğitimler**;**

- Denizde kişisel can kurtarma teknikleri eğitimi,
- Temel ilkyardım eğitimi,
- Yangın önleme ve yangınla mücadele eğitimi,
- Personel güvenliği ve sosyal sorumluluk eğitimi,
- Cankurtarma araçlarını kullanma yeterliği eğitimi, almak zorundadırlar.

Bu belgeleri aldıktan sonra yeterliliklerini ispat için beş senede bir defa olmak üzere denizcilik idaresinin belirlediği sınava girerek belgelerini yeniletmek zorundadırlar. Eğer girilen bu sınavda yeterli başarıyı gösterememeleri durumunda aynı eğitimleri baştan alarak tekrar aynı sınava tabi tutulurlar.

2.5 Gemi Adamı Sınavını Kim Yapar Ve Belgelerini Hangi Kuruluş Verir?

Gemi adamı sınavlarını ve belgelendirmesini Ulaştırma ve Altyapı Bakanlığına bağlı Gemi Adamı Sınav Merkezi (GASM) yapmaktadır. Gemi adamı belgesi almak isteyen adaylar,

gerekli evrakları tamamlayıp, bakanlığın hesabına sınav harcını yatırdıktan sonra Liman Başkanlıklarından sınavlar için başvuru yapabilirler. Yine sınavda başarılı olan adaylar Liman Başkanlıkları vasıtasıyla aldıkları belgeleri Liman Cüzdanlarına işletebilirler. [3]

3. Gemi adamı türleri

1.1 Tayfa Sınıfı Gemiadamları

Gemide görev alan, zabitler ve stajyerler dışındaki personele tayfa denir. Görevlerine göre; makine, güverte veya kamarada çalışabilirler. [4]

Tayfa sınıfı gemi adamlarını Gemi Adamları Yönetmeliği yaptıkları işe göre üç başlık altında incelemektedir. Bunlardan birincisi güverte sınıfı tayfalardır ki bunlar güverte lostromosu, usta gemici ve gemicilerden oluşur. İkinci sınıf ise makine sınıfı tayfalardır. Bunlar da makine lostromosu ve yağcıdır. Üçüncü sınıf tayfalar ise yardımcı gemiadamı görevinde olup, aşçı ve kamarottan oluşur.

1.2 Zabitan Sınıfı Gemiadamları

Gemilerde yönetim ve karar verici pozisyonda olan; kaptan, başmakinist/başmühendis ve zabit yeterliliğindeki gemi adamlarıdır.

1.2.1 Kaptan ve güverte zabitleri

Asıl görevleri gemilerin sevk ve idaresidir. Kaptan ve güverte zabitlerini çalıştıkları gemilerin tonajlarına göre üç başlıkta inceleyebiliriz. 500 Grostondan az ve yakın kıyısal sefer bölgesinde çalışan kaptan ve vardiya zabitlerine; sınırlı kaptan ve sınırlı vardiya zabiti denir. 500-3000 Groston arası gemilerde çalışabilen gemi yönetim adamlarına kaptan ve zabit denir. 3000 Grostondan fazla gemilerde çalışabilen ve herhangi bir yük veya mesafe sınırı olmayan gemi yönetim adamlarına uzakyol vardiya zabiti veya uzakyol kaptan denir.

1.2.2 Makine Zabitleri

Asıl görevleri gemide ana makinenin çalıştırılması, bakım ve onarımında sorumludurlar. Makine zabitlerini çalıştıkları gemilerin motor güçlerine göre üç başlıkta inceleyebiliriz. 750 Kw'den küçük ana makinayla ve yakın kıyısal sefer bölgesinde çalışan makine

zabitlerine; sınırlı makine zabiti yada sınırlı makine baş makinisti denir. 750-3000 Kw arası ana makine gücü olan gemilerde çalışabilen makine zabitlerine makinist yada baş makinist denir. 3000 Kw'dan fazla gemilerde çalışabilen ve herhangi makine gücü veya mesafe sınırı olmayan makine zabitlerine ise uzakyol makinisti veya uzakyol baş makinist denir.

Görevli telsiz zabiti ise gemilerde iletişimden sorumlu zabittirler. Sahip oldukları belge türüne göre; kısa veya uzun mesafe, GMDSS tahditli veya genel telsiz operatörü gibi farklı yeterliliklerle, yeterlilik ve sınav yönetmeliğine göre belgelendirilmiş, gemilerde çalışan iletişim zabitleridirler.

Görevli elektrik zabitleri görevleri gemilerde oluşabilecek olası elektrik ve elektronik hasar ve arızaların giderilmesinden sorumludurlar. Elektrik tayfası, elektrik zabiti, elektronik tayfası ve elektronik zabitinden oluşur.

Görevli sağlık zabitleri görevleri gemideki personelin olası sağlık sorunlarına acil müdahale ve olası yaralanma durumlarında acil yardımdan sorumlu personellerdir. Hemşire, sağlık memuru ve doktordan oluşur.

Gemide çalışan bir diğer personel türü ise stajyerlerdir. Staj yapmak maksadı ile bulunan ve belirli vardiya yükümlülüğü olmayan yardımcı vardiya zabitleridirler. Yaptıkları işe göre; Güverte ve makine stajyerleri olarak iki gruba ayrılırlar.

Ulusal gemiadamları yönetmeliğine göre diğer gemiadamı türleri ise balıkçı gemilerinde kontrol ve yönetiminde yetkili kaptanlar ile alakalı iki yeterliktir. Bunlar; balıkçı gemi kaptanı ve açık deniz balıkçı gemi kaptanıdır. [5]

2. Ülkemizde Gemiadamı Yetiştiren Eğitim Kurumları

Denizcilik eğitimi ülkemizde Milli Eğitim Bakanlığına (MEB) bağlı liseler ve Yüksek Öğretim Kurumu'na (YÖK) bağlı Meslek Yüksek Okulları ve Fakültelerle beraber 625 sayılı kanuna tabi Özel Eğitim Kurumları vasıtasıyla verilmektedir. Ulaştırma ve Alt Yapı Bakanlığı'nın 2019 yılı verilerine göre Gemiadamı Belgesi vermeye yetkilendirilmiş toplam eğitim kurumu sayısı; lise düzeyinde 40, yüksekokul düzeyinde 22 iken özel eğitim

kurumu sayısı ise 32'dir. Yüksek Öğretim Kurumuna bağlı olan eğitim kurumlarının ise 7 tanesi Fakülte düzeyinde eğitim vermekte iken 15 tanesi yüksek okul seviyesinde denizcilik eğitimi vermektedirler. [6]

Tablo 1: Ülkemizde Gemiadamı Yetiştiren Eğitim Kurumları

YÜKSEK ÖĞRENİM KURUMUNUN ADI	İLİ
BARTIN ÜNİVERSİTESİ BARTIN MESLEK YÜKSEKOKULU	BARTIN
BÜLENT ECEVİT ÜNİVERSİTESİ ALAPLI M.Y.O.	ZONGULDAK
DOKUZ EYLÜL ÜNİVERSİTESİ DENİZCİLİK FAKÜLTESİ	İZMİR
EGE ÜNİVERSİTESİ URLA DENİZCİLİK MESLEK YÜKSEKOKULU	İZMİR
GİRNE AMERİKAN ÜNİVERSİTESİ DENİZCİLİK VE ULAŞTIRMA YÜKSEKOKULU	MERSİN
GİRNE ÜNİVERSİTESİ DENİZCİLİK YÜKSEKOKULU	MERSİN
GİRNE ÜNİVERSİTESİ (YAKINDOĞU ÜNİVERSİTESİ) DENİZCİLİK FAKÜLTESİ	MERSİN
GİRNE ÜNİVERSİTESİ (YAKINDOĞU ÜNİVERSİTESİ) DENİZCİLİK MESLEK YÜKSEKOKULU	MERSİN
İSTANBUL BİLGİ ÜNİVERSİTESİ MESLEK YÜKSEKOKULU	İSTANBUL
İSTANBUL TEKNİK ÜNİVERSİTESİ (İTÜ) DENİZCİLİK FAKÜLTESİ	TUZLA
İSTANBUL TEKNİK ÜNİVERSİTESİ (İTÜ) KKTC EĞİTİM ARAŞTIRMA YERLEŞKELERİ	TUZLA

İSTANBUL ÜNİVERSİTESİ MÜHENDİSLİK FAKÜLTESİ DENİZ ULAŞTIRMA İŞLETME MÜHENDİSLİĞİ	AMBARLI
MUĞLA SITKI KOÇMAN ÜNİVERSİTESİ BODRUM DENİZCİLİK MESLEK YÜKSEKOKULU	BODRUM
NİŞANTAŞI ÜNİVERSİTESİ MESLEK YÜKSEKOKULU	İSTANBUL
PİRİ REİS ÜNİVERSİTESİ DENİZCİLİK FAKÜLTESİ	TUZLA
PİRİ REİS ÜNİVERSİTESİ MESLEK YÜKSEK OKULU	TUZLA
ORDU ÜNİVERSİTESİ FATSA DENİZ BİLİMLERİ FAKÜLTESİ	FATSA
ORDU ÜNİVERSİTESİ FATSA M.Y.O.	FATSA
KTÜ SÜRMENE DENİZ BİLİMLERİ FAKÜLTESİ	SÜRMENE
RECEP TAYYİP ERDOĞAN ÜNİVERSİTESİ TURGUT KIRAN DENİZCİLİK YÜKSEKOKULU	RİZE
YALOVA ÜNİVERSİTESİ YALOVA M.Y.O	YALOVA
YILDIZ TEKNİK ÜNİVERSİTESİ (YTÜ) GEMİ İNŞAATI VE DENİZCİLİK FAKÜLTESİ	İSTANBUL

3. Ülkemizin Dünya Denizcilik Filosu Sıralamasındaki Yeri Ve Kolay Bayrak Uygulaması

3.1 Dünyanın Toplam Gemi Filosu Ve Ülkemizin Dünyadaki Yeri

Denizcilik mesleki bir kültür olarak, yüz yıllardan beri ülkeler için devam eder. Kısa bir değerlendirme yapacak olursak Osmanlıdan ayrılan devletlerden olan Yunanistan, yıllarca krizlere maruz kalmasına rağmen, dünyada en fazla gemiye sahip olan ülke durumundadır.

Dünyada şu anda sektörü Yunanlı armatörler domine etmektedir. Toplam varlıkları 100 milyar Usd'yi geçmektedir. Yunan devletini sırasıyla varlık değeri 89 milyar Usd ile Japonya ve 84 milyar Usd ile Çinli gemi sahipleri takip etmektedir.

Yunanlı armatörlere ait olan filonun 36 milyar Usd ile büyük bir bölümünü tanker ve 35,75 milyar Usd ile dökme yük ve 13,5 milyar Usd'lik bölümünü ise LNG oluşturur. Bütün bu değerleri hesaba kattığımızda Yunanlı armatörler genel marketin yüzde 19 dan fazlasını elinde bulundurmaktadırlar.

Listenin ikinci sırasındaki Japonlar ise daha çok LNG ve Dökme yük ağırlıklı bir sermayeleri vardır. Tanker segmentinde ise 2000 li yıllardan itibaren Japon rafinerilerindeki düşüşe ilaveten Asya pazarındaki yoğun rekabette geride kalmışlardır. Listenin üçüncü sırasındaki Çin ise ekonomisindeki hızlı büyümeye paralel olarak enerji ve emtiya ihtiyacında da artış gözlenmektedir. Ve bununda akabinde LNG ve Dökme yük ağırlıklı bir filoya sahiptirler. Her sene yakaladıkları ortalama yüzde 11'lik büyüme ile artış eğilimindedirler. Çinlileri listenin ilk iki sırasındaki ülkelerden ayıran önemli özellik ise yapılan bu yatırım ve filo artışının önemli katkısını devlet teşebbüslerince yapılmasıdır. [7]

Tablo 2: Dünyadaki Toplam Gemi Filosu Ve Bayrakları

ÜLKELER		MİLLİ BAYRAK		YABANCI BAYRAK		TOPLAM FİLO		YILLIK DEĞİŞİM	YABANCI BAYRAK PAYI %
DWT SIRALAMASI		SAYI	1000 DWT	SAYI	1000 DWT	SAYI	1000 DWT		
1	YUNANİSTAN	712	68.743	4.015	296.617	4.727	365.360	6,7	81,2
2	JAPONYA	815	34.427	3.316	207.030	4.131	241.456	-0,2	85,7
3	ÇİN	2.809	79.744	2.447	157.095	5.256	236.839	10,1	66,3
4	ALMANYA	189	8.414	2.752	97.289	2.941	105.703	-7,3	92,0
5	GÜNEY KORE	706	12.794	908	67.150	1.614	79.944	-6,9	84,0

6	NORVEÇ	525	16.730	1.167	56.080	1.692	72.810	10,6	77,0
7	AMERİKA	206	5.078	1.016	62.234	1.222	67.312	16,3	92,5
8	SİNGAPUR	711	27.185	676	25.605	1.387	52.790	-3,5	48,5
9	TAYVAN	109	4.432	857	47.030	966	51.463	7,2	91,4
10	İTALYA	460	13.090	667	37.527	1.127	50.617	12,1	74,1
11	DANİMARKA	330	16.917	576	26.441	906	43.358	17,5	61,0
12	HONG KONG	506	28.668	476	13.746	982	42.414	8,0	32,4
13	KANADA	117	1.322	384	29.224	501	30.546	1,4	95,7
14	İNGİLTERE	194	6.247	533	24.039	727	30.286	1,5	79,4
15	****TÜRKİYE****	483	7.288	1.028	21.323	1.511	28.611	-2,2	74,5
16	HİNDİSTAN	630	16.699	133	8.063	763	24.762	6,7	32,6
17	RUSYA	1.092	6.849	363	15.352	1.455	22.201	2,4	69,1
18	BELÇİKA	71	7.854	151	13.703	222	21.557	1,6	63,6
19	ENDONEZYA	1.708	16.814	79	1.223	1.787	18.037	6,1	6,8
20	İRAN	139	3.849	61	13.925	200	17.773	-5,1	78,3
21	SUUDİ ARABİSTAN	119	13.235	36	3.707	155	16.942	9,5	21,9
22	FRANSA	108	3.177	190	11.725	298	14.842	-4,8	79,0
23	B.A.E.	49	303	502	14.065	551	14.369	-5,4	97,9
24	MALEZYA	204	6.616	126	7.597	330	14.214	7,0	53,5
25	HOLLANDA	564	4.787	343	7.724	907	12.511	6,3	61,7
26	BERMUDA	--	--	58	10.514	58	10.514	16,2	100,0
27	İSVİÇRE	35	1.466	164	7.994	199	9.460	3,2	84,5
28	VİETNAM	804	6.749	107	1.469	911	8.218	5,2	17,9
29	UMMAN	6	6	42	7.782	48	7.788	4,0	99,9
30	TAYLAND	304	5.210	74	2.530	378	7.739	8,4	32,7

30 ÜLKENİN TOPLAMI	14.705	424.633	23.247	1.295.803	37.952	1.720.435	4,3	75,3
DİĞERLERİ	2.211	33.216	2.549	68.058	4.760	101.273	-7,0	67,2
ARA TOPLAM	16.916	457,849	25,796	1.363.860	42.712	1.821.709	3,6	74,9
BİLİNMEYEN					409	3.025	-36,8	
DÜNYA TOPLAMI					43.121	1.824.734	3,5	

3.2 Dünyada Kolay Bayrak Uygulaması Ve Ülkemizdeki Durumu

Gemi sahipleri bir takım nedenlerden dolayı sahip oldukları gemileri ''Kolay Bayrak'' olarak adı geçen ülkelerin bayrakları himayesinde çalışmayı tercih ederler. Bu tercih nedenleri yıllar içinde değişiklik gösterse de genel maksat armatörlerin faydasına olan sebeplerden dolayıdır. Bu kolay bayrak uygulamasının kökeni Roma İmparatorluğu dönemine kadar gitmektedir.

Kolay bayrak uygulamasının gemiler açısından faydaları, askeri ve siyasi olabileceği gibi, genellikle günümüzde ekonomik nedenlerle olmaktadır. En genel ifade ile ekonomik fayda işletmeler için maliyetlerden tasarruf ve vergi muafiyeti olabileceği gibi düşük vergi ödeme de genel tercih sebeplerinin başında gelmektedir [8].

Tablo 3: Kolay Bayrak Devletleri Ve Sıralaması

DWT SIRALAMA		BAYRAK	1 OCAK 2017				1 OCAK 2018				Toplam DWT içindeli yeri %	Yıllık Değişim %
2018	2017		GEMİ ADEDİ	1000 GT	1000 DWT	1000 TEU	GEMİ ADEDİ	1000 GT	1000 DWT	1000 TEU		
1	1	PANAMA	6.480	216.522	333.363	3.214	6.395	212.134	326.118	3.132	17,8	-2,2
2↑	3	MARSHAL ISL.	2.892	127.950	208.563	1.179	3.117	140.951	229.735	1.282	12,5	10,2
3↓	2	LİBERYA	3.126	136.331	213.934	3.896	3.160	139.109	218.893	3.798	11,9	2,3
4	4	HONG KONG	2.420	106.744	172.420	2.702	2.462	112.401	180.585	2.932	9,8	4,7

5	5	SİNGAPUR	2.328	80.698	121.177	2.166	2.333	82.723	124.563	2.226	6,8	2,8
6	6	MALTA	2.016	65.654	98.669	1.419	2.036	71.445	107.748	1.519	5,9	9,2
7	7	ÇİN	3.008	47.904	74.918	686	3.224	51.855	80.288	856	4,4	7,2
8	8	YUNANİSTAN	963	42.262	74,493	52	946	41.129	72.201	44	3,9	-3,1
9	9	BAHAMALAR	1.160	53.644	68.057	199	1.133	52.571	64.788	177	3,5	-4,8
10	10	B. KRALLIK	757	29.002	38.896	843	767	30.671	41.854	816	2,3	7,6
11	11	JAPONYA	2.620	23.262	33.782	63	2.640	25.429	36.792	84	2,0	8,9
12	12	G.K.R.Y.	797	20.864	33.000	438	811	21.544	34.112	446	1,9	3,4
13↑	19	PORTEKİZ	352	10.417	13,712	644	474	14.793	19.349	945	1,1	41,1
14	14	ENDONEZYA	2.915	12.189	17.131	184	3.069	13.658	19.161	213	1,0	11,8
15↓	13	NORVEÇ	788	15.088	19.063	57	799	14.990	18.867	60	1,0	-1,1
16↓	15	DANİMARKA	460	15.002	16.940	984	480	16.778	18.715	1.180	1,0	10,5
17↓	16	HİNDİSTAN	850	9.596	16.451	44	878	10.284	17.608	50	1,0	7,0
18↓	17	İTALYA	710	15.498	15.347	128	701	15.313	14.489	127	0,8	-5,6
19↓	18	KORE	1.045	9.859	14.654	101	1.028	9.674	13.920	107	0,8	-5,0
20↑	38	S. ARABİSTAN	102	2.451	3.619	8	137	7.592	13.451	8	0,7	271,7
21↓	20	ALMANYA	266	9.501	10.316	760	265	9.011	9.803	721	0,5	-5,0
22	22	BERMUDA	140	10.432	8.999	25	140	10.306	8.653	39	0,5	-3,8
23↓	21	A.BARBUDA	921	7.781	10.089	555	810	6.505	8.505	450	0,5	-15,7
24	24	A.B.D.	342	7.032	7.963	236	363	7.333	8.220	232	0,4	3,2
25	25	BELÇİKA	76	4.781	7.755	1	83	5.025	8.200	1	0,4	5,7
26	26	RUSYA	1.441	5.960	7.580	89	1.486	6.388	7.999	100	0,4	5,5
27↓	**23**	**TÜRKİYE**	**834**	**5.637**	**8.102**	**111**	**805**	**5.441**	**7.638**	**123**	**0,4**	**-5,7**

158	143	SOMALİ	1	2	4	--	--	--	--	--	--	-100
TOPLAM			52.183	118.269	1.772.435	22.327	53.045	1.224.375	1.833.549	23.102	100	+3.4

4. Dünyada Ve Ülkemizde Gemi Adamı Arz Ve Talebi

4.1 Bimco ısf manpower report

BIMCO ve ICS insan gücü raporları, denizciler için küresel arz ve talebin en kapsamlı değerlendirmesi olarak kabul edilmektedir. Oluşturulan bu raporun 2015 yılına ait olanı; 1990, 1995, 2000, 2005 ve 2010'da yapılan güncellemeler üzerine kuruludur. Bu raporun iki esas maksadı vardır: deniz işletmecileri için dünya genelinde mevcut arz ve talep durumunu tanımlamak ve endüstrinin gelişmeleri önceden tahmin etmesine ve uygun önlemleri almasına yardımcı olmak için 5-10 yıl içerisinde muhtemel konum hakkında öngörülerde bulunmak.

Küresel gemiadamı talebi 2015 yılında tahmini 1.545.000 olup, endüstri yaklaşık 790.500 zabitan ve 754.500 tayfa talep etmektedir. 2010 yılından itibaren yaklaşık %24,1 oranında zabitan talebi artış gösterirken tayfa sınıfı % 1 oranında artış göstermiştir [9]

Tablo 4: Gemiadamı Arz-Talep Tahmini

	2015	2020	2025
Gemiadamı Arzı	774.000	789.500	805.000
Gemiadamı Talebi	790.500	881.500	952.500
Arz Eksikliği / Fazlası	-16.500	-92.000	-147.500
% Yüzde Olarak	% -2.1	% -11.7	% -18.3

Basit olarak zabitan sınıfı arz talep dengesi %2,1 yönetilebilir bir oranda zabitan açığında artış göstermiş, daha ciddi bir zabitan açığı %11,7 ile 2020 ve %18,3 ile 2025 yılındadır. [9]

4.2 Gemiadamı Arzının Önemi Ve En Çok Arz Eden İlk Beş Ülke

Gemi adamları çalıştığı ortam koşulları itibariyle uluslararası çalışma alanına sahiptirler. Bu durum da onları farklı ülke ve bayrak devletleri adına çalışabilir duruma getirmektedir. Daha iyi ücret ve çalışma koşullarına sahip olan şirketler adına çalışabilme imkanına sahiptirler.

Yeme içme gibi temel ihtiyaçları gemiden sağlandığından, öteki kara merkezli yurtdışı işlerinden farklı olarak (Ülke dışında inşaat işi yapıp şantiyelerde kalan işçiler hariç) kazandıkları maaşlarının küçük bir bölümünü kendi ihtiyaçlarına harcamakta olup, maaşlarının çoğunu ülkeye döviz olarak getirebilmektedirler

Denizci tedarikçisi olup dünyada Çin'den sonra ikinci ülke olan Filipinler'in yıllık bu işten 5.6 Milyar Dolar kazandığı düşünülürse ülke olarak bunu başarmaya olan ihtiyacımızı anlamış oluruz. Her yıl yaklaşık 230.000 Filipinli dünya denizlerinde gemilerde görev yapmakta olup, 2015'te 358.898 gemiadamı arzı sağlamıştır. 2014 yılında ise bu rakam 402 bin olmuştur.

Gemiadamlığı mesleği Filipinler'in uluslararası döviz girdisi olarak ülke stratejisi olup (görünürde her ne kadar bunu kabul etmeseler de) 2014 yılı itibariyle 1.8 Milyon işgücünü yurtdışına ihraç etmişlerdir. Bunun 1.431.000 kişisi shore based ve 402.000 kişi ise seabased olarak çalışmıştır. Toplam gelirleri ise 24 milyar dolar olup gemiadamlarının ülkelerine gönderdiği miktar ise 5.6 milyar dolar olmuştur. Ülkenin yurtdışına işgücü ihracından kazandığı gelir Gross Domestic Product (GDP) a payı yüzde 10'dur. [10]

Tablo 5: Dünyada En Çok Gemiadamı Arz Eden Ülkeler

TÜM GEMİADAMLARI	ZABİTAN	TAYFA
Çin	Çin	Filipinler
Filipinler	Filipinler	Çin

Endonezya	Hindistan	Endonezya
Rusya	Endonezya	Rusya
Ukrayna	Rusya	Ukrayna

4.3 Dünyada Ve Ülkemizdeki Güncel Gemi Adamı Verileri

Dünyada çalışan toplam gemiadamı sayısı yaklaşık olarak 1.647.500'dür. Bu rakamın yaklaşık 777.000 küsür adeti zabitan grubu olup, 873.500 küsuru tayfa sınıfındadır. Gemiadamı miktarı geride kalan beş yıl içerisinde yaklaşık olarak % 24 oranında artmıştır. Gemiadamı arz-talep tahmini incelendiğinde ise 2020 yılı itibariyle gemi adamı ihtiyacında artış yaşanacağı düşünülmektedir. Ülkemiz ise bu alanda gemiadamı yetiştirmeyi hedef edinen ülkeler arasındadır. Önümüzdeki yıllarda ise gemiadamı yetiştiriciliğinde önemli bir rol üstlenmesi beklenmektedir. Ülkemiz günümüz itibariyle de yine dünyada en çok gemi adamı yetiştiren ülkelerden biridir.

Tablo 6: Ülkemizdeki Aktif Çalışan Gemiadamı Sayısı

Ülkemizde Aktif Olarak Çalışan Toplam Gemiadamı Sayısı (2017 yılı Eylül ayı itibariyle):	**116.250**
Aktif Zabitan Sayısı:	36.500
Aktif Tayfa Sayısı:	79.750

Ülke çapında 2017 yılı itibariyle amatör denizci sayısı 199.250, kılavuz kaptan sayısı 579, profesyonel balıkadam 1.429, Vts operatörü sayısı ise 175'tir [11].

5. Ülkemizde Gemiadamı İstihdamı

5.1 Ülkemizde Gemi Adamlarının İş Bulma Olanakları

Dünyada gemiadamı ihtiyacının artan eğilimde olduğu gibi ülkemiz için de aynı durum söz konusudur. Ancak bu ihtiyacı karşılamak adına son yıllarda ardı ardına gemiadamı yetiştirmek üzere açılan eğitim kurumlarının sayısında da bir artış söz konusudur. Eğitim kurumlarından mezun olacak olan adayların ileride iş bulma konusunda zorluk yaşamamaları adına kendilerini sektörün ihtiyaçları doğrultusunda geliştirmeleri gerekmektedir. Denizcilik sektörü doğası gereği uluslararası bir sektör olduğu için bu arenadaki gemi adamı ihtiyacı konusunda şirketler kendi menfaatleri doğrultusunda daha ucuz işgücü hedefi ile farklı milletlerden eleman teminine gidebilirler. Aynı durum farklı ülkelerde çalışabilecek Türk vatandaşı olan gemiadamları için de fırsat olarak değerlendirilebilir. Gemiadamı olacak kişilerin bu durumu da hesap ederek kendilerini ülke dışında farklı firmalarda da çalışabilecek düzeyde geliştirmeleri; yabancı dil, sertifika durumu gibi uluslararası gereklilikleri karşılayabiliyor olmaları önem arz etmektedir. [12]

Özellikle Bimco İCS Manpower 2015 Raporuna göre ülkemiz milli bayraklı gemilere gemi başına düşen zabit sayısı 34 iken gemi başına düşen tayfa sayısı 47'dir. En çok tayfa ve zabit açığı ise Singapur, Hollanda, Belçika, Japonya ve Yunanistan gemilerindedir. Bu ülkeler açık oluştuğu yerlerde teminlerini dünyada en çok gemiadamı yetiştiren ülkeler olan; Filipinler, Çin, Hindistan ve Endonezya gibi ülkelerden karşılamaktadırlar. Bunun sebebi ise hem işgücünün ucuz olması hem de nitelikli eleman konusunda sayılarının fazla olmasındandır. [10]

5.2 Ülkemizde Gemi Adamlarının İş Arama Kanalları

Denizcilik sektöründe iş arayanların hem alacakları ücret, hem de çalışma koşulları olarak mağdur olmamaları adına güvenilir iş arama kanallarını kullanmaları önem arz etmektedir. Bu bağlamda Türkiye'nin en büyük ve tek kamusal iş arama kanalı olan Türkiye İş Kurumu'ndan yardım almaları önemlidir. Son yıllarda hem çalışan nitelikli işgücü sayısını artırması hem de bütün sektörlere ulaşmayı kendisine hedef edinerek

çalışmasıyla Türkiye İş Kurumu denizcilik sektöründe de hatırı sayılır bir işgücü bulma kaynağıdır.

Buna örnek olarak; 26.05.2017 tarihinde Deniz Ticaret Odası ve İşkur Genel Müdürlüğü arasında imzalanan protokolle Odaya kayıtlı işverenlerin İşkur'a kolay ulaşımı sağlanmış olup iş ilanları İşkur Kurum Portalı üzerinden ülke geneli vatandaşlara ulaştırılmaya başlanmıştır. 200'ün üzerinde işgücü talebi İşkur sisteminden yayınlanmaya başlanmıştır. [13]

6. Sonuç

Dünyada ticaret hacminin günden güne büyümesi ve özellikle deniz yolu ticaretinin diğer taşımacılık türlerine göre avantajlı olmasından dolayı uluslararası raporlarda da görüldüğü gibi bir eleman talebi artışı yaşanacağı öngörülmektedir. Bu ortaya çıkacak olan eleman ihtiyacına en güzel şekilde cevap verebilmenin yolu iyi yetiştirilmiş gemiadamı olmaktan geçmektedir. Bu noktada da gemiadamı mesleğinde eğitim veren kurumların başarısı ön plana çıkmaktadır. Uluslararası standartlarda eğitim vermek ve öğrencilerini global bir sektör olan denizcilik sektörüne hazır elaman haline getirmek önem arz etmektedir. Verilen eğitim kadar önemli olan bir diğer husus da bu mesleği yapacak olan kişilerin çalışmak istedikleri pozisyonlarla alakalı uluslararası gereklilikleri (eğitim, Stcw belgeleri, sertifika vs.) sağlamaları gerekmektedir.

Deniz ticaretinde işgücü arz ve talebi Bimco gibi uluslararası kuruluşların yaptığı araştırmalarda da görüldüğü gibi artış eğilimindedir. Her ne kadar eleman artışı öngörülmekteyse de günden güne iş hayatında rekabet de artmaktadır. Her geçen gün ülkemizde ve dünyada denizcilik eğitimi veren eğitim kurumlarının ve bu alanda yetişmiş eleman sayısı da artmaktadır. Üstelik bu alanda rakipler sadece kendi ülkemizin yetiştirdiği gemiadamları da değildir. Şirketler bazen ucuz işgücü bazen denizcilik kültürü, bazen yabancı dil bazen de farklı sebeplerle yabancı gemiadamlarını tercih edebilmektedirler. Bu sebeplerden dolayı Türk vatandaşı olan gemiadamlarının da yabancı firmaları kendisine çalışmak için hedef belirlemesi ve bunun gerekliliklerine göre de kendisini yetiştirmesi gerekmektedir. Özellikle Çin ve Filipinler gibi ülkelerin

vatandaşları bu alanda en çok kazanan kişiler durumundayken, bu alanda ülkelerine de milyarlarca dolar girdisi sağlayarak ekonomik olarak da katkı sağlamaktadırlar. Tabi uluslararası alanda çalışabilmek için de uluslararası denizcilik prosedürlerine harfiyen uyan kendisini iyi geliştirmiş gemi adamı olmak önemlidir.

Gerekli nitelikleri edinen gemiadamının bir sonraki adımı ise iş hayatına atılması için uygun bir iş bulmaktır. Uygun bir iş bulmanın yolu da doğru iş arama kanallarını kullanmaktan geçmektedir. Gemiadamlığı mesleği maddi imkanlarından dolayı bazen art niyetli insanlar tarafından dolandırıcılık yöntemi olarak kullanılmakta ve insanlar mağdur edilmektedir. Bu sebeple herhangi bir mağduriyet yaşamama ve doğru işi bulabilme adına resmi iş arama kanallarını kullanmak önemlidir. Burada da ilk akla gelen yerli kurumlar Deniz Ticaret Odası ve İşkur'dur. İkisi arasında 2017 yılında imzalanan protokol gereği iş ilanları Türkiye İş Kurumu Portalı'nda yayınlanmaktadır. Bu iki iş arama kaynağı haricinde sektörde faaliyet gösteren denizcilik şirketlerine özgeçmiş ile birlikte de müracaat edilebilir.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Future of Vessel Traffic Service as A Socio Technical System and Simulation Tools

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ABSTRACT

Transportation is a large complex system which comprises interactions between different types of entities, including technical systems, operational stakeholders, regulators and consumers. Especially in aviation and maritime industry, technology and human play central role in terms of interdependence, effectiveness and continuity. In this way, vessel traffic service (VTS) is sophisticated socio technical system (STS) that is created by technology and human factors in maritime industry. Today, the quantities and types of cargo transported by sea continue to increase depending on the increase of the world population and the evolution of the industry. As a result of this increase, marine transportation tools as vessels are also increasing in tonnage and numbers. Especially in the ecologically and strategically important waterways of the straits, canals and inland seas, increasing vessel traffic has become a necessity to be controlled and monitored continuously. In the maritime industry, contributing to the continuity of maritime trade by providing efficient vessel traffic organization and being able to maintain safety of life, cargo and environment at sea is the basic task of vessel traffic services. Therefore, vessel traffic services must continue to function in all adverse conditions that may occur by carrying out necessary proactive studies like modeling, simulation and analyzing. So, we examine close relationship and similarities between vessel traffic service and socio technical system. Also, we show that simulation tools are needed for vessel traffic service as complex socio technical system. In the context of the study, one can see general

information of the vessel traffic service and socio technical system. Thanks to these general information, this paper can outline that VTS organization and STS approach have same basic principles. In addition, simulation tools may also be described in paper. Other chapters are about the future of complex socio technical vessel traffic service system and conclusion.

Keywords: Vessel Traffic Service, Socio Technical Systems, Safety Navigation, Simulation

1. Introduction

Using of technology has an important place in transportation as in every sector. Especially space sciences, aviation and maritime are the sectors where the use of technology in transportation is more important. When there are increasingly complex technological systems, manpower and different management organizations, a structure with multifaceted operating mechanisms emerges. In order to work efficiently these structures which are defined as socio technical systems, different socio technical system approaches have been created and modeling and simulation methods have been developed in order to be able to react quickly and effectively against unexpected adverse situations. Concepts such as time management, energy efficiency, planned and organized movement of port facilities and vessels, vessel traffic organization, environmental management, risk analysis are important for the economic reductions and time losses that may occur in the maritime industry, issues that need to be addressed [1,2].

Vessel traffic service aims to minimize the economic losses due to ship accidents and the risks that may arise due to the increasing vessel traffic and to ensure the safety of navigation, life, property and environment. VTS is seen as an important organization where the technology and human factor are used together in the maritime sector [3].

2. Vessel Traffic Service (VTS)

The oldest navigational aids are lighthouses and buoys for vessels. However, after the Second World War, these short-range visual and auditory navigational aids were insufficient to ensure the efficiency of navigation safety and port facilities, given the traffic density caused by the diversity and size of the goods and vessels. As a result of the development of technology, remote sensing and monitoring systems were needed in order to increase the efficiency of the ports/terminals and to ensure the safety of the dense vessel and cargo traffic. As a result, the first radar-based port control station was established in 1948 on Douglas Island in England (see Figure 1). In the same year, a radar

station was installed in the ports of Liverpool and Rotterdam. Later, a series of coastal centered radar monitoring chains were established in other European ports, including approaches to the port of Amsterdam in 1952 and the entire Rotterdam port area in 1956 [4]. Technical structure of an improved vessel traffic services; from a simple radar and voice radio system, to increase the safety of the marine environment, to increase the efficiency of sea traffic, to protect the marine environment in accordance with the objectives of using a remote sensor is described as a system [5].

290 *The Shipping World* MARCH 10, 1948

Figure 1: First Established Radar Based Port Control Center (Douglas, UK) [6].

Vessel traffic service (VTS) is a service designed to ensure the safety of life, property and environment in the area where it is responsible. This service must be capable of responding to all traffic situations in the VTS area and interacting with all relevant vessels (monitoring, communication, analysis, etc.). According to the common definition of VTS, explained by IMO, IALA, EU and all relevant documents, the main objectives of the VTS can be listed as follows;

- Increasing vessel traffic safety in the VTS area
- Increasing vessel traffic efficiency in the VTS area
- Protecting the marine environment from the negative impact of vessel traffic.

There are general characteristics of the regions where VTS can be established, but it is not necessary to provide all the features specified for the establishment of a VTS system. One or several features can be seen even enough to establish the VTS system. General characteristics of the regions where VTS system can be established can be listed as follows;

- High sea traffic density and complexity in navigational structure
- Dangerous goods transportation
- Difficult meteorological and hydrological conditions
- Shelters and other local hazards (rocky, sunken, etc.)
- Environmental and social factors (population of the region, ecological structure, etc.)
- Interaction of vessel traffic with other marine activities (pilotage, military activities, fishing activities, sport activities, local traffic, training, supply, escort, underwater operations etc.)
- Number of accidents per period
- Need for cooperation with other VTS Centers
- Regional structures (bridges, pipelines etc.) that will affect vessel traffic
- Current traffic patterns and possible changes

The common purpose of all VTS centers is to ensure the safety of life, property and environment at sea and to increase the efficiency of marine traffic. However, due to the unique characteristics of the regions where the VTS is established, the areas of responsibility and focus areas of the VTS can be different. In addition, different legal, economic or political purposes of the states in establishing the VTS system were also effective in the classification of VTS centers. Various VTS systems available on the world can be listed as follows;

- Port VTS
- Coastal VTS
- Combined (Port-Coastal) VTS
- Regional VTS
- River VTS
- Bridge Protective VTS

There are three basic functions of vessel traffic services in operational terms as follows;

- Information Service (INS)
- Navigational Assistance Service (NAS)
- Traffic Organization Service (TOS) [6].

3. Approaching of Socio Technical System (STS)

The approaching of socio technical system with its most general definition is the structures formed by social and technical systems and the sub-units forming these systems complement each other. The systems created by these two systems are called socio-technical systems [7]. A socio technical system consists of sub-systems that express the sub-components of the system. Figure 2 shows the structure of subsystems of a socio-technical system. We can sort subsystems as follows;

- *Physical systems:* These are the basic structures representing the places or tools in which the system exists.
- *Information systems:* represent components that enable the functioning of physical systems. Physical and information subsystems; it refers to the technology part of the socio-technical system.
- *Individual system:* Represents the individual who conducts the operation of the technological system. There are many factors affecting the role of the human factor as an individual in the execution of the operation. Criteria such as competence, ability, work experience, age, gender, education background, instincts, self-

confidence, motivation and spiritual values are factors that can affect the whole system. A simple system of human and mechanical structure is called system Human Computer Interaction (HCI). So; This is the simplest version of the socio technical structure that occurs as a result of the gathering of human and technic.

- *Organization (Group) system:* It is the structure that forms the roof of the socio technical system and completes the system. This structure, which consists of more than one person, represents the entire management of the system, its organizational structure, leadership styles, division of labor and coordination. In addition, the place of the system in national and international conventions, the changes in the organization and the rules determined are considered within this structure [8].

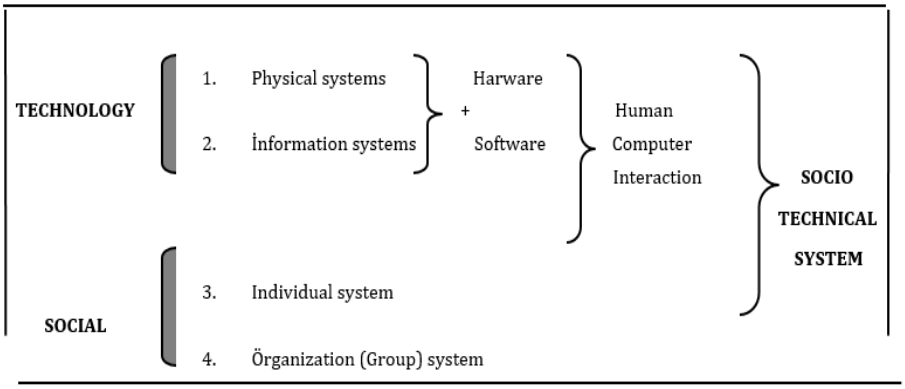

Figure 2: Sub-Systems of Socio-Technical System [8].

In addition to the existence of sub-systems to be able to define a socio technical system for a structure, some requirements must be provided. The requirements of the socio technical system can be listed as follows;

- *Security:* The system must be able to control and reject an unwanted entry. Technical and organizational infrastructure must be sound against any risk of attack.

- *Extendibility:* The system should be able to use different data obtained for different purposes. It should be open to change.
- *Reliability:* The internal structure of the system should be able to manage all of the subsystems, be able to react quickly and take necessary measures to reduce the risks.
- *Flexibility:* The system must adapt to changes in the external environment and follow the changes continuously. Furthermore, it should not be adversely affected by the organizational and technological changes that may occur in the system.
- *Functionality:* The system should be able to use its resources in the most efficient way and be able to work to make more efficient use of resources and outputs.
- *Usability:* The system should make the cost-benefit analysis correct in the use of resources and always aim to get the most efficiency with minimum cost.
- *Connectivity:* The system must be in communication with different systems and should be in constant connection with similar systems.
- *Privacy:* The system must have its own communication channel and should be able to limit the communication of the external environment with the system when necessary [8].

4. Suitability of Vessel Traffic Service to Socio Technical System Approach

When the definition of socio technical system approach, sub-systems, requirements and definition of vessel traffic services, planning, interaction units, technological requirements and organizational structure are compared, it is possible to evaluate VTS system as a socio technical system. VTS system which has intense technology and human interaction, organizational flexibility, technical infrastructure and openness to change is the most important example of socio-technical system approach in maritime sector. Figure 3 shows the VTS central components and the units in which they interact. VTS

centers collect a wide range of operational data to effectively manage emergency emergencies in vessels, crew, ports and terminals.

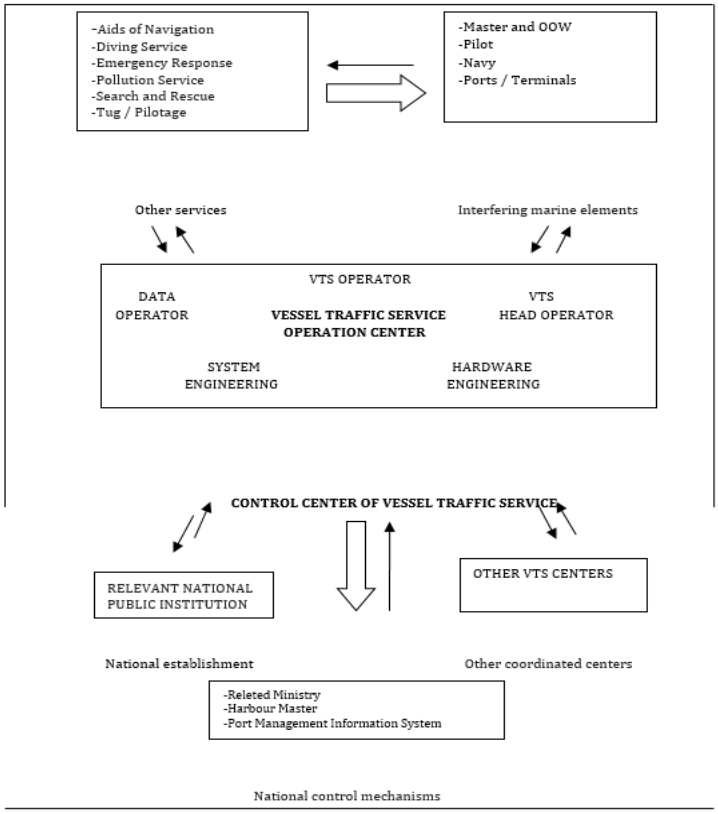

Figure 3: Agents Of Vessel Traffic Services Center Units And Other Components They İnteract With.

5. Simulation Tools

Solving some of the problems we encounter in real life can be very difficult in terms of cost, time or difficulty in processing. However, instead of actual attempts or attempts to solve these problems, models and solution options can be reached easily and with less risk. Modeling stages start with the transfer of real events to the model environment and after the selection of the reduction / generalization level to be used, all the processes that will contribute to the solution of the problem on the model are created [9]. Problem analysis with simulation and modeling methods is important for high quality solution of

problem and a system with dynamic features even though it is costly due to the need for training in computer infrastructure [10]. It is the only option to use modeling and simulation technique;

- If the system to be designed is not yet available,
- If the test, measurement and analysis to be performed in the real environment is risky and costly,
- If test, measurement and trails are not possible in the real environment.

Combining all the modeling and simulation approaches that may be necessary in solving complex problems is effective in obtaining solutions that can be applied to the problem, can be created quickly, and are less costly and adapt to changing conditions. There are approaches to modeling and analysis of changes in complex systems and the results of these changes. Basically, if we list;

- Network Flow Based Methods
- Stochastic Reachability Analysis
- Viability Theory
- Agent Based Modeling and Simulation

There are four main conclusions that are taken into consideration in the transportation sector and which have priority and exact data depending on the risks.

- (i) Negligible results
- (ii) Major results affecting one or more means of transport
- (iii) Significant local performance results
- (iv) Information performance results

As it can be understood from Table 1, from the modeling and analysis approaches, it is the most suitable agent-based modeling and simulation approach for transportation sector.

Table 1: Modeling And Analysis Of Results Which Are Resulting From Problems And Risks.

Approaching of Modelling and Analyse	Results from problems and risks (i) (ii) (iii) (iv)			
-Network Flow Based Methods	+	-	+	+
-Stochastic Reachability Analysis	+	+	+	-
-Viability Theory	+	-	+	-
-Agent Based Modeling and Simulation	+	+	+	-

When we examine Table 1, human factor plays key role in results 1, 2 and 3. In terms of applicability to the results, the Agent Based Modeling and Simulation approach and the Stochastic Reachability Analysis approach are the most appropriate approaches. However, Stochastic Reachability Analysis should be combined with some mathematical methods. Without these mathematical methods, modeling, simulation and analysis of this approach may take too long. On the other hand, the Network Flow Based Methods approach can be applied to results 1, 3 and 4, but it has no role in analyzing human-source failures. Therefore, it will not be appropriate to apply to the entire transport sector. Viability Theory approach does not address all of the main conclusions achieved. In this case, the agent-based modeling and simulation approach is the most appropriate approach that can be applied in the transport sector [11].

Agent based modeling and simulation approaching have four basic elements. ''Agents'' are the most important elements of the model (VTS operator, Captain, port facility, etc.) and have specific characteristics, behaviors and rules defining these properties. The second key element of the model is that there are ''Relationships'' between factors (VHF, telephone, mail, AIS, etc.). Each factor relationship helps to identify how agents interact. Third, there is a definition of ''Environment'' (VTS area, sectors) where the factors interact. The last element is the ''Systems'' (VTS system), which have all boundaries

defined by certain boundaries, including the environment and the factors in which these interactions take place [12,13].

The agent-based modeling and simulation approach has been applied in many areas, at different times, using different programs and tools. The first simulation tool is Swarm, developed for use in libraries. Later MASON was developed. These software have been used to a large extent because they provide standard software designs without limiting the complexity and variety of models that can be implemented. However, both software have well-known limitations. NetLogo, RePast, Brahms, LEADSTO [14], TOPAZ are other important programs and tools. Other agent-based modeling and simulation approaches; AgentSheets, AndroMeta, AnyLogic, Ascape, Breve, Cormas, DEVS, EcoLab, FLAME, JAS, LSD, MAML, MATSim, MASS, MetaABM, MIMOSE, MobiDyc, Modeling4all, Open StarLogo, Repast Simphony, SimPack, SimPy, SOARS, StarLogo, We can list as SugarScape, VisualBots, Xholon [15].

6. Future of Vessel Traffic Service

It should be understood that, advanced remote sensing systems and autonomous vessels will be included in the maritime sector in the following years. It is necessary to define ways to monitor and manage the variability of the system in order to redesign the vessel traffic services as a system that can cope with the various working conditions. Especially with the expansion of autonomous vessels, it can be foreseen that the vessel traffic services system will become a more complex system with different operational and management groups with more advanced technological infrastructure. In fact, there may be radical changes in the profession and definition of vessel traffic services.

7. Conclusions

In parallel with all studies conducted in the field of behavioral sciences and technical sciences, it has once again been clarified that with this academic study, the future development of the maritime sector needs to be studied for the resilience and sustainability against various possible failures. In the following years, the changing

technology and the increase of autonomous systems will lead to the change of human and group administrations, as well as the continuous updating of emergency management.

This paper, which is done to analyze some dynamics of the agent-based modeling and simulation approach, which is applied extensively in the aviation field of the transportation sector, such as time and human management in the maritime sector, needs to be considered more extensively. All the components of the ship traffic are included in the study and the impact on the port operations, cost analysis, the impact on the pilotage operations and even the damages of the affected shipowners can be minimized.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

The Analysis of Endorsement and Recognition Problem for Turkish Marine Officers' Certificate of Competencies (CoC)

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ABSTRACT

Maritime education, training and certification standards are set in accordance with the STCW Convention and Code. Since the seafarers and their competencies play an important role in marine accidents, significant problems and issues are required to be studied carefully. There have been considerable amount of studies describing the effects of STCW Convention over some specific countries. However, there are few studies have been published about the different implementations of STCW requirements as well as endorsement and recognition problems among the member states. It is observed that still different practices such as upgrade requirements for officers CoC and formats of seafarers' documentation have been followed by the member states. In this study, different practices of member states have been investigated in order to recommend a full standardization on the STCW implementations. Representatives of ship management companies have been consulted and questionnaire is applied among them. The results of questionnaire have been comparatively analyzed. On the basis of these findings, the lack of recognition and endorsement problems for Turkish CoC has been analyzed. Significant results have been found which it is believed that these results will be reference and helpful for the future researches and probable revisions. At the end of this study, recommendations are provided for a better practice of maritime legislation and provide standardization for the STCW Convention and STCW Code for all member states.

Additionally, by means of this work, also the reputation and recognition of Turkish CoC are aimed to be increased at the international level.

Keywords: STCW Convention and Code, Certificate of Competency, Recognition of Turkish CoC, Endorsement, SWOT-AHP

1. Introduction

Maritime education, training and certification standards are set in accordance with the STCW Convention and Code. STCW 78 has been ratified by 162 member states which consist of %99.44 of world tonnage [1]. In order to operate these expensive assets safely and environment friendly, there should be well-trained crew who are competent in accordance with the International rules and regulations. As seafarers' competencies play an important role in marine accidents, some of the significant issues are required to be studied carefully.

First of all, the requirements for upgrading Certificate of Competency (CoC) differ from country to country although the STCW Code clearly explains the minimum requirements. Some countries require more sea service and/or course and/or examination (written-oral) while others require less sea service without course or exam to upgrade CoC. This creates unequal working environment among the seafarers from different parts of the world. Also, the experience of officers would not be considered as same.

Furthermore, although the formats of competencies are identified within the STCW Code Part-A, there are still differences among the parties' implementations. For instance, while some parties provide STCW certificates within the seaman's book such as Turkey, the others may provide as a separate paper such as Panama or Brazil. In this study, documents of seafarers with different formats have been collected and checked to reveal the differences.

The aim of this study is therefore to compare the different upgrading requirements for officers around the world and understand the endorsement and recognition problem for Turkish CoC.

1.1. Background and Literature Review

International Convention for STCW was entered into force on 28 April 1984 after its adoption in July 7th, 1978. The main aim of the convention is to ensure the safety and protection of life and property at sea [1].

Since the date of entry into force (28th April 1984), four amendments has been adopted in 1991, 1994, 1995, and 2010.

The latest one; 2010-amended STCW Convention came into force on 1 January 2012. However, there was a five-year transitional period, until 1 January 2017, to allow for a phased in implementation of the provisions [2].

Considering the differences, Stenman [3] presented the difference of the different level of seafarer training based on period and conditions. Chong Ju. Chae [4] from the World Maritime University has studied the STCW Manila Amendments in terms of its challenges to the Far East countries in which a strong source of manpower is produced.

Dahlberg and Nyqvist, [5] worked on the differences between the assessment of nautical competence of Swedish and Philippine final year students by investigating the curriculum of the programs for maritime competence between Swedish and Philippine final year students at the master mariner programmes.

A large and growing body of literature has investigated the human error and the rules and procedures of STCW Code and its implementations over the member states. However, there are few studies have been published about the reason of different implementation of STCW Convention and Code as well as endorsement and recognition problems.

1.2. Method of Research

Firstly, this study will conduct a detailed review of the CoC upgrading requirements for officers among member states, materials such as the STW sub-committee papers, related publications, reports dealing with the STCW Manila amendments, UNCTAD reports and BIMCO/ISF manpower reports, will be used as the basic source of this research.

Secondly, more than 30 flag states have been consulted to get information about the CoC upgrading requirements for officers and endorsement procedures. Also, these flag states have been asked if they recognize and issue endorsement for Turkish CoC. Similarly, Turkish administration has also been consulted in order to learn by which flag states Turkish CoC is endorsed.

Besides, interviews carried out with ship management companies' staff such as crew managers, fleet managers, and designated person ashore (D.P.A.) especially for the questionnaire. The data received from these meetings have been used to make comparative analysis about standardization of STCW Convention & STCW Code and problems of Turkish CoC with regards to endorsements and recognition in the international shipping market.

2. Recognition and Endorsement Problem for Turkish Certificate of Competencies

2.1. Flag Registration Analysis

Leading flags of registration by tonnage (DWT tonnage) have been listed on Table-1 in accordance with the Clarkson and UNCTAD (United Nations Conference on Trade and Development) reports.

Table 1: The Overview of Largest Flag Registrations [6].

Flag of Registration	**Number of vessels**	**Dead-weight tonnage**	**Share of world total dead-weight tonnage (percentage)**	**Dead-weight tonnage growth, 2016-2017 (percentage)**
Panama	8052	343 397 556	18,44	2,75
Liberia	3296	219 397 222	11,78	5,66
Marshall Islands	3199	216 616 351	11,63	7,76
Hong Kong*	2576	173 318 337	9,31	6,23
Singapore	3558	124 237 959	6,67	0,21
Malta	2170	99 216 495	5,33	5,14
Bahamas	1440	79 842 485	4,29	0,79
China*	4287	78 400 273	4,21	2,12
Greece*	1364	74 637 988	4,01	1,6

United Kingdom*	1551	40 985 692	2,2	10,42
Japan	5289	34 529 405	1,85	6,6
Norway*	1585	21 900 458	1,18	6,89
Denmark*	654	16 893 333	0,91	-1,73
Turkey	1285	8 200 982	0,44	-3,83
Islamic Republic of Iran*	739	6 583 064	0,35	34,49
Cayman Islands*	161	5 549 056	0,30	28,52

*shows the Flag States which do not recognize Turkish CoC, do not issue endorsement for Turkish CoC

2.2. Endorsement Problem

For the recognition of STCW qualification certificates, all officers on foreign flagged vessels are required to obtain the national qualification certificates recognized by the foreign flag administration they are working abroad. The foreign flag authority shall give an approval confirming that a certificate issued under the provisions of the STCW Convention has been recognized. For instance, if a seafarer has a certificate from country 'x' , but he is working for a ship registered in country 'y' , then he needs to apply to the maritime administration of country 'y' for a certificate authorizing him to serve on ships registered under its flag. Under the 2010-amended STCW Convention and Part A-Part, Part-I / General Provisions, Regulation I/2-Certificates and approvals, and Regulation I/10-Recognition of the certifications, all seafarers serving on foreign ships must obtain an endorsement.

In accordance with the information received from Turkish Ministry of Transportation, Maritime and Communication, Directorate General of Maritime and inland waters regulation, the Table-2 provides the flag states which do recognize Turkish CoC and issue endorsement.

Table 2: List of Flag States Which Recognize and Endorse Turkish CoC according to Turkish Directorate General of Maritime and Inland Waters Regulation. [7]

Mutual Recognition (bilateral agreement)	**Below countries recognize Turkish CoC and provide Endorsement (unilateral agreement)**	
Azerbaijan	Antigua and Barbuda	Poland
Bulgaria	Bahamas	Portugal
Italia	Barbados	Slovakia
Islamic Republic of Iran*	Belize	St. Vincent and the Grenadines
Malaysia	Cambodia	Vanuatu
Malta	Dominican Republic	Luxembourg
Romania	Germany	The Marshall Islands
Russia	Japan	Liberia
Singapore	Lebanon	
Thailand		
The Netherlands		
Ukraine		

*Although the Islamic Republic of Iran was on the list received from the Turkish Authorities, the Iran Maritime Authorities did not confirm recognition.

On the other hand, Turkish CoC is not recognized by some important flag states. Table-3 reveals the list of flag states which do not recognize Turkish CoC.

Table 3: List of Flag States which do not Recognize and Issue Endorsement for Turkish Competencies (CoC) [7, 8]

Country	**Reason for not accepting Turkish CoC**	**Tonnage (DWT-Millions)**	**Number of Ships**

Hong Kong	Lack of Agreement IAW STCW Reg. I/10	173.318.337	2.576
Greece	Lack of Agreement IAW STCW Reg. I/10	74.637.988	1.364
UK	Lack of Agreement IAW STCW Reg. I/10 Audit on training and certification procedures	40.985.692	1.551
Norway	Lack of Agreement IAW STCW Reg. I/10	21.900.458	1.585
Denmark	Lack of Agreement IAW STCW Reg. I/10	16.893.333	654
Bermuda	Lack of Agreement IAW STCW Reg. I/10	10.957.895	160
France	Lack of Agreement IAW STCW Reg. I/10	6.966.582	547
Islamic Republic of Iran	Lack of Agreement IAW STCW Reg. I/10	6.583.064	739
Turkey	Comparison regarding fleet capacity	30.000.000	1.285

2.3. Different Requirements for Upgrading Officers' Competencies

In this section, minimum STCW requirements and different implementation regarding the requirements of upgrading CoC have been analyzed [9]. Selected model countries are Turkey, The UK (MCA)*, Japan, Germany, Brazil*, Hong Kong*, Philippines*, India*, Norway*, Israel.

Chapter II within STCW Code Part-A consists of all information about minimum requirements for Master and Deck Department while Chapter III consists of all information about minimum requirements for Engine Department. A total of four detailed comparison table have been attached at the end of this study while the comparison analysis and discussion have been carried out within the text.

3. Analysis and Discussions

3.1. Comparative Analysis for Master and Chief Mate Competencies

In accordance with the STCW minimum requirements, it is possible to become unlimited master provided that minimum 36 months seagoing service as officer of the watch is proved [9]. Most of the developed countries have been following the minimum requirements of STCW Convention for upgrading system. It means that there is possibility to upgrade for master level directly from OOW competency level, by-passing the chief mate competency. However, according to the STCW Convention and Code, the 36 months of seagoing service can be reduced to 24 months if not less than 12 months of such seagoing service has been served as chief mate [9]. In another words, the required seagoing service is divided into two parts; 12 months sea service as OOW and 12 months sea service as chief mate.

It is noted that Turkey and Brazil have been demanding the longest seagoing service duration for upgrading master CoC.

Additionally, it should be emphasized that Germany requires minimum 12 months sea service as chief officer for upgrading master CoC, without any additional training course or exam obligation.

Another significant finding is that Germany, Brazil and Norway do not require any exam for upgrading master CoC. The options for the evaluation of competence have been left with the administration according to the STCW Convention and Code, Section B-II/2, B-II/1, Article 17.

Unfortunately, although the Turkish CoC upgrading requirements are one the most difficult ones among the member states, there are still important parties (flag states) do not recognize and issue endorsement for Turkish CoC.

Last but not least, an approved education and training have to be completed and meet the standard of competence specified in section A-II/2 of the STCW Code for masters and chief mates on ships of 3,000 gross tonnage or more.

Additionally, it is noted that most of the developed countries such as UK, Germany, Japan, and Hong Kong require a minimum 12 months seagoing service as officer of the navigational watch to upgrade for chief mate competency. In other words, they follow minimum STCW requirements without adding any extra conditions.

As can be seen from the Attachment-2, Turkey, Brazil, and Norway are the countries requiring the longest seagoing service for upgrade chief mate CoC while most of the others prefer to follow the STCW minimum requirements.

Regarding the obligation for training course for upgrading; UK, Brazil, India, Norway, Israel require such training for officers while countries such as Japan, Germany, and Hong Kong do not require. The most striking finding in this part of the study is that Germany even does not require any training course for upgrading. Moreover, there is no obligation for officers of the watch to sit exam to upgrade competencies in Germany.

As can be seen from Attachment-2, some member states require course and exam while some of the others do not. At the end, some of the flag states do not recognize each other and do not issue endorsement to allow other nations' officers to work onboard its own flag and vice versa.

There is a striking point to note that evaluation of competence issue has been left with the preferences and responsibility of member states according to the STCW Convention, Code Section B-II/2, B-II/1, Article 17. In another words, the obligation to sit for exam (written or oral) to upgrade CoC, is depending from state to state.

What is more surprising is that although Turkish upgrading requirements for chief mate CoC is much more difficult and tighter than UK, especially in terms of seagoing service duration, both states do not recognize each other [10]. This problem prevents Turkish officers to work onboard UK flagged ships including Red-ensign flags (Bermuda, British Virgin Islands, Cayman Islands, Gibraltar, and Isle of Man) As it is known, there are also many mega-yachts and super-yachts with a minimum size of 50 meters up to more than 100 meters which fly UK and Red-ensign flags. Therefore, Turkish CoC holders (Turkish

officers) are not allowed to work onboard these yachts due to the lack of recognition for endorsement.

Also, difference to Turkish system, in accordance with the Brazilian regulation, unlimited C/O is allowed to work as master on all ships within the inner waters/rivers, and on ships up to 500 GRT in all waters.

Similarly, German watchkeeping officers are issued with an endorsement of extension, so that they can also serve as chief mates on feeder-ships of between 500 GT and up to 3,000 GT.

Last but not least, an approved education and training have to be completed and meet the standard of competence specified in section A-II/2 of the STCW Code for masters and chief mates on ships of 3,000 gross tonnage or more.

3.2. Comparative Analysis for Chief Engineer and Second Engineer Competencies

Attachment-3 and 4 show an overview of upgrading requirements of flag states together with minimum STCW requirements for unlimited chief engineer and second engineer CoC.

In compliance with the STCW minimum requirements it is possible to become unlimited chief engineer officer provided that minimum 36 months seagoing service as engineer of the watch is proved [9]. Most of the developed countries have been following the minimum requirements of STCW Convention for upgrading system. It means that there is possibility to upgrade for chief engineer level directly from EOW competency level, by-passing the second engineer competency. However, according to the STCW Convention, for certification as chief engineer officer, shall have not less than 36 months' approved seagoing service of which not less than 12 months shall have been served as an engineer officer in a position of responsibility while qualified to serve as second engineer officer. As same as deck department requirements, also an approved education and training have to be completed and meet the standard of competence specified in section A-III/2 of the STCW Code.

Unlike upgrading requirements for master CoC, it is not possible for chief engineer CoC to decrease the required approved seagoing service from 36 months to 24 months.

It is apparent from Attachment-3 that most of the developed countries such as UK, Germany, Norway, and Hong Kong follow minimum STCW requirements for upgrading chief engineer CoC without adding any additional requirements.

Furthermore, it has been noted that Germany and UK have the quickest upgrading system for chief engineer, requiring 12 months seagoing service as 2/E to become unlimited chief engineer while Turkey [10] require minimum 36 months of seagoing service as 2/E.

On the other hand, Turkey and Brazil have been following the longest upgrading way and requiring the longest sea service period.

It is also surprising that Germany, Israel, Japan and Hong Kong do not require any training course for upgrading this level.

As can be seen from the Attachment-3, most of the countries require exam for assessment and evaluation of competence for upgrading. However, Germany and Brazil do not require any exam. Likewise, Belgium and Lithuania are other two countries mostly follow the same procedures like Germany, and they also do not require any exam procedure for upgrading.

Furthermore, the countries such as UK, Japan, Germany, India, Philippines follow the STCW minimum requirements for upgrading second engineer level without demanding any extra conditions. Some developing countries such as Finland, Belgium, and Lithuania have not been put into this list since their upgrading procedures are same as Germany's requirements.

Turkey and Brazil again appears as top-notch demanding countries for the duration of approved seagoing service unlike others. As the Attachment-4 provides, it is required to provide a minimum 36 months seagoing service as engineer of the watch to become second engineer (III/2)

Regarding the obligation for training course for upgrading; UK, Brazil, India, Norway, Israel require such training for engineering Officers while countries such as Japan, Germany, and Hong Kong do not require. The most striking finding in this part of the study is that Germany even does not require any training course for upgrading. Moreover, there is no obligation for engineers to sit exam to upgrade competencies in Germany.

It should also be noted that according to the German regulations, a second engineer is allowed to work as chief engineer on ships powered up to 3000 kW unlike in Turkey.

Similarly, unlimited second engineer in Brazil is allowed to work as chief engineer on ships powered up to 3000 kW in all waters or can work on ships without any kW limitations within the inner waters/rivers/cabotage.

As same as deck department requirements, also an approved education and training have to be completed and meet the standard of competence specified in section A-III/2 of the STCW Code.

3.3. Comparative Analysis for STCW Certificates

Although most of the member states provide STCW certificates as separate sheets, there are several ways to provide certificates. For example, Croatia provides STCW certificates as separate sheet while Turkey provides all of the certificates inside the seaman's book by writing the name of certificate and regulation number as per STCW Code together with the issue date and expiry date.

In accordance with the STCW Convention and Code [9], the definition of certificate appearing in Article II (c) provides three possibilities: (STCW Code, Section B-II, Art.-2, Guidance regarding definitions and clarifications)

a. The Administration may issue the certificate;

b. The Administration may have the certificate issued under its authority; or

c. The Administration may recognize a certificate issued by another party as provided for in Regulation I/10.

It means that the administration can recognize and authorize private training centers to provide training and issue certificates which are accepted by its own administration and other authorities. (E.g. Panama)

Another way is that the administration can only authorize the training centers or maritime schools to provide maritime trainings, however related certificates can be issued only by the administration with reference to the training received at the approved training centers or maritime schools. (E.g. Turkey) In this option, there are also two ways to issue certificates. Some countries provide STCW certificates as separate sheet while others do not.

Overall, these findings indicate that countries like Belize, Honduras, and Panama approves the certificates issued by training centers and such certificates are directly used by officers. On the other hand, countries such as Brazil, Croatia, and Egypt issue its own certificates as separate sheet (A4 size). Azerbaijan and Georgia also provide separate certificates issued by the administration, in a smaller size while Turkey prefers writing the names of certificates inside the seaman's book without identifying the duration of course, date of start and finish of course, name of trainers, etc.

3.4. Questionnaire with Ship Managers

The costs which have been born due to the issuance of endorsements have been checked by questioning ship managers in order to analyze its economic burden. By means of the questionnaire directed to the crew managers of these companies, important results have been provided.

A total of 23 participants from ship management industry have contributed the questionnaire. The Figure-1 shows the distribution of participants.

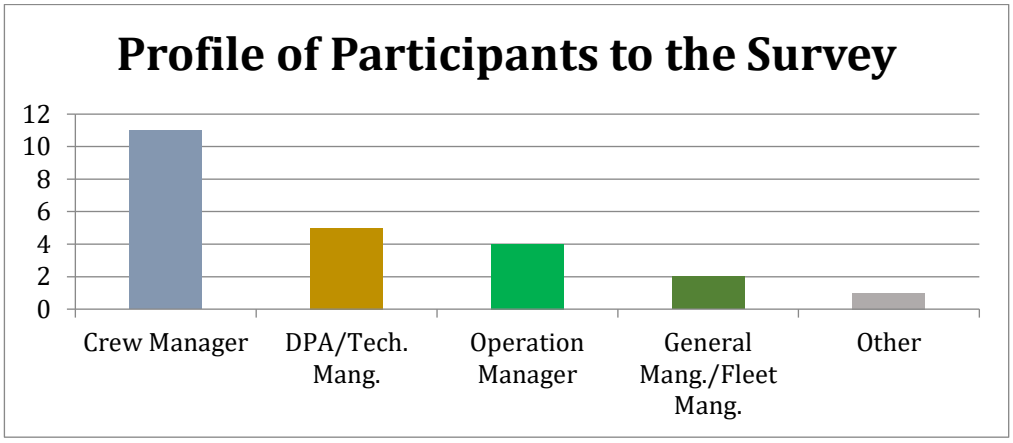

Figure 1: The Profile of Participants.

According to the results of questionnaire, there is a great variety of seafarers' nationalities which the companies employ. Onboard the vessels of participants, there are seafarers from a total of 15 different nations; Azerbaijan, Bulgaria, Egypt, Georgia, India, Indonesia, Iran, Maldives, The Philippines, Poland, Romania, Russia, Sri Lanka, Turkey, Ukraine.

Also, a wide diversity of the flag states of ships has been observed. There are different flags which are hoisted by the participants' ship management companies, a total of 15 different flag states; Bahamas, Comoros, Cyprus, The Netherlands, Hong Kong, Liberia, Malta, Marshall Islands, Palau, Panama, Portugal, Saudi Arabia, Singapore, St Vincent and Grenade, Turkey.

One of the most interesting questions has been that if participants have ever had any difficulty while checking or handling documents/seaman's book/certificates of crew from different countries?

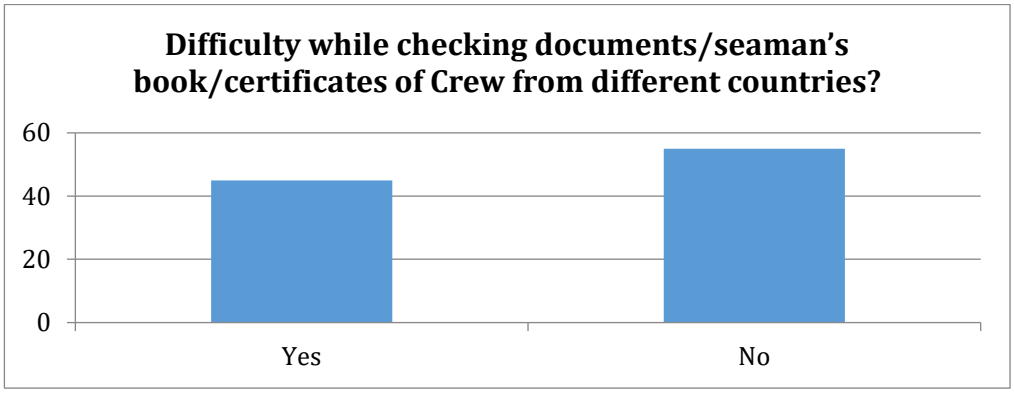

Figure 2: Difficulty in Handling Seafarers' Documents from Different Countries.

A total of 20 participants have answered this question. Interestingly, the results show that almost half of the participants (%45 of the participants) have difficulties while handling documents of crew from different nationalities as it can be seen on Figure-2. Considering the fast and safe operation are the most important factors in shipping, such time-taking procedures will slow the maritime operations or crewing personnel will endeavour more time to carry out the mentioned duties.

In the next question which illustrated on Figure-3, the participants have been asked if the companies or crewing personnel have ever had any difficulty due to the lack of original endorsement onboard.

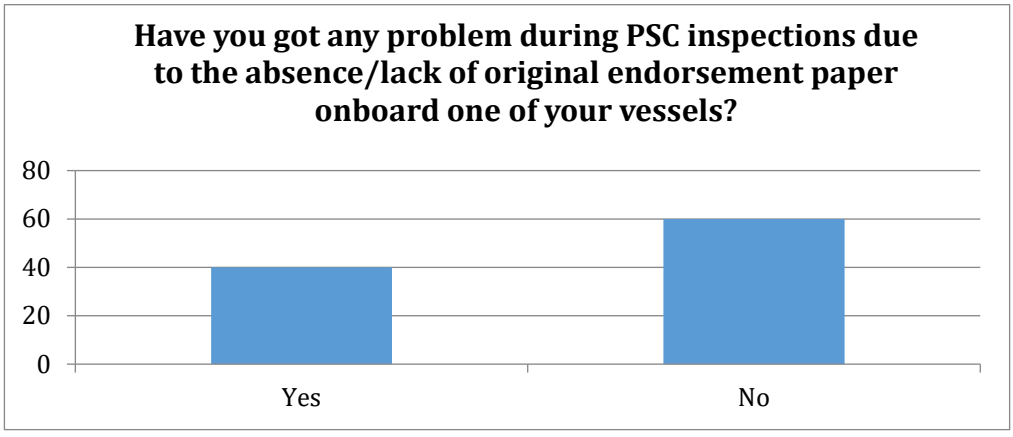

Figure 3: Problem during PSC Inspections due to the Lack of Original Endorsement.

A total 20 participants have answered this question. The results show that %40 of the participants has had problems due to the lack of original endorsement sheet onboard during PSC inspections although they have short-term copy.

Next significant question to the participants aimed to learn the expectations of ship management companies, especially crewing personnel. The participants have been asked if they would prefer a standardization of seafarers' documentation from all over the world to resolve the necessity of endorsement issue, regards to officers to work onboard different flagged ships other than seafarer's nationality as well as to have a better understanding in terms of format of documents, content of documents, accessibility of information on documents. As it can be seen on Figure-4, all of the answers shows that the participants would prefer standardization on the documentation of seafarers, and resolve the necessity of endorsement requirement to enable all officers from different nationality to work onboard all flags' ships providing that their countries from which they got training and certificate of competency has ratified STCW Convention and been meeting the minimum STCW requirements.

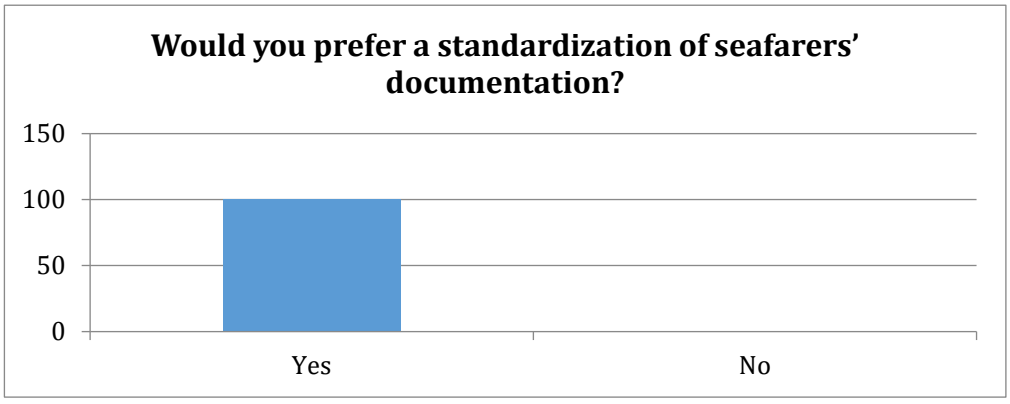

Figure 4: Preference for Standardization of Seafarers' Documentation.

Moreover, according to the answers derived from participants, it is understood that there is a considerable cost born due to the expenses of endorsement application. Surprisingly,

the amount of cost for endorsement issue per ship per year ranges between 5.000 USD and 15.000 USD even though the range of cost depends according to the rate of retention for crewing. It is understood that if the officers onboard are continuously changing, the amount of cost for issuing endorsements also increases. In contrast, if the officers have been working on same flagged ships, there is no need to apply for endorsement again which allows them to work without any further application and not causing any additional cost.

Last question has been asked about the difference on the requirements of CoC upgrading among countries which already ratified STCW Convention. %95 of the answers show that the participants would prefer standardization on the requirements for all officers, believing that same practices and procedures should be applied by the parties which already adopted STCW Convention.

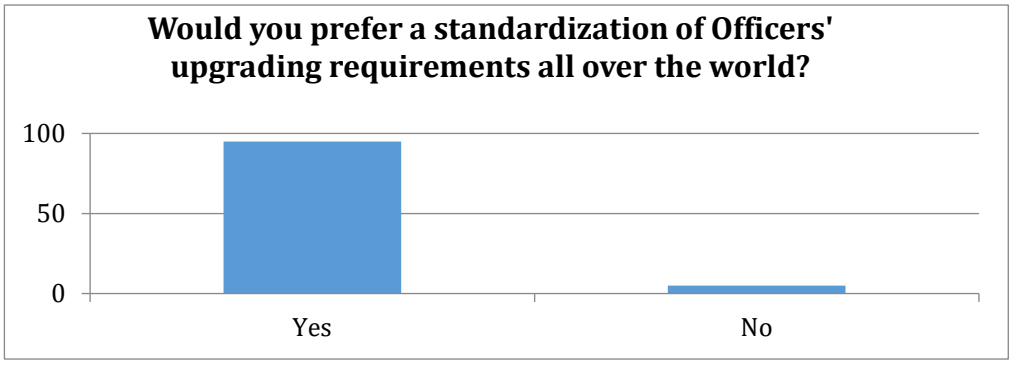

Figure 5: Preference for Standardization of Upgrading Requirements for Officers.

This standardization will also provide the equal working rights and conditions in the maritime industry regarding officers upgrading. Additionally, considering the safety concern, there will be officers with the same experience in terms of seagoing service. For instance, the chief mate from UK with a minimum experience of 12 months seagoing service cannot be considered as experienced as chief mate from Turkey with a minimum experience of 36 months. Once this standardization is provided, there will be

consequently same conditions and requirements resulting with officers who gain similar experience.

4. Conclusions and Recommendations

4.1. Conclusions

This study has been undertaken to figure out the international status of Turkish CoC as well as the recognition and endorsement problem of Turkish officer competencies. It has been demonstrated, for the first time, the different practices and implementation among countries which adopted STCW Convention and STCW Code.

Revealing the main problem; the study has shown that there is not a unique practice method for upgrading officer competencies and issuing the seafarers' certificates although all of the countries follow the minimum requirements STCW Convention and its Code. The main problem is hidden herein due to the fact that only minimum requirements are announced within the convention and STCW Code Part-A, and the recommendations are provided within the STCW Code Part-B as guidance [9].

Secondly, the recognition and endorsement problem for Turkish CoC has been proved. In another words, the certificates of competencies for Turkish officers are not accepted and recognized. This situation is likely to create a significant problem for Turkish CoC holders (Turkish officers) to be employed by the international shipping fleet. If endorsement agreements with other flag states that has been mentioned within the Table-3 are not signed, there is a strong possibility that Turkish officers will soon have major difficulties in finding vacant positions to work in long term.

One of the most important reasons is that there has been a significant increase in the number of maritime universities in Turkey. However, for the last 5 years, the Table-8 shows that there has been a steady trend in the number of ships, and a slight decrease in the capacity of ownership deadweight tonnage (including foreign flag under the management of Turkish companies).

Table 4: Turkish Ownership (Including Foreign Flag Registration) Growth Analyses of Last 10 Years.

TURKEY	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Number of Vessels	1163	1222	1199	1174	1580	1547	1530	1540	1563
Ownership incl. Foreign Flag (DWT)	15,4 x 10^6	16,7 x 10^6	19,7 x 10^6	23,4 x 10^6	29,0 x 10^6	29,2 x 10^6	27,6 x 10^6	27,9 x 10^6	27,7 x 10^6

Furthermore, the findings from this study make several contributions to the current literature.

First, the current national market for Turkish officers will be clearly understood, including the Turkish flag fleet and number of maritime training schools in Turkey.

Secondly, the international market requirements can be realized and it can be figured out how Turkish officers can work abroad more frequently with a good reputation.

Last but not least, all the member states under the STCW Convention will realize the different practices and implementation on the requirements of officers CoC upgrading as well as seafarers' documentation formats. This research will serve as a base for future discussions and studies in the committee levels at IMO (International Maritime Organization) since these minimum requirements are likely to be insufficient to make a full standardization for seafarers' documentation and upgrading requirements. Additionally, the endorsement procedures are not only time-taking, but also puts additional costs for the ship management companies. Therefore, it is predicted that the endorsement issue procedure may end in the close future and give way to the technology such as online verification system that is able to run and shared by all the administrations.

4.2. Recommendations

The overall findings of this study have a number of important implications for future practice. The following recommendations are listed in order to improve the functions of STCW Convention and Code:

- To provide a full standardization on officers' upgrading requirements among member states. (duration for seagoing service, requirement for training courses and exams)
- To provide a full standardization on the format for seafarers' documents; CoC (certificate of competency), STCW certificates, seaman's book.
- To improve the online verification system previously mentioned at the STCW Manila Conference [11] (STCW/CONF.2/32, 2010) and establish a mutual and online (7/24 accessible) verification system to enable related parties (Administrations, PSCO, Flag states, companies, seafarers) to instantly check and verify competencies and certificates all over the world. By means of this attesting system, the requirement for endorsement issue can be resolved. Also, the cost spent for endorsement issue can be avoided.
- To make endorsement agreements (Undertakings/MoU-Memorandum of Understanding) with as many flag states as possible, especially the ones which do not recognize and issue endorsement for Turkish CoC in accordance with the STCW Regulation I/10.
- Enhancing the working areas and reputation for Turkish officers all over the world.
- Revising upgrading requirements for Turkish CoC and follow the leading maritime nations such as UK.

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Attachments

Attachment-1 reveals the upgrading requirements; seagoing service duration, the necessity for course and examination for unlimited master CoC (Certificate of Competency).

Attachment-1 **Comparison Table for Master (>3000 GRT) II/2**				
	Seagoing Service	**Course**	**Exam (written)**	**Exam (oral)**

STCW	36 months as OOW or 24 months: 12 m as OOW + 12 m as C/O	Yes	Optional	Optional
Turkey	36 months as C/O	No	Yes	No
UK	36 months as OOW or 24 months of which (12 m as OOW + 12 m as C/O)	No	Yes	Yes
Japan	24 months of which at least 12 months as C/O	No	Yes	Yes
Germany	12 months as C/O	No	No	No
Germany	36 months sea service as OOW (while holding C/O CoC) (means 48 months sea service as OOW)	Yes	No	No
Brazil	24 months as C/O + 24 months as CCB (Cabotage Master)	Yes	No	No
Hong Kong	36 months as OOW Or 12 months as OOW + 12 months as C/O	No	Yes	Yes
Philippines	36 months sea service as OOW Or 24 months sea service	Yes	Yes	Yes

	(12 m as OOW + 12 m as C/O)			
India	36 months as OOW (of which min 18 m over 3000 GT) (of which 12 m must be performed after obtaining CoC C/O, of which min 6 m over 3000 GT) 30 m sea service provided that 12 m sea service as C/O over 3000 GT	Yes	Yes	Yes
Norway	Meeting requirements of previous 4 levels + 36 months as OOW (over 500 GRT) or 24 m: 12 months as OOW + 12 months as C/O over 500 GT	No	No	No
➢ *IAW Norwegian regulations, there are 5 different Deck Officer Competency levels.*				
Israel	18 Months as C/O	No	No	Yes

Attachment-2 reveals the upgrading requirements; seagoing service duration, the necessity for course and examination for unlimited chief mate CoC (Certificate of Competency).

Attachment-2

Comparison Table for Chief Officer (>3000 GRT) II/2

	Seagoing Service	Course	Exam (written)	Exam (oral)
STCW	12 months as OOW	Yes	Optional	Optional
Turkey	36 months as OOW	No	Yes	No
UK	12 months as OOW	Yes	Yes	Yes
Japan	12 months as OOW	No	Yes	Yes
Germany	12 months as OOW	No	No	No
➢ *German watchkeeping officers are also issued with an endorsement of extension, so that they can also serve as chief mates on feeder-ships of between 500 GT and up to 3,000 GT.*				
Brazil	48 m as OOW (24 m as limited OOW + 24 m as unlimited) or 36 months as unlimited OOW	Yes	No	No
➢ *IAW Brazilian regulation, Unlimited C/O is allowed to work as Master on all ships within the inner waters/rivers, and on ships up to 500 GRT in all waters.*				
Hong Kong	12 months as OOW	No	Yes	Yes
Philippines	12 months as OOW	Yes	Yes	Yes

India	18 months as OOW (over 500 GT-of which min 6 m over 3000 GT)	Yes Phase I + Phase II:	Yes For Ph-I and Ph-II	Yes For Ph-I and Ph-II
Norway	36 months as OOW or 24 m: 12 months as OOW + 12 months as C/O over 500 GT	No	No	No
➢ *IAW Norwegian regulations, there are 5 different Deck Officer Competency levels.*				
Israel	18 months as OOW	Yes (1 year)	No	Yes

Attachment-3 reveals the upgrading requirements; seagoing service duration, the necessity for course and examination for unlimited chief engineer CoC (Certificate of Competency).

Attachment-3 **Comparison Table for Chief Engineer (>3000 kW) III/2**				
	Seagoing Service	**Course**	**Exam (written)**	**Exam (oral)**

STCW	36 months as EOW or 24 months as EOW + 12 months as 2/E	Yes	Optional	Optional
Turkey	36 months as 2/E	No	Yes	No
UK	36 months as EOW (of which min 18 m over 3000 kW) or 12 months as 2/E	Yes	Yes	Yes
Japan	24 months as EOW (of which min 12 months as 2/E)	No	Yes	Yes
Germany	12 months as 2/E (over 750 kW)	No	No	No
Germany	36 months sea service as EOW (with 2/E CoC) (means 48 months sea service as EOW*)	Yes	No	No
IAW German regulations, 2/E is allowed to work as Ch/Eng on ships powered up to 3000 kW.				
Brazil	36 months as 2/E	Yes	No	No
➢ *Unlimited 2/E is allowed to work as Ch/Eng on ships powered up to 3000 kW in all waters or can work on ships without any kW limitations within the inner waters/rivers/cabotage.*				
Hong Kong	36 months sea service over 1500 kW ships (of which min 12 m. while holding 2/E CoC) Out of	No	Yes	Yes

	this 12 months, min 9 m over 3000 kW ships			
Philippines	36 months sea service while holding EOW over (750 Kw) or 24 months (12 M as EOW + 12 M as 2/E)	Yes	Yes	Yes
India	-36 months sea service while holding EOW over (750 Kw) (of which min 12 m after obtaining 2/E CoC on 3000 kW) -30 m sea service provided that 12 m sea service as 2/E over 3000 kW)	Yes	Yes	Yes
Norway	36 months as EOW or 24 M: 12 months as EOW + 12 months as 2/E over 750 kW	Yes	Yes	No
Israel	18 Months as 2/E	No	No	Yes

Attachment-4 reveals the upgrading requirements; seagoing service duration, the necessity for course and examination for unlimited second engineer CoC (Certificate of Competency).

Attachment-4

Comparison Table for Second Engineer (>3000 kW) III/2

	Seagoing Service	Course	Exam (written)	Exam (oral)
STCW	12 months as EOW	Yes	Optional	Optional
Turkish	36 months as EOW	No	Yes	No
UK	12 months as EOW	Yes	Yes	Yes
Japan	12 months as EOW	No	Yes	Yes
Germany	12 months as EOW	No	No	No
➢ *IAW German regulations, 2/E is allowed to work as Ch/Eng on ships powered up to 3000 kW*				
Brazil	36 months as EOW	Yes	No	No
➢ *Unlimited 2/E is allowed to work as Ch/Eng on ships powered up to 3000 kW in all waters or can work on ships without any kW limitations within the inner waters/rivers/cabotage.*				
Hong Kong	18 months as EOW (of which min 12 months with CoC) (out of this 12 m, min 9 m main propelling machinery works)	No	Yes	Yes

Philippines	12 months as EOW	Yes	Yes	Yes
India	12 months as EOW (III/1-MEO Class IV) (over 750 Kw)	Yes	Yes	Yes
Norway	24 months as EOW	Yes	Yes	No
Israel	18 Months as EOW	Yes (1 Year)	No	Yes

*Note4: Refer as 750 kW for vessel tonnages regarding sea service unless it is specified otherwise such as 3000 kW.

*Ships powered by Steam or combined competencies' requirements are omitted.

III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Investigation of Bilge System Assembly Operations of the Black Sea Type Fishing Vessels

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ABSTRACT

Bilge systems transfer contaminated water that accumulates in bilge pipes, wells and ballast to the sea or bilge tank via a pump after making it harmless. This bilge system contains bilge water. Depending on the intended use and design of the ship, bilge water may contain many different substances such as water, oil, urine, detergents, solvents, chemicals, bitumen and particles. All ships have bilge systems in different types but for the same purpose. Bilge systems are also important in fishing vessels. Because the fish caught with these vessels are placed to be stored in the fish storage rooms located under the main deck. The wastewater of the stored fish must be evacuated from the bilge wells in the fish storage rooms. Bilge water may also accumulate in the ballast, but significant amounts of wastewater do not accumulate in the ballast on fishing vessels. While producing a fishing vessel, the bilge system mentioned above goes through some stages of production. Before expounding these stages in detail, information is given about what is bottom of a fishing vessel. After the bottom of a fishing vessel have been examined, a detailed job analysis carried out on the production of the bilge system. In this study, it is explained step by step how the assembly operations of bilge system is performed on a fishing vessel, how the stages of production progress, and how long each stage takes place. At the end of this study, solution proposals for shortening the durations of activities in these production stages is presented.

Keywords: Bilge system, Fishing vessel, Production stages

1. Introduction

Ship-based marine pollution is one of the most effective environmental problems of our time. Waste and garbage formation in ships; the ship structure, machinery equipment, ship's running time, fuel consumption, the number of people left on board and the load carried by the ship are directly proportional [1].

Considering the international conventions and the rules on prevention of marine pollution, the substances causing pollution of the seas from ships and other marine vessels can be listed as follows: petroleum products, radioactive substances, toxic liquids carried in bulk, harmful substances transported in packed or portable tanks, cargo containers, wagons or tank trucks, ballast, bilge and tank washing waters of ships, domestic wastewater from ships (toilet, wash basin, shower and water from kitchen), and garbage of the ships [2]. For this reason, bilge water is one of the biggest causes of marine pollution from ships.

According to the form of marine pollution, origin of ship can be examined in two separate groups as routine pollution and accidental pollution. Routine pollution is the result of pollution caused by discharging the wastewater produced by vessels, such as bilge, ballast and domestic wastewater, while they are still operating, without applying international rules. Accidental pollution is the result of an accident such as running aground and collision of ships loaded with hazardous wastes, and tanker [3]. Therefore, it can be said bilge water is the result of routine pollution in ships.

Bilge waters occur in ships and contain high amounts of oil. The amount of bilge water in a ship depends on the age, tonnage and maintenance of the ship. Bilge waters are collected in the bilge tank at the bottom of the ship and must be evacuated to the ship within a certain time. Otherwise, it may cause corrosion in the ship. In ships with cold storage, excessive accumulation of water in the bilge tank may cause deterioration of the hold insulation, and on cargo ships, it may cause wetting and moistening of the cargo [4].

Bilge waters carry a very special and significant pollutant character in terms of their impact on the marine environment due to the oil they contain. The density of the oil is

lower than the density of the seawater. This creates a layer on the surface of the sea. This layer prevents the entry of oxygen into the water for the survival of sea creatures. Oxygen deficiency limits the presence of living creatures in places where oxygen concentration is high, and this leads to the degradation of ecosystem balance [5].

Turkey is among the countries with rich resources in terms of culture fishing [6]. Turkey about 79% of the total mariculture constitutes marine fish production [7]. Fishing vessel production, maintenance and modification in Turkey is important due to reasons such as this. The number of fishing vessels built in Turkey has especially increased in recent years. As mentioned above, the reasons for the necessity of the bilge system on a ship are clearly explained. Fishing vessels are also one of the vessels where the bilge system is required.

2. The Bottom of a Fishing Vessel

Figure 1 shows the appearance of the parts the bottom of a fishing vessel. Figure 1 clearly shows that there are steering gear room, engine room, hydraulic room, electric room, fish storage rooms, bow thruster room, sonar room and other rooms at the bottom of the fishing vessel. As you can see, fish storage rooms form a large part of the bottom of a fishing vessel.

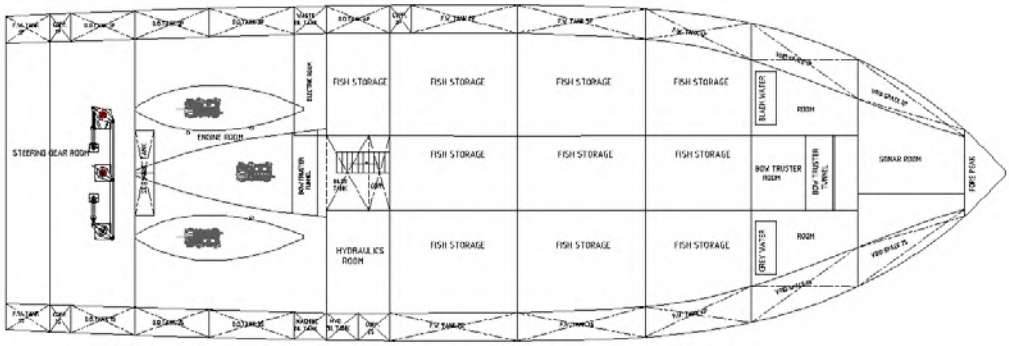

Figure 1: The Bottom of a Fishing Vessel

Bilge water can accumulate especially in fish storage rooms. Each of these fish storage rooms are made up of bilge wells in certain sizes and the bilge water accumulates in these wells. Bilge main pipeline discharges the water that accumulates in these wells through a

pipe, and from there to the bilge tank or to the sea by means of the bilge pump. Figure 2 shows the bilge well.

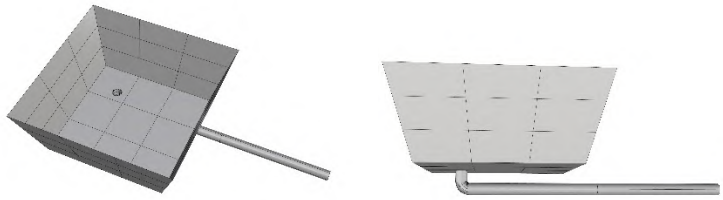

Figure 2: Bilge Well on the Fishing Vessel

The more important the blood vessel system in the human body, the more important is the piping system on a ship [8]. For this reason, galvanized steel pipes of various nominal diameters are used in bilge systems on ships. The galvanizing process is carried out to extend the life of the metals that will work in all conditions against corrosion.

3. Bilge System Assembly Operations

In this part of the study, the time elapsed during the construction of the bilge system of a fishing vessel will be analyzed. This analysis is based on the bilge system of a 50 m long and 17 m wide fishing vessel built in Çamburnu shipyards region. As can be seen from the bottom view of this fishing vessel (Figure 3), there are many fish storage rooms under the deck and many different areas for the purpose of use. Bulkheads that are positioned in transverse and longitudinal form these areas.

Firstly, there are some working conditions:

- On this ship, one worker and one assistant work together for the construction of the bilge system.
- The worker and his assistant do handling and assembly of the required material.
- The welding connections of the pipes are welded at the deck or in a more suitable place after measure the size of the pipes. If the welding is to be done in a more suitable place, it is carried out by a welder, otherwise by the worker who makes the bilge system.

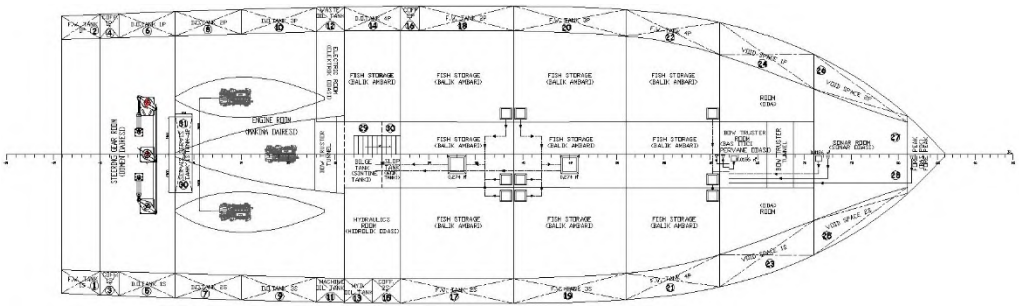

Figure 3: The Bottom View of Fishing Vessel Built in The Region of Çamburnu Shipyards

We have done detailed assembly operations for only three fish storage rooms in this article. The production stages of the other assembly operations and the duration of the activities for the bilge system are examined in the conclusion part of the article. Table 1, Table 2 and Table 3 give the production stages and durations of activities for the three fish storage rooms within the marked area in Figure 4.

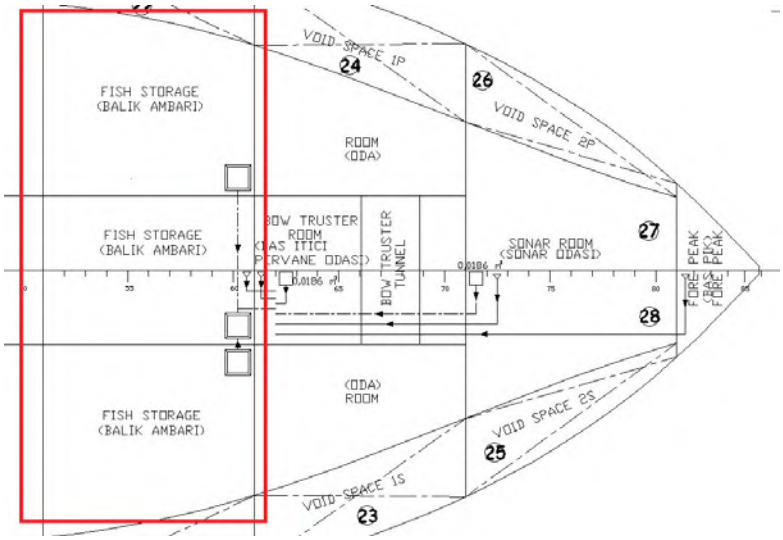

Figure 4: Three Fish Storage Rooms Within the Marked Area

Table 1: Production Stages and Duration Activities for Port Side Fish Storage Room.

Process	Production Stages	Duration
1	Bringing the pipe to the deck by worker and his assistant from where it is stored	5-10 min.

2	Measuring the size from port side fish storage room to determine the length of the pipe to be cut	2-3 min.
3	Cutting of the pipe according to the determined dimensions	2-3 min.
4	Grinding of the burrs on the cut pipe	1-2 min.
5	Welding the elbow to the cut pipe	2-4 min.
6	Cooling the elbow connection	1-2 min.
7	Handling the elbow connection to port side	1-2 min.
8	Welding the elbow connection just below the bilge well in the fish storage room (Figure 2)	10-15 min.

Table 2: Production Stages and Duration Activities for Starboard Side Fish Storage Room.

Process	Production Stages	Duration
1	Bringing the pipe to the deck by worker and his assistant from where it is stored	5-10 min.
2	Measuring the size from starboard side fish storage room to determine the length of the pipe to be cut	2-3 min.
3	Cutting of the pipe according to the determined dimensions	2-3 min.
4	Grinding of the burrs on the cut pipe	1-2 min.
5	Welding the elbow to the cut pipe	2-4 min.
6	Cooling the elbow connection	1-2 min.
7	Handling the elbow connection to starboard side	1-2 min.
8	Welding the elbow connection just below the bilge well in the fish storage room (Figure 2)	10-15 min.

In addition, there are some rooms where the amount of wastewater will be very small (such as bow thruster room and sonar room). Such rooms have small sizes of bilge wells. Figure 6 shows small size of bilge wells.

Table 3. Production Stages and Duration Activities for Middle Fish Storage Room

Process	Production Stages	Duration
1	Bringing the pipe to the deck by worker and his assistant from where it is stored	5-10 min.
2	Measuring the size from middle fish storage room to determine the length of the pipe to be cut	2-3 min.
3	Cutting of the pipe according to the determined dimensions	2-3 min.
4	Grinding of the burrs on the cut pipe	1-2 min.
5	Welding the elbow to the cut pipe	2-4 min.
6	Cooling the elbow connection	1-2 min.
7	Handling the elbow connection to middle	1-2 min.
8	Welding the elbow connection just below the bilge well in the fish storage room (Figure 2)	10-15 min.
9	The connection formed by welding the pipes from the port side, starboard side and middle storage room by means of T connection is connected to the bilge pump in the bow thruster room. This connection use two T connections. There are four connections as the T connections are welded on both sides. (Figure 5)	30-35 min.

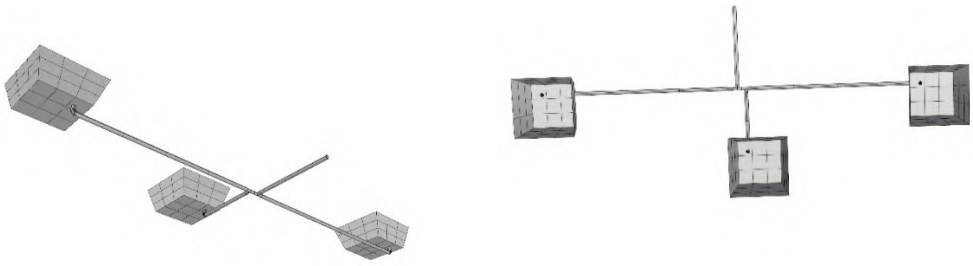

Figure 5: Structure of Bilge Wells Formed by The Use of T Connections

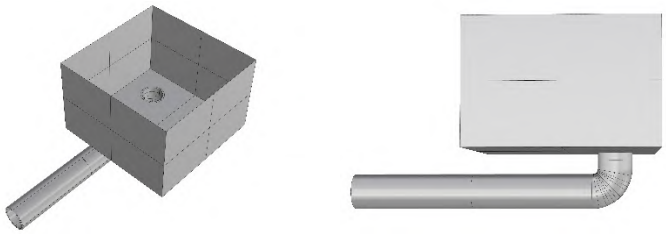

Figure 6: Small Size of The Bilge Wells

4. Production of Bilge Wells

The bilge wells placed in fish storage rooms drawn on the computer through a program and turned into an open box. Table 4 shows production stages of the bilge wells. The drawing program is used for the bilge well, such as AutoCAD or Rhinoceros. Figure 7 shows the drawing of the bilge drawn with these programs.

Table 4: Production Stages and Duration Activities for Bilge Wells

Process	Production Stages	Duration
1	Determining the dimensions of the bilge wells and drawing in AutoCAD or Rhinoceros program (Figure 8)	20-30 min.
2	Making the drawing ready for plasma cutting after being coded with code program	3-4 min.
3	Preparing steel sheet on CNC machine for bilge wells to be cut	10-15 min.
4	Cutting of bilge pools on CNC machine	15-20 min.
5	Bringing the bilge wells to the side of the press machine Pressing of the bilge wells to the press machine	15-20 min.
6		20-30 min.
7	Welding the other two parts to the pressed part	80-100 min.
8	Grinding of welded parts	10-20 min.
9	Handling the bilge wells to the fishing vessel	5-10 min.
10	Assembling the bilge wells to be placed to fish storage room after handling them to main deck	150-200 min.

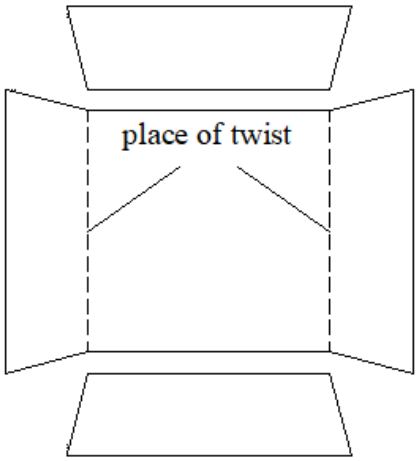

Figure 7: Computer Drawing of the Bilge Wells Placed in Fish Storage Rooms

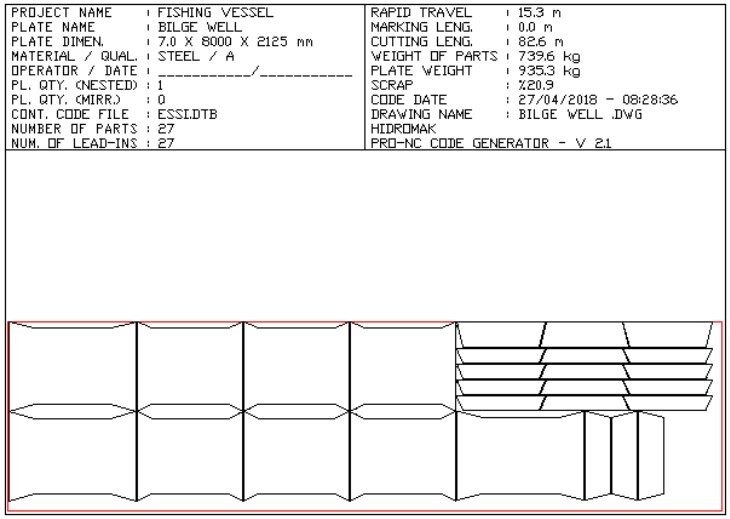

Figure 8: The Coding of the Bilge Wells After Drawn with The Autocad Program

5. Conclusions

In this article, bilge system assembly operations of a fishing vessel built in the Çamburnu shipyard region have examined. Bilge structure of a fishing vessel and production stages of bilge system were discussed. The total duration of the production stage activities of the fishing vessel built according to the production logic used in the current shipyard has calculated as approximately 850-1125 minutes. This total duration is equal to 16 hours

on average. This duration was calculated if all conditions were at the desired level. This duration is increasing because the conditions are generally not at the desired level. It has seen that this total duration could be reduced by changing the production logic and working conditions at the current shipyard. In addition, if the number of workers working in the construction of the bilge system increases, the total duration decreases. Because only one worker and one assistant worked during production stages of the bilge system. It is certain that a product that is much more efficient will be produced if such deficiencies are eliminated during the production stages of bilge system.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Comparison of Damage Stability in Tankers for Different Subdivision

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ABSTRACT

Ships are faced with the risk of sinking for reasons such as accidents, explosions, grounding or enemy attack. These injuries which occur in any parts of the ship may lead to changes in the buoyancy of the ship, the draft, trim and slope. International rules try to decrease the possibility of damages in order to prevent the marine pollution and ship. There are 9 different configurations of tankers. In this project, try to choose one or two ship configurations which have highest stability criteria and low damage to the environment when ship damaged. Damage cases were created by damage assumption of the MARPOL regulation. Nine different configurations were loaded to 8.5 m draft and compared to the each other. The load space of the ship identified and divided into equal transverse watertight bulkheads and kept constant for each ship configuration. 96 m ship's load carrying space is divided into six equal parts by the transverse bulkheads. Deterministic and probabilistic approaches are used to calculate the damage cases.

Keywords: Ship, Tanker, Damage stability

1. Introduction

Ships are faced with the risk of sinking for reasons such as accidents, explosions, grounding or enemy attack. These injuries which occur in any parts of the ship may lead to changes in the buoyancy of the ship, the draft, trim and slope. According to international criteria, no more than the size of the damage foreseen in the ship's condition must be stable. Furthermore, the tanker damages have an important place in terms of environmental pollution and safety. International organizations have brought design and stability rules in order to minimize damage as a result of an accident.

The International Maritime Organization (IMO) is the United Nations Agency responsible for maritime safety and environmental protection of the oceans. All of the world's major shipping nations are members of IMO. The majority of the world's shipping countries are individuals from IMO. Every part country is urged to acknowledge the international agreements received by IMO.

In this study, as a combination of various types of cargo and ballast tanks capacity of example ship were created, and damaged stability analyzes were performed. Made it all tank arrangements and damaged stability calculations were performed considering international rules. Regulation of ship design for safety and pollution prevention is achieved primarily through three international conventions: the first of which is the International Convention on Load Lines (1966), or ICLL , the second of the International Convention for Life at Sea (1974) and its 1978 Protocol (SOLAS) and finally The International Convention for the Prevention of Pollution from Ships (1973) and its 1978 Protocol (MARPOL) [1].

The overall objective of SOLAS is to assure safety of the crew, ports, passengers, ships, and cargo, and, indirectly, the environment. Among the more important provisions are:

The safety of the crew, ports, passengers, ships, and cargo are the main objective of the SOLAS. In addition, these elements are connected to the safety of the environment. In addition, most significant regulations are

- Subdivision and stability requirements, to prevent ships from capsizing, and to ensure survival under specified collision and grounding damage circumstances;
- General construction principles, to ensure the ship are strong enough for its intended trade;
- Safety equipment requirements, to assure the carriage of sufficient lifeboats and other safety equipment;
- Fire protection requirements, to ensure that ships could withstand certain fire damage and fight fires effectively;
- Radio telegraphy requirements, specifying the communications and navigation equipment ships must carry.

SOLAS [5] has the indirect effect of preventing oil spills and marine pollution. The MARPOL convention aims to prevent pollution directly, both from normal operational discharges and accidents. MARPOL regulations [3] are separate the 6 parts which are:

1. Regulations for the Prevention of Pollution by Oil
2. Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk
3. Regulations for the Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form
4. Regulations for the Prevention of Pollution by Sewage from Ships
5. Regulations for the Prevention of Pollution by Garbage from Ships
6. Regulations for the Prevention of Air Pollution from Ships

2. Regulations for The Preventation Of Pollution by Oil

The progress measurements of the damage that can occur in any part of the ship are as follows. [1]

The damage extents boundary conditions in a ship according to the damage location are shown in table 1.

Table1: Damage Extents.

Side Damaged	
Longitudinal extent (Lc)	$\frac{1}{3}L^{\frac{2}{3}}$ or 14,5 meters,whichever is less
Transverse extent (tc)	$\frac{B}{5}$or 11.5 meters
Vertical extent (vc)	From the baseline upwards without limit
Bottom Damaged	
Longitudinal extent (Lc)	$\frac{L}{10}$or 5 meters, whichever is less
Transverse extent (tc)	$\frac{B}{5}$or 5 meters
Vertical extent (vc)	$\frac{B}{15}$ or 6 meters, whichever is less

Damage stability calculations are performed for ships covering the following dimensions.

- In the case of tankers longer than 225 m, damage may be anywhere in the ship.
- For tankers longer than 150 meters, but not more than 225 meters, damage may be anywhere on the ship's length. (Except involving either after or forward bulkhead bounding the machinery space located aft. The machinery space shall be treated as a single floodable compartment)
- For tankers not exceeding 150 m in length, adjacent to the transverse bulkheads except for the machinearea
- In the final stage of floods, the heel angle should not exceed 25 ° due to non-symmetrical floods, but this angle can be increased up to 30 ° if the deck edge is notsubmerged.
- The righting arm curve must be constructed in such a way to include 20° angle of

heel beyond the angle of equilibrium. In this case, the area under the curve within this range shall not be less than 0.0175-meter reading. The maximum residual righting arm must be at least 0.1 m within the 20° range.

3. Subdivision and Damage Stability Analysis of the Tanker

Damage scenarios and calculations were prepared in *MAXSURF* [2] program. A characteristic of the vessel was used is as follows in Table 2

Table 2: Ship Specification.

Ship Specification	Dimension [m]
LWL	134
B	21
D	12
T	8.75

The load space of the ship identified and divided into equal transverse watertight bulkheads and kept constant for each ship configuration. 96 m ship's load carrying space is divided into six equal parts by the transverse bulkheads. The placement of cargo and ballast tanks are made considering international marine rules. According to international rules, 9 different ship configurations were created using the B/5 and B/15 measures. 9 loading configurations are shown in the Table 3.

Table 3: Configuration of Analysis [3] [4].

Case Study	Damage Area
1	Single sided
2	B/15 double bottom
3	B/15 double sided
4	B/15 double hull
5	B/15 double bottom/double sided
6	B/5 double bottom
7	B/5 double sided
8	B/5 double hull
9	B/5 double bottom/double sided

The machinery space and forepeak arrangements are kept constant for loading condition of each ship configuration. The draft is also kept constant draft for each loading condition. It has been possible to compare the ships of each loading case. Taken to hold the draft of the ship, ballast and the cargo have been loaded or unloaded. Ballast and cargo capacity of the ship, cargo and ballast weights in the constant draft are shown in the Figure 1.

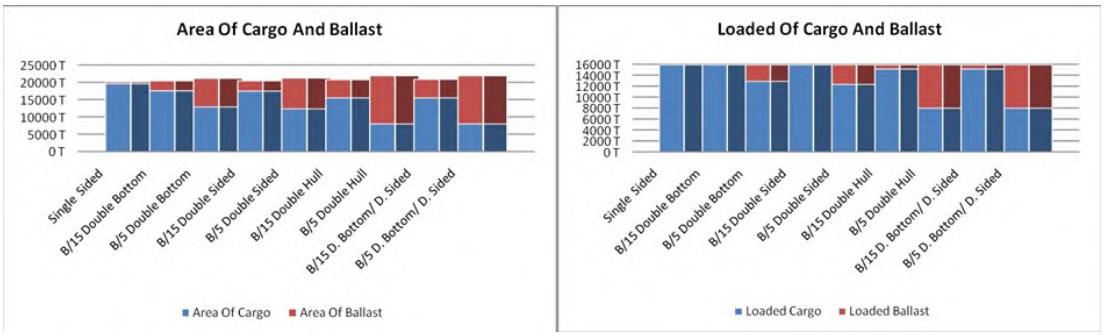


Figure 1. Ballast, Cargo Areas and Initial Loading Conditions.

The damage was taken from any longitudinal region of the tank. Two damage areas were selected in the side and in the bottom of the tank. All damages were determined according to the damage extent in these regions. Damage locations are shown in the Figure 2.

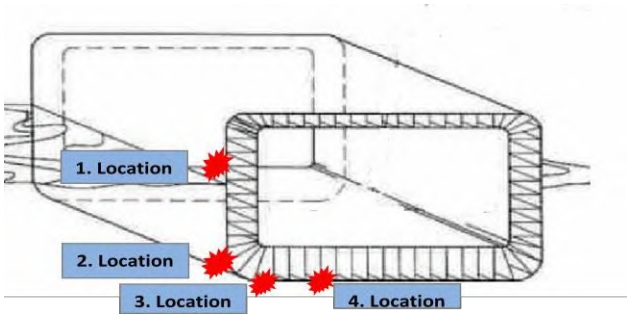


Figure2: Damage Locations.

The stability characteristics of the ship in case of damage and loss of cargo are as in Table 4.

Table 4: Damage Stability Analysis Values Average.

	Damage Location	Single Sided	B/15 Double Bottom	B/5 Double Bottom	B/15 Double Sided	B/5 Double Sided	B/15 Double Hull	B/5 Double Hull	B/15 Double Bottom/ Double Sided	B/5 Double Bottom/ Double Sided
Losted Cargo (Ton)	1. Loc.	869,65	641,98	1066,46	0,00	974,16	0,00	974,16	0,00	0,00
	2. Loc.	579,77	213,99	1066,46	0,00	649,44	0,00	649,44	0,00	0,00
	3. Loc.	288,17	213,74	1066,46	0,00	0,00	0,00	0,00	0,00	0,00
	4. Loc.	0,00	0,00	2132,91	3074,87	0,00	0,00	0,00	0,00	0,00
Area Under GZ Curve (m.Deg)	1. Loc.	6,43	5,55	8,19	9,22	5,90	7,39	6,14	3,69	3,69
	2. Loc.	6,93	6,58	8,19	9,22	6,64	8,23	7,61	5,32	5,32
	3. Loc.	7,82	6,72	8,19	9,22	8,73	9,16	9,64	7,54	7,54
	4. Loc.	6,83	8,25	6,74	7,16	8,73	9,16	9,64	7,54	7,54
Residual Righting Lever (m)	1. Loc.	0,54	0,47	0,76	0,82	0,60	0,66	0,56	0,28	0,28
	2. Loc.	0,62	0,56	0,76	0,82	0,60	0,71	0,70	0,43	0,43
	3. Loc.	0,73	0,60	0,76	0,82	0,84	0,81	0,93	0,63	0,63
	4. Loc.	0,85	0,73	0,58	0,60	0,84	0,81	0,93	0,63	0,63
Heel Angle (Deg)	1. Loc.	8,15	6,60	8,23	6,70	8,48	5,20	11,28	8,70	8,70
	2. Loc.	6,25	6,08	8,23	6,70	9,18	6,38	7,87	3,88	3,88
	3. Loc.	3,10	4,60	8,23	6,70	1,55	4,55	0,00	0,00	0,00
	4. Loc.	0,375	1,4	11,4	9,825	1,55	4,55	0	0	0,00

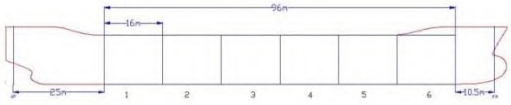
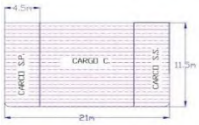
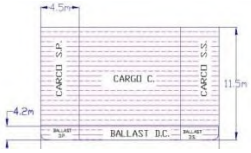
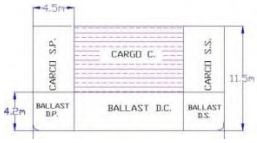
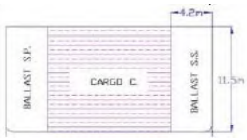
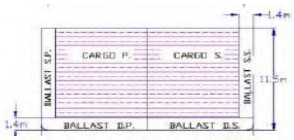
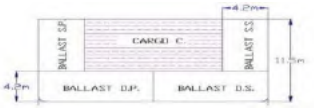
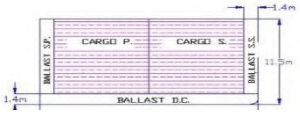
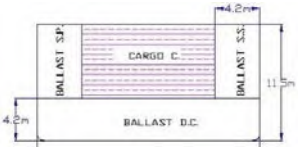
According to Table 4;

- Primarily, cargo loss in ship side damage cases is very high with single side and double bottom ship characteristics. Double-sided, single- sided Configurations have poor features in dip damages. According to the loss of cargo, Double Hull and Double Bottom/ Double Sided Configurations are the best for all damage cases.
- B/ 15 Double Hull and B/15 Double Bottom/ Double Side Configurations have better stability properties than other vessels.
- The best and the worst configurations according to the load loss, the heel angle, the area under the GZ curve and the left-hand lever are indicated in table 5.

Table 5: Ship Compartment Selection To Damage Stability.

Criteria	Worst Configurations	Best Configurations
Cargo Loss	• Single Sided • B/15 D. Sided • B/5 D. Sided	• B/5 D. Bottom/D. Sided • B/5 D. Hull • B/15 D. Bottom/D. Sided • B/15 D. Hull
Heel Angle	• Single Sided • B/15 D. Bottom • B/5 D. Bottom • B/15 D. Sided • B/5 D. Sided	• B/15 D. Bottom/D. Sided • B/5 D. Hull
Area Under GZ Curve	• Single Sided • B/15 D. Hull • B/15 D. Bottom/D. Sided	• B/15 D. Sided • B/5 D. Sided • B/5 D. Hull • B/15 D. Bottom/D. Sided
Residual Righting Lever	• Single Sided • B/15 D. Sided • B/5 D. Sided • B/5 D. Bottom/D. Sided	• B/15 D. Bottom/D. Sided • B/15 D. Hull

Table 6: Ship Configurations.

Configurations	Body Plan
Ship Profile	
1. Single Sided	
2. B/15 Double Bottom	
3. B/5Double Bottom	
4. B/15 Double Sided	
5. B/5 Double Sided	
6. B/15 Double Hull	
7. B/5 Double Hull	
8. B/15 Double Bottom/Double Sided	
9. B/5 Double Bottom/Double Sided	

4. Conclusion

In this study, it is tried to compare the damage stability characteristics of 9 different subdivisions of ships. Damage scenarios were made according to all damage progression lengths in one area of the ship.

According to the results, the worst designs are single sided, double sided and double bottom configurations.

According to the results of the study, the best configuration choice according to cargo carrying capacity, loss of cargo and stability characteristic in damage case will be B/15Double Bottom Double Sided configuration. The second good characteristics are the B/15 Double Hull configuration.

The next study will be the comparison of the strength values of these compartments in the damage cases. In case of damages, B / 15 Double Bottom Double side configuration ultimate strength calculations will be made.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Interpretation of Rule-Based Ship Structural Element Sizing by Finite Element Analysis

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ABSTRACT

Structural design methods and processes of ships may vary within the framework of national and international rules. It is important to examine whether the rule-based design is closer to the safe side or costlier side. One of the most important steps leading us to answer is to carry out the local and global Finite Element Analysis (FEA). In this study, engineering principles and Loyd rules are taken as basis. Firstly, five bulk carriers were selected and the mid-ship sections dimensioned based on the Loyd rules were examined using FEA. As a result, critical deformation and stress zones were determined. The stresses, as will be expected, are concentrated in the regions close to the ends. The deformations increase towards the middle of the hold at an acceptable level. Also, the relations between the deformation and von-Mises stress values with the hold length, width and depth of the ship were determined in order to determine the changes in the ship characteristics. Secondly, the selected bulk carrier was analyzed at the same boundary conditions by taking 1 mm and 2 mm both down and up values of the element thicknesses determined. It is aimed to investigate the effect of thickness change on total deformations and von-Mises stresses. When the thickness values of the elements on the ship were decreased, deformation and stress values were found to be increased very rapidly. When the thickness values of the elements in the ship were increased, deformation and stress values decreased with very small values.

Keywords: Structural Design, Rule-Based, FEA, Turkish Loyd, IACS-CSR

1. Introduction

Analysis and design are the two most used keywords in the shipbuilding process. Although there are significant differences between "making design" and "conduct analysis", they are often confused and used instead of each other in shipbuilding processes. Analysis refers to stress and strength assessment of the structure. Analysis requires information on loads and needs an initial structural scantling design. Output of the structural analysis is the structural response defined in terms of stresses, and deformations. Then, the estimated response is compared to the design criteria.

Design for mid-ship section means a process followed to select the initial structural scantlings and to update these scantlings all the way of design spiral. Briefly, to conduct an analysis, preliminary design is needed and for a final optimum design, detailed analysis is needed.

Ship structural design is a challenging activity. The complexities of modern ships and the demand for greater reliability, efficiency, and economy require a scientific, powerful, and versatile method for their structural design [1].Owners may have different expectations and engineers may designs that satisfy the strength criteria, but there is only one that is the optimum solution in terms of least cost & weight relationship. Ship structural analysis and design are like two friends trying to agree with;

- try to agree with about accuracy and the available time to perform the design. Rule-based design or simplified numerical analysis can be performed but considering the power of today's computer technology a 3D Finite Element Method (FEM) analysis would be welcome.
- try to agree with about weight and cost (operational cost, maintenance, etc.).

2. Aim

The paper describes authors' view on the relationship of rule-based ship structural design and FEA. It is aimed to examine the total deformation and max. von-Mises stress changes with increase in the hold length, breadth and height as a first case study. It is also aimed to investigate the effect of thickness change on total deformations and von-Mises stresses

as a second case study. Ships are designed practically on the basis of rules from classification societies, then application of the finite-element method advanced rational analysis and design methods, allows the engineers powerful control and optimization capability and efficiency.

3. Method (Scantling-Modelling-Analysing)

Rule-based design and rational-based design are two methodologies commonly used in the structural design of ships. The rule-based design method is widely used to design existing ship types and their modifications, especially for merchant ships. The rules related to loads, strength and design criteria and include easy-to-use empirical formulas for scantlings by using ship main dimensions.

The rational-based design method can be used to design new ship types and are needed for control and verification of some ships for which difficulties arise in applying the rule-based design method. In the relevant section of each rule book, named "Direct Strength Calculations" in Turkish Loyd, the method and content of the ship structures with the (FEM) are stated. The aim here is to prevent errors that may occur during the creation of the model, the realization of the analysis and the interpretation of the results, regardless of the user and commercial programs, and to provide an accurate engineering approach. Now, in almost every modern shipyard and design office, designers use modeling and analysis methods based on finite element method in order to provide ship owners' requirements and strength requirements in the most appropriate way. There are some disadvantages of the rule-based design approach, which is entirely dependent on rule books. Due to the simplified formulas, the adequacy criteria against inadequacy remain unclear and it cannot be determined that structural reliability is ensured. Another important disadvantage is that such formulas contain some simplification assumptions and can be used between certain limits. If the calculations are performed outside these limits, it may not give accurate results [1].

The disadvantage of a rational based structural design approach based on direct strength calculations is that important design decisions such as objectives, criteria, priorities and

boundary conditions should be given at the start of design. It is therefore meaningful to compare the design results of these two methodologies in order to better understand their advantages, disadvantages and their limitations. The flowchart of the rational-based structural design approach based on direct strength calculations adopted by the most of classification societies is given in Fig. 1 [2].

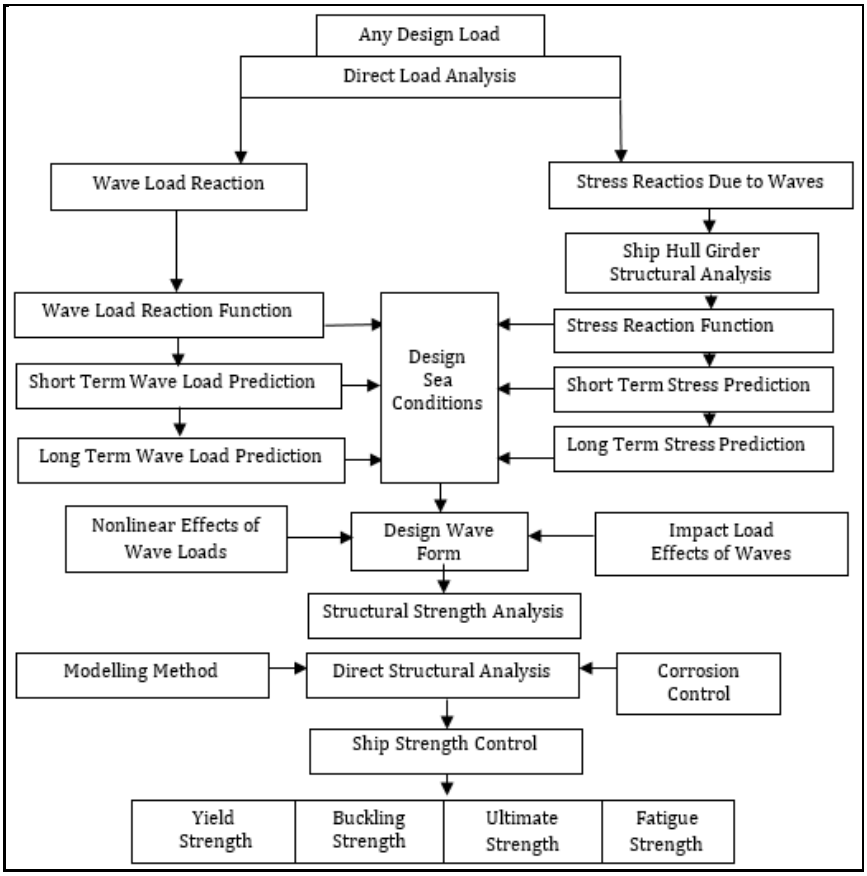

Figure1: The Flowchart of the Rational-Based Structural Design Approach.

4. Findings

4.1. Case Study-1

Structural configuration of a bulk carrier was revealed. Main dimensions of selected ships are given in Table 1. Based on this configuration, mid-section strength elements are dimensioned according to Turkish Lloyd (TL) [3] and IACS-CSR [4]. Parallel body

geometry was modeled in Ansys and finite element analysis was performed [5],[6]. The data obtained for each ship were compared and graphs were drawn and the results were revealed.

Table 1: Main Dimensions of Selected Ships for Case Study.

Ship Name	L_{OA} m	L_{BP} m	L_{WL} m	L_{HOLD} m	B m	T m	D m	C_b	DWT ton	s m
Mohac	135	127	131	20	22	8,35	11,3	0,75	15503	0,9
Darya Shaan	169	160	165	22	26	9,8	13,7	0,75	27000	0,9
Piyade	180	170	175	24	28	10,2	15	0,80	32500	0,9
Aston Trader	180	177	178	26	30	10,6	15	0,75	39486	0,9
African Buzzard	200	193	197	34	36	12,9	18,5	0,75	66652	0,9

4.2. Scantling Calculations by Rule Books

The structural elements in the section were dimensioned according to the Turkish Loyd. With the dimensions obtained, the models of the vessels were formed in the design model section of the Ansys v16. Here, a semi-model technique is used to provide a quicker solution. Plate thicknesses and section modulus of five ships are given in Table 2. and Table 3.

Table 2: Mid-Ship Section Plate Thicknesses of Selected Ships.

Ship Name	Length m	Plate Thickness (mm)						
		Bot. Plate	Keel Plate	Centre Girder	Side Girder	Double Bottom	Side Plate	Double Hull Plate
Piyade	169,8	13	15	11,5	10	13	13	13
Mohac	127,0	11	13	11	9	11	11	11
Darya Shaan	160,1	13	15	13	10	13	13	13
Aston Trader	172,8	13,5	15,5	15	12	13	13,5	13
African Buzzard	191,1	14	16	18	14,5	14	14	14

Table 3: Stiffener Section Modulus of Selected Ships.

Ship Name	**Section Modulus (cm^3)**						
	Bot. Frame	**Inn. Bot. Frame**	**Main Side Frame**	**Half Side Frame**	**Bot. Long. Stif.**	**Inn. Bot. Long Stif.**	**Side Stringer**
Piyade	256	481	242	242	337	641	946
Mohac	235	449	213	198	233	566	1182
Darya Shaan	323	529	233	197	320	668	1295
Aston Trader	348	569	248	219	345	719	1377
African Buzzard	444	708	299	271	441	894	1661

4.3. Finite Element Analysis

The followings have to be explained in detail for strength calculations using FEM [7].

- Purpose, type and scope of the analysis,
- Creation of appropriate engineering model or approach,
- Finite element model of the structure examined,
- Determining the loading and boundary conditions for the type and purpose of the analysis,
- Implementation of the analysis,
- Obtaining and evaluating the results.

The type and size of the analysis to be performed depends primarily on the type of structural responses to be evaluated. In strength analysis, generally, the following responses are examined at first;

- The values of stress and deformation under certain load conditions,
- The collapse behavior of the hull and the highest load values causing the collapse (ultimate strength analysis),
- Dynamic and vibration responses of the structure analyzed.

In this paper, the results of stress and deformation under certain load conditions have been evaluated.

The evaluation of the stress and deformation results is usually subdivided into the following subgroups depending on the structural condition being examined. The purpose of the analysis, the loading and boundary conditions, the scope of the modeling and the evaluation depends on one of these categories.

- Global deformation and stresses on hull girder and primary structural components,
- Local deformation and stresses on primary and secondary structural components,
- Locally increasing stresses in structural detail and geometric discontinuities.

In this paper, global deformation and stress values on hull girder and primary structural components are calculated and examined on a hold model.

When analysing the structural strength of the ship structure examined, linear and / or nonlinear effects in the analysis should be taken into account in order to be compatible with the physics of the situation or problem. In this study, linear structural analysis was conducted.

4.3.1. Modelling and Meshing

For structural analysis of ship structures, modeling is divided into the following four groups [8];

- 3D Global Finite Element Analysis (FEA) Model
- 3D Partial Finite Element Analysis (FEA) Model
- Frame Models
- Local Models

In this paper, 3-D Partial Finite Element Strength Analysis is carried out to study the structural competences of certain parts of the hull girder (structural blocks, etc.) and their primary structural elements. Finite element models of the holds were constructed in geometry creation modulus (Ansys Workbench-Design Models) using the values obtained from the mid-section calculations of the vessels. In the creation of models, semi-model technique was used in the program. In this way, the program is intended to obtain results earlier. The length of a hold was considered as the length of analysis in the modeling of ships. The values obtained in the calculations were transferred to the model appropriately.

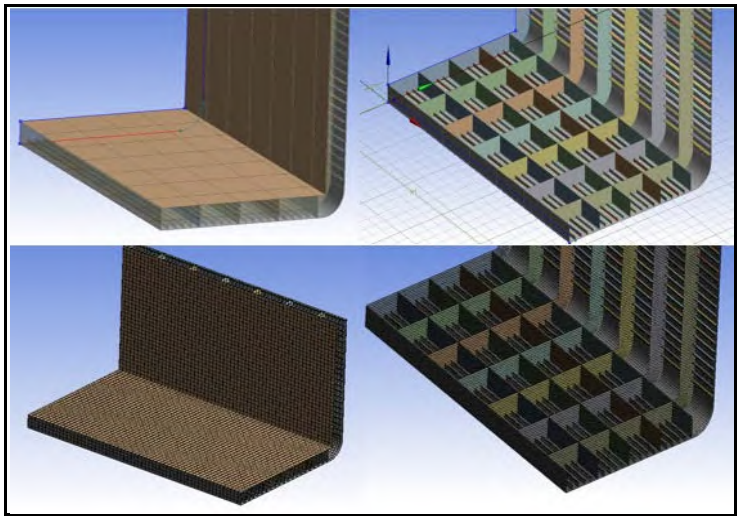

Figure 2: FEM Model and Meshed Model of Half Hold Section.

The choice of element type and mesh density has an important influence on the calculation of local increased stresses and maximum loads. Due to insufficient mesh density, local stresses are calculated at a lower value, the maximum loads are calculated much higher value than it actually is. The 3D mesh structure can be used in 3D global and partial FEA Models.

In the models, the fine mesh is used in forming the structure of the critical regions and the coarse mesh is used in the non-critical regions. In this way, it is aimed to obtain more realistic and reliable results by determining the changes in critical regions with smaller intervals. There are 81337 nodes and 82910 elements in the mesh. The max face size is 0,15 m and min. size is 0,05 m is mesh structure.

4.3.2. Loads and Boundary Conditions

The loads to be applied for the strength analysis of ship structures can be classified as follows.

- Hydrostatic pressure of seawater (calm water, wave top and wave pit)
- Wave-induced hydrodynamic charges affecting the ship girder,
- Hydrostatic pressure load on the ballast and tank structures of cargo and ballast tanks

- Dynamic cargo and ballast loads in cargo and ballast structures due to ship movements
- Loads of rudder, shaft, machinery, equipment and wind and ice loads due to the operational activities of the ship,
- Loads due to unexpected situations (grounding, collision, etc.).

In fact, under global loading conditions, the ship is subjected to shear forces, bending and torsion moments in each section. At the ends of the ship, their value is 0. In 3-D partial models, the missing parts of the model should be transmitted at the end of the partial three-dimensional model as bending moments, shear forces-or normal and shear stresses. As long as loading conditions and the construction of the structure permit, symmetrical boundary conditions can be used in 3D partial models and local models [7].

The end parts of the models are supported by the fixed support command. Hydrostatic pressures affect the models were applied by the 'hydrostatic pressure command. The points where hydrostatic pressure will be applied to the models are the distance between the bottom of the ship and the water line. The sea water density was 1025 kg/m^3 and the gravity acceleration was 9.81 m/s^2.

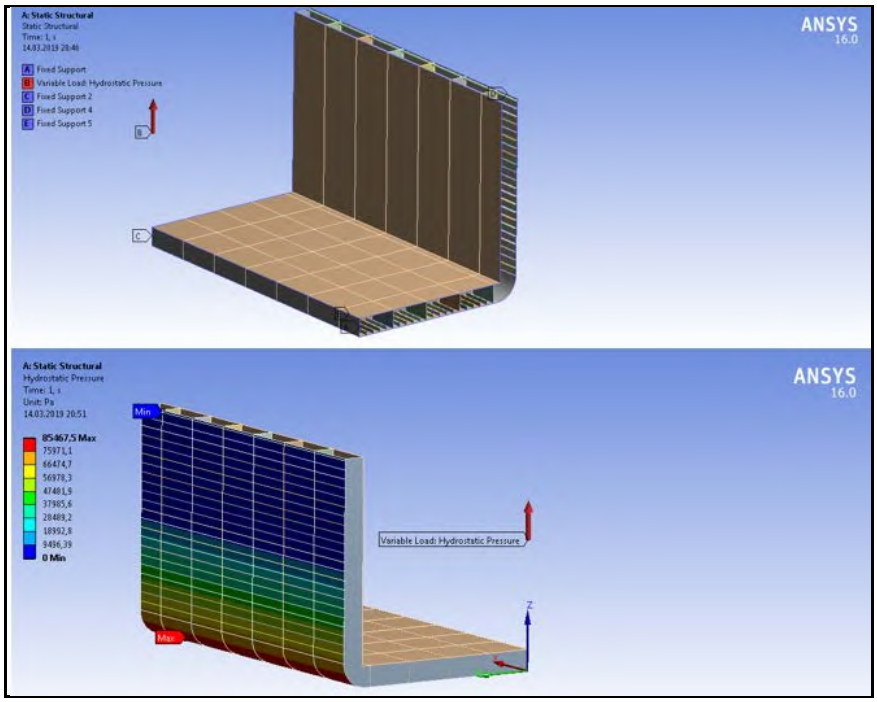

Figure 3: Boundary Conditions and Hydrostatic Pressure on Ship Piyade.

4.3.3. Results

In this part, scantlings of 5 bulk cargo vessels with main dimensions were determined. Linear structural analyses were performed in Ansys Workbench. Here, the finite element model is obtained and transferred to the solution part. The mesh structure, boundary conditions and hydrostatic pressure are applied in the model section. In the solution part, the total deformation and von-Mises stresses on the ships were calculated. The results of total deformation and max. von-Mises stresses are shown at a magnification of 130 times.

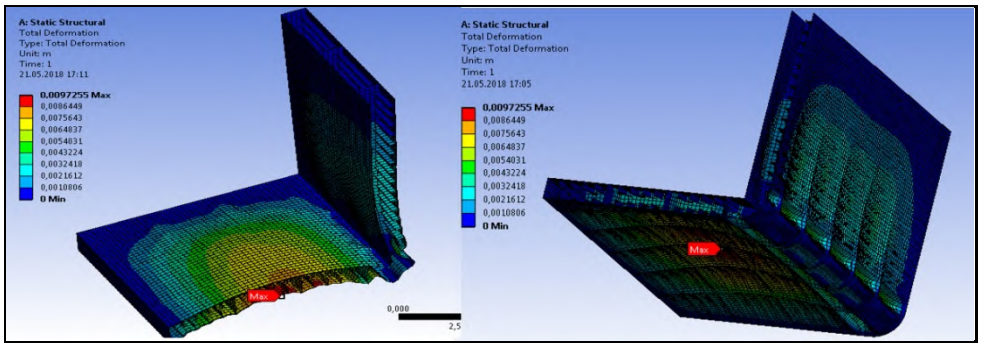

Figure 4: Total Deformation of Ship Mohac.

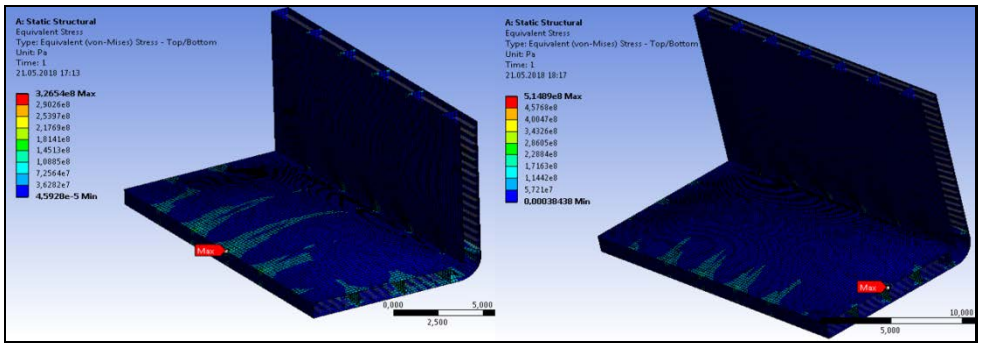

Figure 5: Max. Von-Mises Stress of Mohac (Left) and Piyade (Right).

Change of ship total deformation and von-Mises stress values with ship hold (3-D partial FEM model) length, breadth and height are given in Figure 6 and Figure 7, respectively.

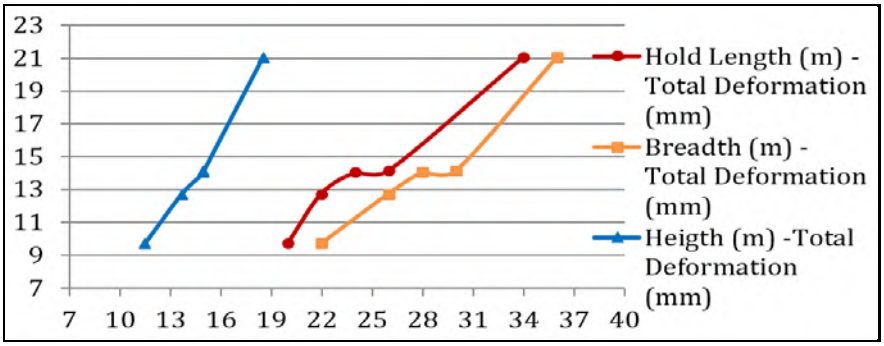

Figure 6: Change of Total Deformation with Ship Hold Length, Breadth and Height.

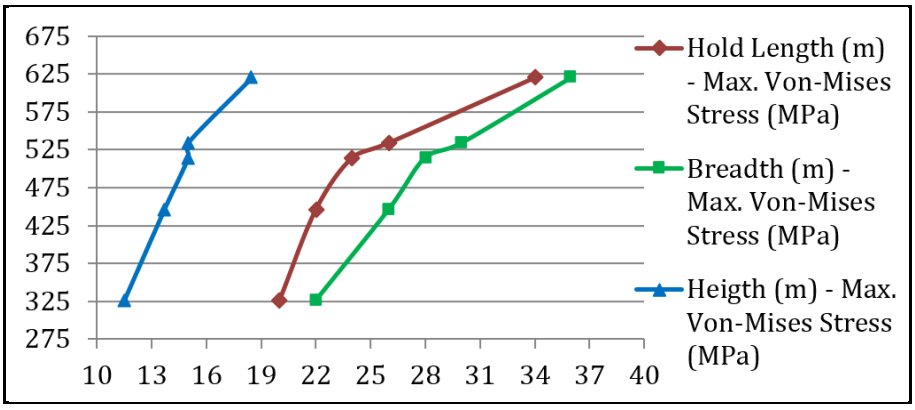

Figure 7: Change of Max. Von-Mises Stress with Hold Length, Breadth and Height.

Percentage increase of total deformation and maximum von-Mises stresses on the ships according to the change in ship length and ship breadth are given in Table 4 and Table 5, respectively.

Table 4: Percentage Increase of Total Deformation and Maximum Von-Mises Stresses On the Ships According to The Change in Ship Length.

Ship Name	Ship Length	Modeled Hold Length	Increase in Ship Length (%)	Increase in Total Deformation (%)	Increase in von-Mises Strength (%)
Mohac	135	20	-	-	-
Darya Shaan	169	22	25,2	31,0	36,8
Piyade	180	24	33,3	43,9	57,7
Aston Trader	179,9	26	33,2	45,5	32,9
African Buzzard	200	34	48,1	116,4	89,9

Note: The increases are calculated based on the values of the Mohac ship.

Table 5: Percentage Increase of Total Deformation and Maximum Von-Mises Stresses On the Ships According to The Change in Ship Breadth.

Ship Name	Ship Breadth	Modeled Hold Length	Increase in Ship Breadth (%)	Increase in Total Deformation (%)	Increase in von-Mises Strength (%)
Mohac	22	20	-	-	-
Darya Shaan	26	22	18,2	31,0	36,8
Piyade	28	24	27,3	43,9	57,7
Aston Trader	30	26	36,4	45,5	32,9
African Buzzard	36	34	63,6	116,4	89,9

Note: The increases are calculated based on the values of the Mohac ship.

4.4. Case Study – 2

Selected bulk carrier Piyade was analysed at the same boundary conditions by taking 1 mm and 2 mm both down and up values of the element thicknesses determined. It is aimed to investigate the effect of thickness change on total deformations and von-Mises stresses. Total deformation and von-Mises stresses as a result of thickness changes in mid-ship section elements have represented in Table 6. Also, total weight - total deformation / max. von-Mises stress relationship due to thickness change has given in Figure 8.

Table 6: Total Deformation and Von-Mises Stresses as A Result of Thickness Changes in Mid-Ship Section Elements.

Thickness Change (mm)	Total Deformations (mm)	Max. von-MisesStress (MPa)
-2	17,829	629,2
-1	16,072	538,7
0	13,998	514,9
1	13,024	471,4
2	12,712	434,8

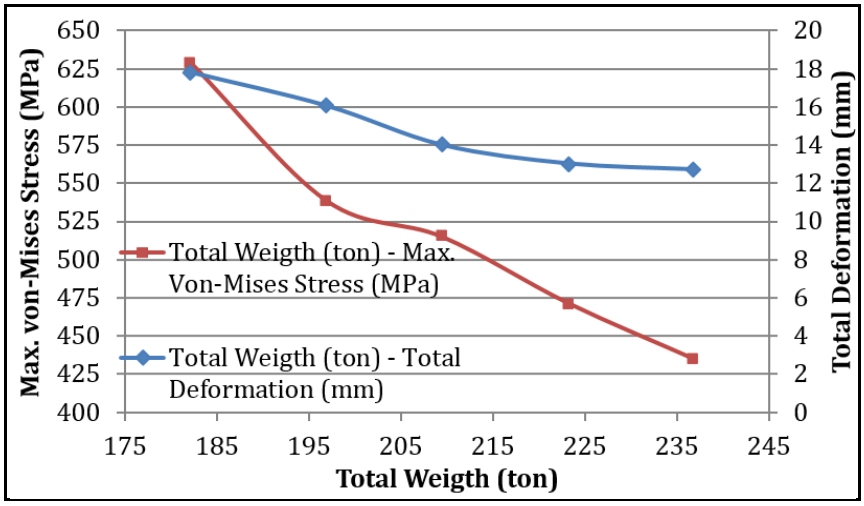

Figure 8: Total Weight - Total Deformation / Max. Von-Mises Stress Relationship Due to Thickness Change.

5. Conclusion

As a conclusion of the first analysis, stress, strain and total deformation conditions and distributions of hydrostatic pressure were calculated and plotted by color scale. Critical regions were observed. The stresses are predominantly concentrated in the regions near the ends. The deformations increase to the middle of the hold at an acceptable level. The changes in FEA results for the five vessels were represented graphically with the hold length, width and depth increase.

As a conclusion of second analysis, the following results were obtained;

- When the thickness values of the elements on the ship were reduced, it was determined that the deformation and stress values increased very rapidly. This showed that the thickness values calculated by the Turkish Loyd rules provide the final strength value at the desired level. When this thickness value is lowered, high deformation and stresses will decrease the strength of the ship.
- When the thickness values of the elements were increased, it was determined that the deformation and stress values decreased with very small values. It is

understood that taking more than the calculated values does not affect the deformation and stresses much. In addition, if the thicknesses are increased unnecessarily, the ship will have higher draft, as it will increase the weight of the ship. This causes the ship to sink into more water and increases the resistance of the ship. Increasing the resistance of the ship increases the costs in the medium and long term, especially the fuel consumption costs. Even though optimization studies can be done with more detailed and local FEM analysis, it can be said that the thicknesses calculated according to the rules determined by national and / or international organizations are suitable and reliable for ships.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

The Prediction of Ship Shaft Bearing Gap by Artificial Neural Networks and Dry Docking Maintenance Planning

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ABSTRACT

In this study, measurements were made on starboard shaft bearings on a ship of four fleet. In the past, bearing wear on the sample vessel has reached the limit values determined by the manufacturer twice and the shaft bearings have been changed unexpectedly. The aim in this studies to estimate the duration to reach of limit wear based on the measurements since the last change and to plan the ship's repair and to extend the operation period of the ship. In this context, an artificial neural network (ANN) model is created using the main bracket gaps measurements and other values recorded in the case when the ship is at port and the time to reach the limit value of the main bracket bearing gaps has been tried to be estimated.

As a result, the value of the bearing gaps measured in the port, the value predicted by the ANN model and the dry docking of the ship were compared. It is concluded that the predicted value evaluated with the model is very close to the value measured while dry docking.

Keywords: Shaft bearing clearance, Dry docking, Ship maintenance, Artificial neural networks (ANN)

Gemi Şaft Yatağı Boşluğunun Yapay Sinir Ağları ile Öngörüsü ve Havuz Bakım Planlaması

ÖZET

Bu çalışmada; dört adet eş gemiye sahip filonun bir gemisinde sancak şaft yatakları üzerine ölçümler yapılmıştır. Örnek gemide geçmiş dönemde yatak aşınması toplam iki kez üretici tarafından belirlenen sınır değerlere ulaşmış ve şaft yataklarının plansız olarak değişimleri yapılmak zorunda kalınmıştır. En son değişimden itibaren yapılan ölçümlere dayalı aşınma miktarının sınır değerlere gelme zamanı tahmin edilmeye çalışılarak, geminin havuz onarımının planlanması ve geminin işletim süresinin uzatılması amaçlanmıştır. Bu kapsamda geminin limanda olduğu durumda yapılan ana braket ölçümleri ve kayıt altına alınan diğer değerler ile bir yapay sinir ağı (YSA) modeli oluşturulmuş ve ana braket yatak boşluklarının sınır değere ulaşma zamanı tahmin edilmeye çalışılmıştır.

Sonuç olarak, limanda ölçülen yatak boşluk değeri, YSA modelinin tahmin ettiği değer ve geminin havuzlanması neticesinde elde edilen değerler birlikte karşılaştırılmıştır. Oluşturulan model ile yapılan tahmin değerinin, havuzda ölçülen değere yakın olduğu tespit edilmiştir.

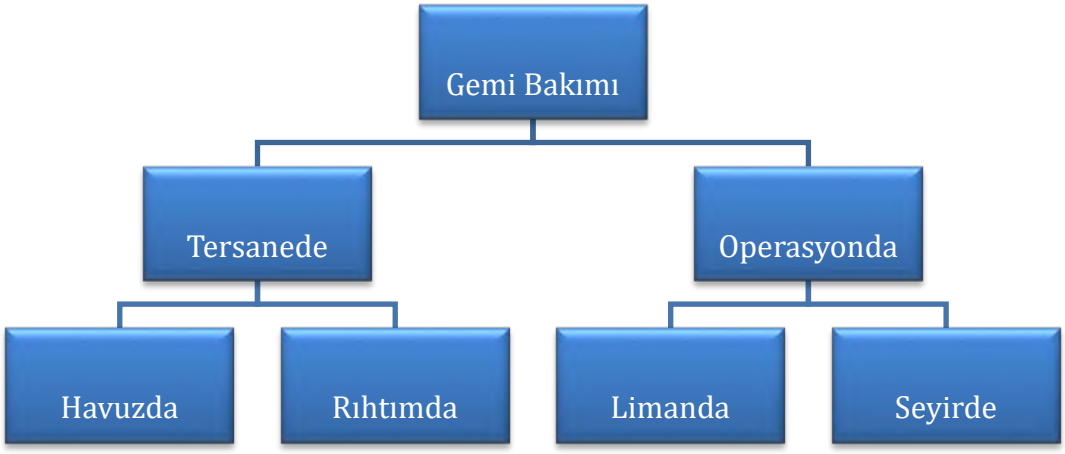
Anahtar Kelimeler: Şaft yatağı boşluğu, Gemi havuzlama, Bakım planlama, Yapay sinir ağları (YSA)

1. Giriş

Bakım, bir unsurun kullanıcı tarafından talep edilen tüm fonksiyonlarını sürdürebilmesi için yapılan faaliyetlerin bütünüdür. Günümüzde değişken şartların etkisiyle, tüm kurum ve kuruluşlar operasyonel hazırlık seviyelerini en üst düzeyde tutabilmek, arızi bakım sayılarını azaltarak sistemlerinin öngörülen ömürleri içinde çalışmasını hedeflemektedir [1]. Bakım, aynı zamanda tüm üretim ekipmanlarını makul bir maliyetle koruyan çalışmalardır [2].

Gemi işletim sistemlerinin uzun ömürlü olması ve düzenli çalışması, uygulanan planlı bakım sistemleri ile mümkün olmaktadır. İşletmeler tarafından cevaplanmak istenen soruların başında, kısıtlı bütçe ortamında bakımın tatmin edici bir şekilde yapılma olasılığı ile; başlangıç ve bitiş zamanlarının doğru öngörülme isteği gelmektedir. Gemi bakımlarının planlanmasında önceliklerin kısa sürede belirlenmesi hedeflenilerek, gemilerin faal kalma sürelerinin uzatılması ve icra ettiği faaliyetlerden en fazla kazancı sağlaması amaçlanılmaktadır. Ancak, gemilerin beklenmedik zamanlarda karşılaştığı arızalara bağlı bakım faaliyetlerinin tahmin edilmesi oldukça zordur. İşletmeler havuz onarımları gibi ağır bakımları yapmak zorunda kaldıklarında büyük zaman ve mali kayıplar ortaya çıkmaktadır. Bu nedenle tüm işletmelerde arıza ile onarım kayıtlarının eksiksiz tutulması, personel eğitimlerinin aksatılmadan yapılması, düzenli denetim faaliyetlerinin icra edilmesi ve tüm bakım prosedürlerinin üretici talimatlarına uygun, bilinçli ve planlı yürütülmesi gerekmektedir.

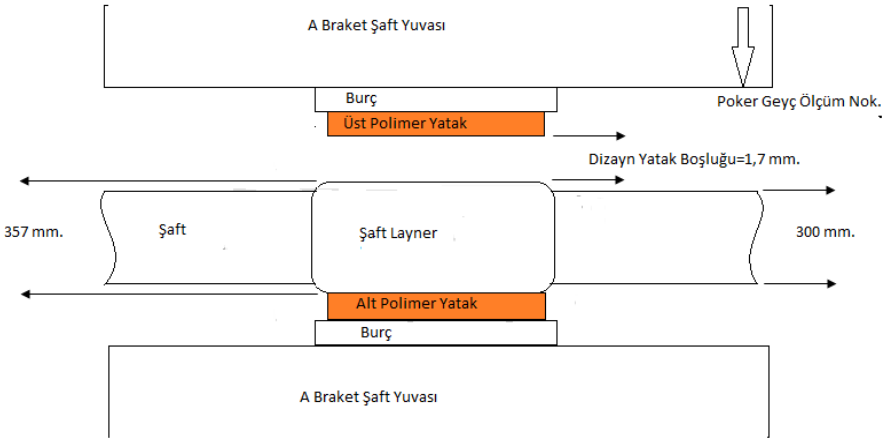
Gemilerde bakım ve onarım faaliyetleri, Şekil 1'de gösterildiği üzere tersanelerde yapılan havuz bakımları ile seyir veya limanda yapılan günlük bakımlar olarak iki başlıkta yürütülebilmektedir [3].



Şekil 1: Gemi Bakımlarının Sınıflandırılması [3]

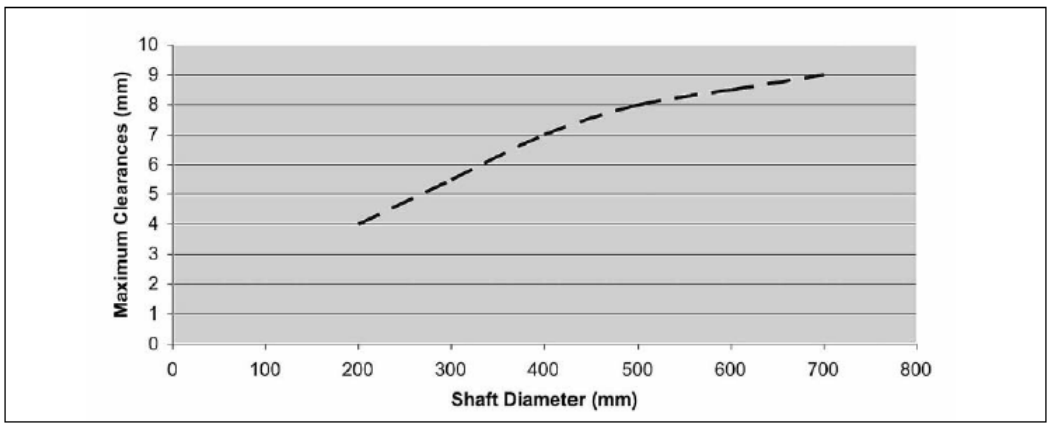
2. Arızanın Tanımı

Gemilerde, yataklama donanımının yerleşimine göre, şaft ve pervane ağırlığından kaynaklı, yataklarda büyük aşınmalar meydana gelebilmektedir. Aşınma; yatak ve şaft aşınmasından dolayı şaftın sarkma ölçüsü olarak ifade edilmektedir. Şaftlarda yatak aşınmalarının ölçümü oldukça zordur. Genelde çift parçalı ve deniz suyu yağlamalı polimer yatakların uygulandığı sistemlerde, dizayn karakteristiği olarak şaft ile alt yatak arasındaki boşluk sıfır kabul edilmekte, üst yatak ile şaft arasında ise, yatak montajının yapılabilmesi için belirlenen oranlarda boşluk bulunmaktadır. (Şekil 2) Dolayısıyla, şaft yataklarında oluşacak herhangi bir aşınmada bu boşluk artma eğilimindedir. Ve bahse konu yatak boşluğunun ölçümü aşınma kriteri olarak belirlenmektedir.



Şekil 2: Ana Braket Polimer Yatak Yerleşimi

Yatak değişiminin gerçekleşmesi gereken aşınma miktarı genelde klas kuruluşları tarafından belirlenmektedir. Örnek gemide kullanılan yatakların, şaft çapına dayalı yatak boşluğu sınır değer grafiği Şekil 3'te yer almaktadır.



Şekil 3: Polimer Yatak Aşınma Grafiği [4]

Şekil 2 incelendiğinde ana brakette şaft çapının layner ile birlikte 357 mm. olduğu görülmektedir. Şekil 3'te 357 mm şaft çapına karşılık gelen yatak sınır boşluğu değerinin yaklaşık 6,5 mm olduğu kolaylıkla tespit edilebilmektedir. Dolayısı ile örnek gemide ana

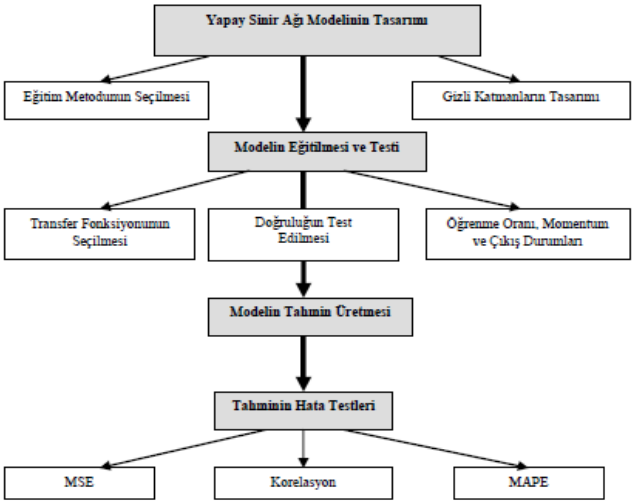
brakette yatak boşluğu 6,5 mm. olduğu takdirde yatakların değiştirilmesi gerekmektedir. (Şekil 4)

Şekil 4: Ana Braket Yatak Boşluğu

Bu kapsamda, sancak şaft ana braket yatak boşluğunun belirlenebilmesi maksadıyla kullanıcı personel tarafından üç yıl sure ile ölçümler yapılmış ve kayıt altına alınmıştır. Kayıt altına alınan değerler ile bir yapay sinir ağı (YSA) modeli oluşturulmuş ve ana braket yatak boşluğunun sınır değere ulaşma zamanı tahmin edilmeye çalışılmıştır.

3. Modelin oluşturulması

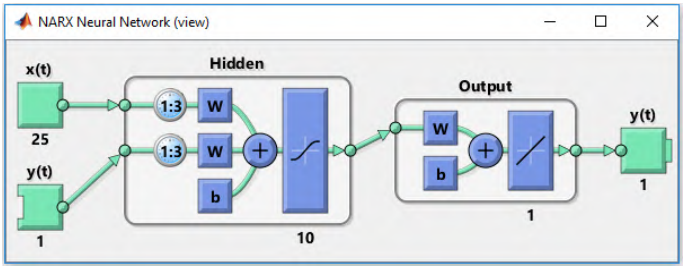
Sancak şaft sistemi ana braket yatak boşluğunun en son yatak değişiminden sonra kayıt edilen değerler üzerinden, sınır yatak boşluk değerine ulaşacağı zamanın belirlenmesi maksadıyla MATLAB® Yapay Sinir Ağı uygulamalarından 'Zaman Serileri' kullanılarak tahminde bulunulmaya çalışılmıştır.



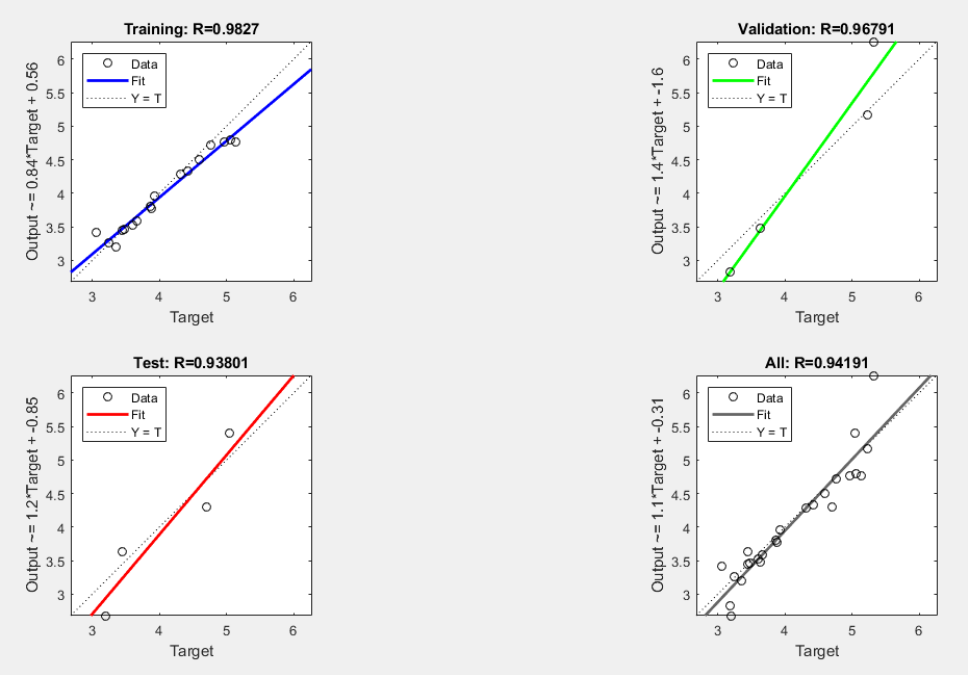
Şekil 5: Yapay Sinir Ağı Modeli Tasarım Süreci [5]

Şekil 5'de görüldüğü gibi YSA modelinin tasarımı, eğitim metodunun ve gizli katmanların belirlenmesi aşamasıyla başlamaktadır. Modelin eğitim ve test aşamasında da transfer fonksiyonları belirlenmekte, modelin tahmin doğruluğu test edilmekte ve öğrenme oranı belirlenmektedir [5].

Zaman serisi tipi yapay sinir ağlarında bir adet gizli katman ve bir adet çıkış katmanı bulunmaktadır. Gizli katman içerisindeki nöron sayısı ve geriye dönük olarak kaç adet değerin işleneceği uygulama üzerinden belirlenebilmektedir. [6] Çalışmada gizli katman içerisinde on adet nöron kullanılmıştır. (Şekil 6) Şekil 7 incelendiğinde test verilerinin bire yakınsadığı açıkça görülmektedir.



Şekil 6: Yapay Sinir Ağı Mimarisi



Şekil 7: Regresyon Değerleri

Belirlenen ağırlık değerleri ile dört adım (periyot) sonrasına kadar tahmin yapılmıştır. Elde edilen sonuçlar, dalgıçlar tarafından yapılan ölçümler ve geminin havuzlanması ile elde edilen gerçek değerler Tablo 1'de sunulmuştur.

Tablo 1: Sancak Şaft Ana Braket Yatak Boşluk Değerlerinin Karşılaştırılması

Ölçüm yapılan yer	Ölçüm yapılan zaman	Poker geyç ölçüm sonuçları (mm.)	YSA ile tahmin edilen değer (mm.)	Havuzlama esnasında ölçülen değer(mm.)
Sancak şaft ana braket yatak boşluğu	2. ay	5,55	6,15	-
Sancak şaft ana braket yatak boşluğu	4. ay	5,75	6,61	-
Sancak şaft ana braket yatak boşluğu	5. ay	5,82	7,13	-
Sancak şaft ana braket yatak boşluğu	6. ay	5,93	7,28	-
Sancak şaft ana braket yatak boşluğu	7.ay	-	6,93	-
Sancak şaft ana braket yatak boşluğu	8. ay	-	-	7,1

Limanda poker geyç ile yapılan ölçümler kullanılarak eğitilen YSA modelinin tahminde bulunduğu sonuçların hata performans analizi Tablo 2'de yer almaktadır. YSA modeli tahmin sonuçlarından yedinci ayda oluşacağı değerlendirilen değer ile geminin havuzlanması ile elde edilen değerin hata performans analizi ise Tablo 3'de bulunmaktadır. Oluşturulan model ile yapılan tahmin değerinin, havuzda ölçülen değere yakın olduğu görülmektedir.

Tablo 2: Eğitim Verilerinin Hata Performans Analiz Sonuçları

MAD	MSE	RMSE	MAPE
5.107	1.122	1.059	17.527

Tablo 3: Tahmin Değeri Hata Performans Analiz Sonucu

MAD	MSE	RMSE	MAPE
0.17	0.029	0.17	0.024

4. Sonuçlar

Beş yılık işletme geçmişine sahip sahip gemide ana tahrik sistemi şaft yatak yük dağılımının bozulması, gemi gövdesinde aşırı titreşim ve şaft yatak aşınması arızaları toplam iki kez meydana gelmiştir. Filonun diğer üç gemisinde de benzer arızalar oluşmuş

ve her gemi plansız olarak havuzlamak zorunda kalınmıştır. Gemilerin havuzlanması ile sonuçlanan bu arızaların giderilmesi amacıyla polimer yatakların bir bölümünün değiştirilmesi gerekmiştir. Böylece büyük zaman ve maliyet kayıpları meydana gelmiştir. Ayrıca arızaların tekrar meydana gelmemesi için bakım yöntemlerinde çeşitli iyileştirmeler yapılmıştır.

Sonuç olarak, YSA modeli kullanılarak geminin sancak şaft ana braket yatak boşluğunun sınır değeri geçebileceği zaman tahmin edilmiş olup, geminin planlı havuzu sonucunda elde edilen yatak boşluğunun gerçek değerine oldukça yakın bulunmuştur. YSA modelinin bahse konu geminin havuz planlaması yapılırken kullanılabileceği değerlendirilmektedir.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Determination of Evaluation Criteria for the New Traffic Separation Schemes and Implementation for the 1915 Çanakkale Bridge

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ABSTRACT

The main purpose of this study is to determine the applicable criteria for the detection of safe navigation areas due to the bridge etc. to be constructed in the existing traffic separation system. For this purpose, the study was carried out on the navigation area which will be changed with the "1915 Çanakkale Bridge". First of all, the information about the bridge and the oceanographic and meteorological data of the region were researched, analysis of marine traffic, accidents in the region and related regulations were examined. Secondly, the bridge and its location were transferred to the simulation in order to reveal the effect of the bridge on the marine traffic. In addition, two-way safe passage distances determined by international rules for safe navigation were investigated. After all examinations, 11 different options have been created depending on 6 main conditions. In order to evaluate the data obtained correctly, a group of experts consisted from the maritime pilots who are actively working in Çanakkale Strait, representatives of operators of VTS who are responsible for the monitoring and management of traffic, representatives of construction consortium and marine experienced academicians. As a result of the evaluation of the experts, it was decided to implement the 4 options in the bridge simulator including emergency situations. As a result of 30 different experiments, 9 criteria were determined by experts in terms of navigation safety, the layout of the traffic, protection of buildings and their applicability. Options according to these 9 criteria such as the widest navigable area, minimum turning

angle, and minimum turning point was evaluated and detected most suitable one. It is also envisaged that this study could be applied to in similar areas where marine traffic is intense in the future.

Keywords: Maritime Transportation, Navigation, Traffic Separation, Simulation, Marine Traffic.

1915 Çanakkale Köprüsü için Yeni Trafik Ayrım Düzeninin Değerlendirme Kriterlerinin Belirlenmesi ve Uygulanması

ÖZET

Bu çalışmanın temel amacı, mevcut trafik ayrım düzeninde inşa edilecek olan köprü vs. gibi yapılar nedeniyle güvenli seyir alanlarının tespitinde uygulanabilir kriterleri belirlemektir. Bu amaçla "1915 Çanakkale Köprüsü" ile değişecek olan seyir alanı üzerinde çalışma yapılmıştır. Öncelikle bölgede köprü yapısı ile ilgili, oşinografik ve meteorolojik veriler araştırılmış, deniz trafiğinin analizi yapılmış, bölgedeki kazalar ve ilgili düzenlemeler incelenmiştir. İkinci olarak, köprünün deniz trafiği üzerindeki etkisini ortaya çıkarmak için köprü ve konumu simülasyona aktarılmıştır. Ek olarak, güvenli seyir için uluslararası kurallarla belirlenen iki yönlü güvenli geçiş mesafeleri incelenmiştir. Tüm incelemelerden sonra 6 ana duruma bağlı olarak 11 farklı seçenek oluşturulmuştur. Elde edilen verilerin doğru değerlendirilebilmesi için Çanakkale Boğazı'nda aktif olarak çalışan kılavuz kaptanlardan, deniz trafiğinin izlenmesi ve yönetiminden sorumlu GTH operatörleri ile inşaat konsorsiyumu temsilcilerinden ve denizcilik tecrübesine sahip akademisyenlerden oluşan bir uzman grubu oluşturulmuştur. Uzmanların değerlendirilmesi sonucunda, acil durumlar dâhil olmak üzere simülatörde 4 seçeneğin uygulanmasına karar verilmiştir. 30 farklı deney sonucunda, seyir güvenliği, trafiğin düzeni, yapıların korunması ve uygulanabilirliği konularında uzmanlar tarafından 9 kriter belirlenmiştir. Seyir yapılabilir en geniş alan, minimum dönüş açısı ve minimum dönüş noktası gibi bu 9 ölçüt uyarınca seçenekler değerlendirilmiş ve en uygun olanı tespit edilmiştir. Bu çalışmanın gelecekte deniz trafiğinin yoğun olduğu benzer alanlarda da uygulanabileceği öngörülmektedir.

Anahtar Kelimeler: Deniz Ulaştırması, Seyir, Trafik Ayrım Düzeni, Simülasyon, Deniz Trafiği

1. Giriş

Bir kıyı tesisinin operasyonel gereklilikleri, her bir yapının belirli fonksiyonu veya tüm fonksiyonlarıyla birlikte etkileşim içerisindedir. Bu nedenle deniz trafiğini ve kıyı tesislerini içeren tüm çalışmalarda gemi operatörleri ve gemi kullanıcıları (kaptanlar, kılavuz kaptanlar ve römorkör kaptanları), deniz trafiği yöneticileri ve hatta ilgili otorite arasında iş birliği olmadan, bilgi alışverişi ve iletişim kurulmadan operasyonel gerekliliklerin karşılanması mümkün değildir. Bu gerekliliklerin belirlenmesi ve çalışmaların başarılı şekilde sürdürülebilmesi için ise tasarımdan önce beklentilerin ve gerekliliklerin netleştirilmiş olması önemlidir. Emniyetli ve ekonomik açıdan maksimum operasyonel fayda sağlanması amacıyla da bu beklenti ve gerekliliklerin simülasyon çalışmaları ile test edilmesi tavsiye edilmektedir [1][2][3].

Suyollarının tasarımında, kanalların düzenlenmesinde alternatif rotaların tespitinde, yanaşma alanlarının tasarımında, deneyimli kaptanların ve kılavuz kaptanların düşünceleri önem taşımaktadır. Bu nedenle tasarım aşamasında simülasyon ortamında tüm şartlar dikkate alınarak geliştirilen sahada gemi manevra deneylerinin tecrübe sahibi olan kaptanlar, kılavuz kaptanlar tarafından testi önem taşımaktadır [1][4].

2. Gemi Manevra Deneylerinde Kullanılan Köprüüstü Simülatörü

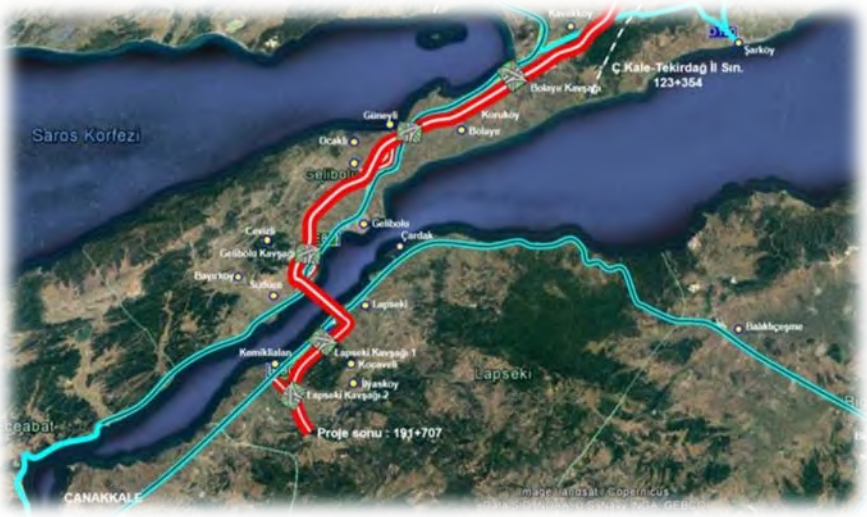
Günümüzde gemi kullanma simülatörlerinde köprüüstü seyir yardımcılarının simüle edilmiş aygıtları vasıtasıyla bire bir ölçekli istasyonlar oluşturulabilmektedir. Bu istasyonlarda kullanılan yazılım sayesinde, gemi tipine bağlı manevra karakteristikleri, deniz dip yapısı ve gemiye etkisi (paralel batma, bank etkisi vb.), akıntılar, rüzgâr şiddeti/yönü, dalga yüksekliği/yönü, römorkör etkisi, yedekleme güçleri, gemi modeli ile tüm etmenlerin birbirleri ile oluşturduğu hidrodinamik etkiler, bilgisayar yazılımlarıyla matematiksel olarak oluşturulmaktadır. Kıyı tesisleri ve deniz trafiği ile ilgili çalışmaların bilgisayar simülasyonlarıyla test edilmesi sırasında gemi modelinin hareketlerinde hangi iç ve dış faktörlerin dikkate alınacağı Gucma [4] tarafından detaylı bir şekilde sıralanmıştır. Gemilerin köprüüstünde bulunan aygıtların fonksiyonlarını tam olarak benzetimini sağlayacak şekilde tasarlanan ve 360 derece görüntü açısı bulunan

köprüüstü simülatör sistemleri "tam donanımlı köprüüstü simülatörü" (full mission bridge simulator) olarak adlandırılmaktadır [5].

Çalışmanın gerçekleştirildiği ve Dokuz Eylül Üniversitesi Denizcilik Fakültesi'nde kullanılan köprüüstü simülatörü, yazılımı Transas Firması tarafından üretilmiş olan NTPro 5000 modelidir. Köprüüstü Simülatörü, "Gemi Manevra Simülasyonu" yardımıyla tam olarak kontrol edilmiş ve gerçekçiliğe uyarlanmış gemi modelleri ile çalışmaktadır. Dolayısıyla yanaşma/ayrılma/demirleme manevraları, yedekleme operasyonları, halat operasyonları ve diğer liman sahası operasyonlarında geminin hareketleri gerçekçi ve matematiksel verilerle desteklenerek elde edilmektedir. Kullanılan simülatör sistemi, manevralar sonucunda elde edilen analitik verilere dayalı olarak, gemiler ile gemiler, gemiler ile kıyı yapısı arasındaki etkileşimden kaynaklanan manevra risklerini tanımlamakta, derecelendirmekte ve raporlamaktadır. Bu açılardan literatürde belirtilen çalışmaların etkin bir şekilde gerçekleştirilebileceği benzetimi sağlayacak donanıma sahip olduğu görülmektedir.

3. 1915 Çanakkale Köprüsü Konumu ve Çevresel Faktörler

1915 Çanakkale Köprüsü, "Malkara – Çanakkale Otoyolu" çalışmalarındaki, Gelibolu Sütlüce ve Lapseki Şekerkaya mevkileri arasında yer alan ve Çanakkale Boğazının iki yakasını birleştirecek bir köprüdür. Çanakkale boğaz geçişinin, 2023 metrelik ana açıklık, 700 metrelik yan açıklıklar ve Lapseki tarafındaki 650 metrelik, Gelibolu tarafındaki 900 metrelik yaklaşım viyadükleri ile beraber yaklaşık 5.173 metre olması planlanmaktadır.

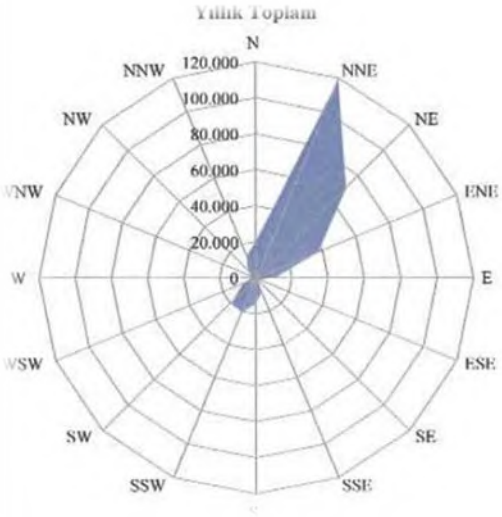


Şekil 1: 1915 Çanakkale Köprüsü Uydu Fotoğrafı

Asma Köprü tabliyeleri, her biri 3,65 m. genişliğindeki 2x3 şeritli ve toplam 39 metreye sahip genişliği ile her iki tarafında bakım ve muayene amaçlı yol olacak şekilde planlanmıştır. Şekil 1'de "Malkara – Çanakkale Otoyolu" üzerinde bulunan 1915 Çanakkale Köprüsünün bulunduğu uydu fotoğrafı verilmiştir. Köprünün kuleleri yaklaşık 318 metre yükseklikte olup, denizin 40 metre derinliğine oturması planlanmaktadır. 1915 Çanakkale Köprüsü'nün; dünya asma köprüler sıralamasında, 2023 metrelik ana açıklığı ile birinci sırada olacağı belirtilmektedir.

a. Meteorolojik ve Çevresel Faktörler

Çanakkale Merkez Meteoroloji İstasyonunun 1970 - 2010 yılları arasındaki verilerinden faydalanılarak aylık rüzgâr esme sayıları ve yönleri araştırılmış ve bölgedeki birincil rüzgâr yönünün Kuzey Kuzeydoğu (NNE) olduğu tespit edilmiştir. Çanakkale Meteoroloji İstasyonunun 1970-2010 yılları arasında yapılan gözlemlere göre rüzgâr yönleri verilerinden yararlanılarak oluşturulan rüzgâr diyagramı ise Şekil 2'de gösterilmektedir.



Şekil 2: Çanakkale İli 1970 – 2010 Yılları Arası Rüzgâr Diyagramı

Seyir ve simülasyon çalışmalarına başlamadan önce gerçekleştirilen çalışmalarda 1915 Çanakkale Köprüsü bölgesindeki hakim rüzgarın boğaz doğrultusunda olduğu ve rüzgar ana yönünün NE olduğu, ikincil ana yönünün ise SW olduğu belirlenmiştir. Simülasyon deneylerinde birincil rüzgar yönü olan Kuzeydoğu (NE) ile ikincil rüzgar yönü olan Güneybatı (SW) rüzgar yönleri referans olarak alınmıştır.

Tablo 1: Çanakkale İli Ortalama Sisli ve Kar Yağışlı Gün Sayılarının Aylara Göre Dağılımı

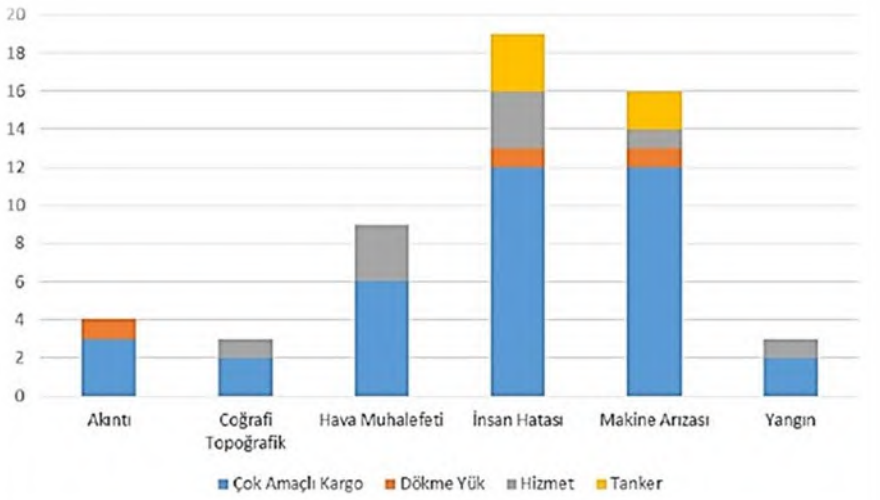
	AYLAR											
	1	2	3	4	5	6	7	8	9	10	11	12
Kar Yağışlı Gün Sayısı	2,8	2,5	1,2	-	-	-	-	-	-	-	0,2	1,9
Ortalama Sisli Gün Sayısı	1,8	1	1	0,5	0,1	-	-	-	-	0,4	1,3	1,2

Bölgede Çanakkale referans alınmak kaydıyla seyir emniyetini etkileyen sisli gün sayıları ortalamaları ise Tablo 1'de gösterilmektedir. Buna göre Haziran, Temmuz, Ağustos ve

Eylül Aylarının dışında her ay en az bir gün sisli hava olayı yaşanmaktadır. Bunun dışında, yerel olarak sis durumlarının yaşandığı da bilinmektedir. Bunlarla ilgili bir istatistiki veri olmamakla birlikte seyir çalışmalarına katılan uzmanlar tarafından yerel bilgi niteliği taşıyan vakaların yaşandığı bildirilmektedir. Ayrıca Tablo 1'de Çanakkale ili Ortalama sisli ve kar yağışlı gün sayılarının aylara göre dağılımı verilmiştir. Çanakkale Köprüsünün oluşturduğu yeni geçiş aralığı ortalama - 40 metre derinlikte emniyetli bir seyir imkanı sağlamakta olup, bu nedenle gemilerin squat ve dalgadan dolayı etkilenmeleri ile ilgili bir çalışma yapılmamıştır.

b. Çanakkale Boğazı Deniz Trafik Emniyeti

Çanakkale Boğazına ait Ulaştırma ve Altyapı Bakanlığı deniz trafiği verilerine göre son beş yılda boğazdan geçiş yapan gemi sayısı yıllık olarak 44.000 olarak ölçülmüştür. Bu gemilerin sadece %43 lük bir kısmının kılavuz kaptan alarak, % 57'sinin ise kılavuz kaptan almadan Çanakkale Boğaz seyri yaptığı tespit edilmiştir.



Şekil 3: Çanakkale Boğazı Karaya Oturma Kazalarının Nedenleri ve Bunların İçindeki Gemi Tipi Dağılımları

Deniz trafiği emniyetine ilişkin gerçekleştirilen araştırmalarda yine Ulaştırma ve Altyapı Bakanlığına bağlı Ana Arama Kurtarma Koordinasyon Merkezi verilerinin kullanıldığı görülmüştür [6][7][8]. İlgili çalışmalarda ortalama yılda 6 defa karaya oturma kazası

yaşandığı, en çok yaşanan ayın ise Eylül ayı olduğu, kazalara en çok kuruyük gemilerinin karıştığı ve kazalardaki insan hatalarının yüksek bulunduğu tespit edilmiştir [8].

Şekil 3'te ilgili araştırmaya ait detaylı grafik gösterilmiş olup "insan hatası" ve "makine arızası" payının yüksek olduğu görülmektedir. Aynı sonuçlar Kuleyin ve Aytekin'in [7] çalışmalarında da desteklenmektedir. Buna göre, Çanakkale Boğazında 2004 – 2014 yılları arasında meydana gelen kazalarda sayıca en çok kazanın Nara Burnu sahasında meydana geldiği karaya oturma kazalarının ise Çanakkale Boğaz girişinde bulunan Kumkale sahası olduğu tespiti yapılmıştır. Elde edilen araştırma sonuçları aynı zamanda PIANC:2001'de [9] açıklanmış olan ve gemilerin köprülere çarpma sebepleri ile de büyük oranda benzerlikler göstermektedir. Ilgar'ın [6] yapmış olduğu çalışmada, Çanakkale Boğazının kaza riski en yüksek olan bölgenin "Lapseki – Gelibolu arası" olduğu tespit edilirken, kaza riski yüksek diğer bölgeler Nara, Kumkale, Çanakkale ve Gocuk Burnu olarak bulunmuştur.

c. Çanakkale Boğazı Gemi Trafik Hizmetleri

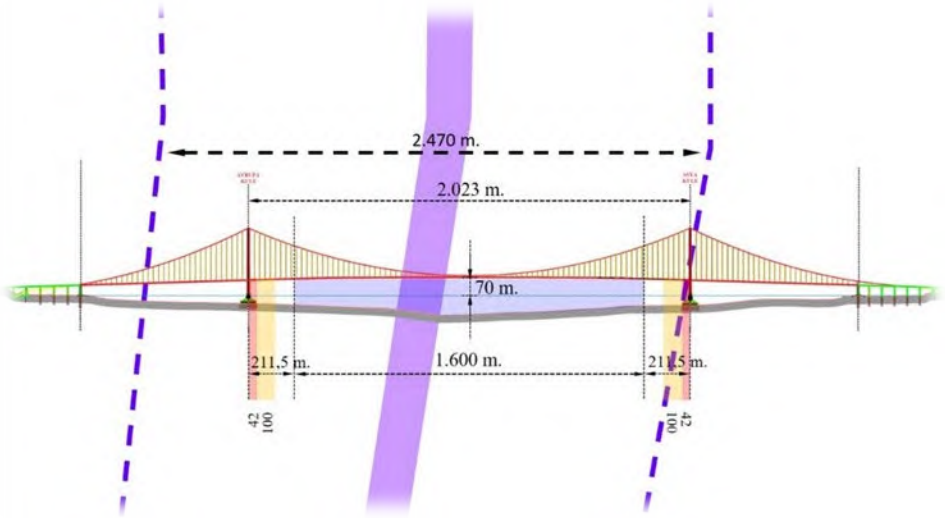
Çanakkale Boğazında deniz trafiği Türk Boğazları Deniz Trafik Düzeni Tüzüğü'ne göre yönetilmektedir. Bu amaçla kurulan Çanakkale Gemi Trafik Hizmetleri (GTH), boğazda belirli alanlarda farklı operatörler tarafından yönlendirilmektedir. Bu sahalar Kumkale, Nara ve Gelibolu sektör olmak üç sahaya ayrılmıştır. GTH Operatörü kendi sektörü içerisindeki gemileri, AIS, VHF ve Radar sistemleri ile takip etmekte, gemilerin belirlenmiş olan sahaların içerisinde seyir yapıp yapmadığı, düzenlemelere uygun hareket edip etmediğini takip etmektedir.

Çanakkale Boğazı güney girişindeki Bozcaada'dan başlayarak, Marmara ve İstanbul Boğazı Kuzey çıkışına kadar gemilerin seyirde izledikleri rotaların kesişmemesi için, Trafik Ayrım Düzeni (TAD) geliştirilmiştir. TAD içerisinde seyir yapan bir gemi karşı ayrıma geçemez ve kendi trafik ayrımında seyir yapması gereklidir. Gemiler seyirleri sırasında mevki koyma yöntemlerini kullanarak, radar ve elektronik seyir haritalarında (ECDIS) anlık pozisyonlarını görerek konumlarını kontrol ederler. Boğaz seyri sırasında

daha önce belirtilen GTH alanlarını geçerken kendilerini takip etmekte olan GTH'ne rapor vererek sektör geçişlerini bildirmekle yükümlüdürler.

2. 1915 Çanakkale Köprüsünün Deniz Trafiğine Etkisi

1915 Çanakkale Köprüsü uluslararası deniz trafiğinin yoğun olduğu bir bölge üzerinden geçeceği için, gemi trafiğini aksatmayacak bir şekilde konumlandırılması gerekmektedir. Köprüye ait planların incelenmesi sonucunda, kule ayakları arasındaki mesafenin 2023 metre olduğu ve 1.600 metre boyunca da 70 metrelik geçiş gabarisi sağlandığı görülmüştür.

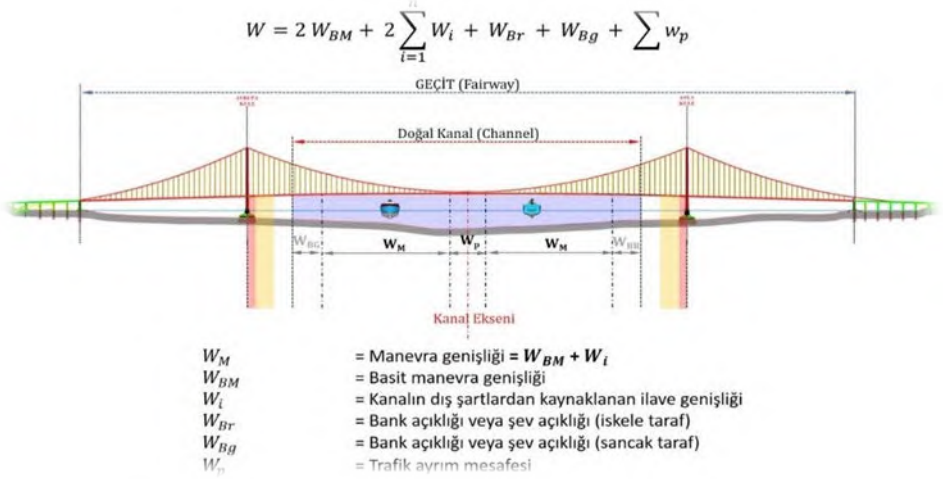


Şekil 4: Çanakkale Köprüsü ve Trafik Ayrım Düzeni

Şekil 4'te köprünün ayaklarının konumlandığı noktalar ile mevcut TAD birlikte gösterilmiştir. Köprünün geçtiği kesitte TAD'ın dıştan dışa genişliği yaklaşık olarak 2.470 metredir. Köprü tamamlandıktan sonra oluşacak TAD'ın ise dıştan dışa sınırı 1.600 metreye düşecektir. Bu durumda TAD dış sınırı ile kule ayakları arasında yaklaşık olarak 170 metre emniyet açıklığı meydana gelecektir. Bu emniyet payı, İstanbul Boğazından 50 metre, İzmit Körfezinde ise 100 metredir.

Uluslararası suyolları tasarımlarında deniz trafiğinin engellenmemesi açısından en büyük geminin su üstü yüksekliğinin (air draft) de göz önüne alınması gerekmektedir. PIANC [10] tarafından köprülerin tasarımında geçen geminin üst noktası ile köprü alt noktası arasında kalan emniyet mesafesi (ADC) belirlenmiştir. Buna göre bir geminin köprünün altından emniyetle geçebilmesi için en üst noktası ile köprü arasında en az kendi air draftının (hava çekiminin) % 5'i kadar bir emniyet payı veya 2 metre mesafe bırakılması gerekmektedir. 1915 Çanakkale Köprüsünün 70 metrelik yüksekliği düşünüldüğünde bu köprünün altından 66 – 68 metre aralığında yüzer araçların geçişi mümkün olacaktır.

1915 Çanakkale köprüsünün 70 metrelik gabari yüksekliğinde oluşturduğu 1600 metre genişliğindeki geçidin çift yönlü deniz trafiği için yeterli olup olamayacağı da incelenmiştir. PIANC [10] referans alınarak kanal genişliği tasarım ölçütleri en sınır şartlarda hesaplanmıştır. Bu hesaplarda manevra açısından en zayıf gemi, en kötü meteorolojik şartlarda, çift yönlü trafikte, en büyük hız limitlerinde, bazen de en yavaş hızlarda, olmadığı halde sığlıkların da dikkate alındığı, seyir yardımcılarının mükemmel olduğu halde kısıtlandığı bir senaryo tasarlanmıştır. PIANC, kanal genişliği hesabında hesaplama kolaylığı açısından her bir faktörün etkisini tasarım gemisinin genişliği ile ilişkilendirmiş olup, çıkan sonucun tasarım gemisinin genişliği ile çarpımı bize tasarlanan kanalın gerekli genişliğini vermektedir.



Şekil 5: PIANC Çift Yönlü Kanal Genişliği Formülü

Şekil 5'te PIANC tarafından belirlenmiş olan formül grafik yardımıyla gösterilmektedir. En büyük tasarım gemisinin genişliği 60 metre olarak kabul edilerek gerekli genişlik için tüm faktörlerin toplamı 18,1 bulunmuştur. Bu değer bir üst değer olan 20'ye taşınsa dahi bize gerekli olan genişlik değerini 1.200 metre olarak vermektedir. Dolayısıyla 1915 Çanakkale Köprüsünün 1.600 metrelik kanal genişliği tasarımının çift yönlü trafikte, manevrası en zayıf gemi ile seyir yapıldığı, fırtına ve akıntıların olduğu bir ortamda bile uluslararası standartlara göre belirlenenden çok daha fazla bir genişlik sağladığı belirlenmiş olmaktadır.

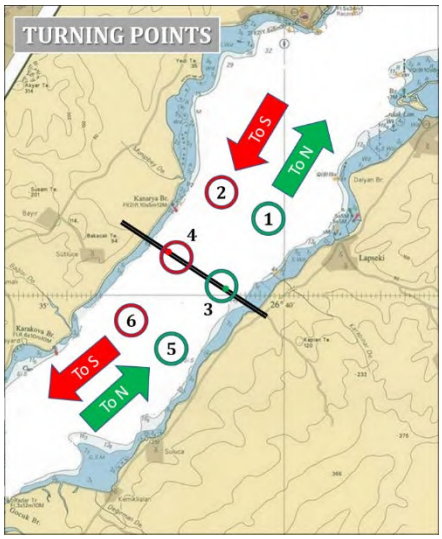
3. 1915 Çanakkale Köprüsü ve Trafik Ayrım Düzeni Opsiyonları

1915 Çanakkale Köprüsünün deniz trafiğine olan en büyük etkisi, Avrupa Kulenin mevcut Güneyli deniz trafiğine ait TAD içerisinde kalması ve yeni bir TAD düzenlemesinin yapılma ihtiyacının doğmasıdır. Yeni TAD içerisinde 1.600 metrelik genişlik sabit olup, Gelibolu – Gocuk Burnu arasında bir adet kırılmanın nereden yapılması gerektiğine karar verilmesi gerekmektedir. Bu amaçla karar seçenekleri geliştirilmiş ve Tablo 2'de yeni geliştirilen TAD dönüş noktalarına göre geliştirilen seçenekler ile Şekil 6'da seçeneklere ilişkin hazırlanan temel görsel verilmiştir.

Tablo 2: Yeni Trafik Ayrım Düzeni Seçenekleri Tablosu

Seçenekler	Kuzey Trafik			Güney Trafik		
	Köprüde Dönüş	Güneyde Dönüş	Kuzeyde Dönüş	Köprüde Dönüş	Güneyde Dönüş	Kuzeyde Dönüş
OPS1v1			x	x		
OPS1v2			x	x		
OPS2v1		x			x	
OPS2v2		x			x	
OPS2v3		x			x	
OPS3v1		x		x		
OPS3v2		x		x		
OPS4			x			x
OPS5v1	x			x		
OPS5v2	x			x		
OPS6			x		x	

Simülasyon deneylerinin tasarım aşamasından önce TAD temel seçenekleri üzerinden DEÜ Öğretim Üyeleri, GTH operatörleri, Kılavuz Kaptanlar ve köprü tasarım firması olan COWI uzmanları tarafından geliştirilen 11 farklı seçenek detaylı olarak incelenmiştir.



Şekil 6: TAD'de Dönüş Noktalarını Belirlemeye Yönelik Temel Görsel

Gerçekleştirilen inceleme ve ön değerlendirmeler sonrası OPS1v2, OPS3v1, OPS5v1 ile OPS6 seçeneklerinin simülatör deneylerinde kullanılmasına karar verilmiştir. KEGM Kılavuz Kaptanları ve GTH operatörleri ile birlikte gerçekleştirilen detaylı değerlendirme çalışmalarından sonra da senaryolar oluşturulmuş ve simülatör ortamında denenmiştir. Boyları 140 metreden 398 metreye kadar 11 farklı gemi tipi ile 1,7 metre dalga yüksekliği ve 35 Knot hızındaki rüzgar etkisi altında Kuzeyden Güneye ve Güneyden Kuzeye gündüz ve gece şartlarında 30 farklı simülasyon çalışması gerçekleştirilmiştir. Simülasyon çalışmaları sonrasında elde edilen bulgular ile literatürde yer alan kaza nedenleri detaylı olarak incelenmiş ve test edilen seçeneklerin karşılaştırılabilmesi amacıyla seyir koşulları, gemi, can, mal ve çevre emniyeti ile olası acil durumların etkileri açısından belirli ölçütlerin oluşturulması zorunlu görülmüştür.

4. Trafik Ayrım Düzeni Karar Verme Ölçütleri

1915 Çanakkale Köprüsünün inşaası ile birlikte değişmek zorunda kalacak olan deniz trafik alanının yukarıda belirtilmiş olan hangi seçeneğe uygun olarak düzenlemesi gerektiği konusunda emniyetli seyir, gemi, can, mal ve çevre emniyeti ile olası acil durumlar dikkate alınacak şekilde karar ölçütleri hazırlanmıştır. Bu karar ölçütleri aşağıda detayları ile aktarılmıştır.

i. *TAD ayrım hatları arasındaki emniyet sahası genişliğinin en az 200 metre olması:* Her iki yönlü trafikte seyreden gemilerin olası çevresel faktörlerle veya beklenmeyen acil nedenlerle emniyet sahasına girmesi durumunda gemi trafik izleme sistemi tarafından fark edilebilmesi ihtimalinin arttırılması için bu ölçüt gerekli görülmüştür. Bir diğer husus ise günümüz artan gemi büyüklükleri ile artan gemi genişliklerinin de dikkate alınarak en büyük gemilerin genişliklerinin yaklaşık 4 katı genişliğinde olması da emniyeti arttıran bir ölçüt olarak görülmüştür.

ii. *TAD'de her iki yönlü trafik için seyir alanı genişliğinin en az 700 metre olması:* Köprü altında 70 metre emniyetli geçiş yüksekliğinin korunabilmesi amacıyla belirlenmiş olan mesafe 1600 metredir. Bu mesafenin 200 metresi orta emniyet sahası olarak belirlendiğinde kalan alan her iki yönü trafik içinde kullanılabilir olmalıdır. TAD'nin oluşturulma amaçlarından biri de seyre engel veya tehlike içeren alanlardan uzak kalınması olduğundan köprü ve altındaki saha da aynı kapsamda değerlendirilmiştir. Dolayısıyla hem trafik düzeninin sağlanması hem de bu genişliğin daha fazla azaltılmadan geçişlere müsaade edilmesi önemli görülmüştür.

iii. *Rota değişikliklerinin 15^0'den fazla olmaması:* Dar suyolları, kanallar veya yoğun trafik bölgelerinde meydana gelen kazalar incelendiğinde gemi dümen sisteminin arıza yapması (takılı kalması, çalışmaması, ters yönde basılması vb) sonucunda meydana gelen kazaların olduğu bilinmektedir. Özellikle 15^0 üstünde dönüşlerin yapıldığı ve/veya çok sık ve birbirine zıt doğrultuda (önce sancağa sonra iskeleye veya tersi) dönüşlerin yapıldığı suyollarında kaza olma olasılıkları artmaktadır. Dolayısıyla seyir, can, mal ve çevre emniyeti açısından trafik ayrım düzeni hazırlığındaki bu durumlarda mümkünse rota açıları arasında olabildiğince düşük

açılar bulunması ve Çanakkale Köprüsü için de 15^0 olarak uygulanmasının uygun olacağı değerlendirilmiştir.

iv. *Seyir boyunca iki yönlü trafik içinde en az sayıda dönüş noktası olması:* Yukarıda gemi sevk sistemleri ile ilgili belirtilen hususlarda da yer aldığı üzere mümkün olan en az sayıda dönüş sahası boğaz seyrini daha emniyetli hale getirmekte, olası arızaları ve dolayısıyla kaza ihtimallerini azaltabilecek bir unsur olarak görülmektedir. Ayrıca TAD açısından, trafik daha düzenli hale gelecek ve gemileri belirgin rotalar üzerinde seyre yönlendirecektir.

v. *Gemilerin taşıdığı görsel seyir işaretlerinin birbirlerinin konum ve doğrultularını yanlış anlamalarına izin vermeyecek şekilde olması:* Özellikle gece seyrinde gemilerin birbirlerine karşı göstermek zorunda oldukları fener ve alametlerin karşı hatta ilerleyen gemilerce yanlış anlaşılmaya izin vermemesi önemlidir. Aksi takdirde kaçınma manevrası yapmak isteyen gemiler, kendileri ile aynı trafik hattında ilerleyen gemilere aşırı yaklaşacak veya trafik ayrım düzeni sınırında seyretmek isteyebilecektir.

vi. *Her iki yönlü trafikte seyreden gemilerin olası aykırı durumlarının GTH (VTS) tarafından tespiti sonrasında trafik emniyeti açısından yeterli reaksiyon zaman ve mesafeye sahip olması:* Olası arıza durumunda emniyet hattına/TAD dış sınırına yaklaşan geminin tespit edilebilmesi önemlidir. Bu tespit sonrasında verilecek tepkinin/önlemin de gemilerce uygulanabilmesi için yeterli seyir sahasının bulunması gerektiği de son derece önemli bir ölçüt olarak değerlendirilmiştir.

vii. *Mümkün olan en fazla seyir yapılabilir alanı içermesi:* TAD'leri seyre engel teşkil eden alanlarda olduğu kadar yoğun trafik alanlarında ve trafiğin çeşitli sebeplerle tehlikeli koşullar içerdiği alanlarda da uygulanmaktadır. Özellikle dar suyollarında ve kanallarda / boğazlarda gemilerin çeşitli sebeplerle oluşabilecek tehlikelerden sakınabileceği alanların bulunması son derece önemlidir. Simülatör deneylerinde üretilen bazı seçeneklerin diğerlerinden görece daha az seyir yapılabilir alan içerdiği görülmüş ve bu nedenle de bir ölçüt olarak uygulanması zorunlu olmuştur. Ancak bu ölçüt ve diğer ölçütlerin değerlendirmesi yapılırken birlikte

değerlendirilmesi, ölçütlerin birbirlerine zıt koşulları içermemesine dikkat edilmesi de önemlidir.

viii. *Köprü ayakları gibi seyir, can, mal ve çevre emniyetine engel teşkil edebilecek denizdeki yapıların pruva istikametinde bulunmaması:* Uzun süreli ve aşırı dikkat gerektiren suyollarında gerçekleşen kazalar, rota değişiminin çeşitli nedenlerle yapıl(a)maması nedeniyle köprü ayağı ve benzeri kıyı yapılarına temas/çarpma ile sonuçlanmaktadır. Bilimsel çalışmalarda mümkünse izlenecek rotaların bu yapıları pruva istikametinde tutmayacak şekilde düzenlenmesi gerektiği şiddetle önerilmektedir. Bu nedenle de bir ölçüt olarak konulması zorunludur.

ix. *Kaptan ve/veya görevli zabitler ve Kılavuz Kaptanlar açısından uygulama kolaylığı içerecek şekilde olması:* Gerek dar suyollarında seyreden gemiler açısından ve gerekse de bu gemilere hizmet veren kılavuz kaptanlar açısından çevresel koşullar da göz önüne alınmalıdır. Bunlardan en önemlisi açık ve emniyetli suyolunda ilerlemek isteyen gemilerin seyre engel teşkil eden noktalara yaklaşımında ve geçmesi sürecinde kolay, anlaşılabilir, açıklanabilir, uygulanabilir manevralar bulunmasıdır. Bölgeyi kullanan gemilerin Kılavuz almadan geçiş yaptıkları da düşünüldüğünde bu ölçüt ayrıca önem kazanmaktadır. Dolayısıyla gereksiz görülebilecek fazladan dönüş noktaları içermemesi kadar mümkün olduğunca düzeni ve emniyetli trafik geçişini sağlayan aşamalardan oluşmasının önemli olacağı değerlendirilmiştir.

Yukarıda belirlenen 9 ölçüt simülatör ortamında denenerek test edilmiş her bir farklı seçenek için tek tek değerlendirilmiştir. Elde edilen sonuçlar aşağıda Tablo 3'te verilmiştir.

Tablo 3: Yeni TAD Karar Matrisi Tablosu

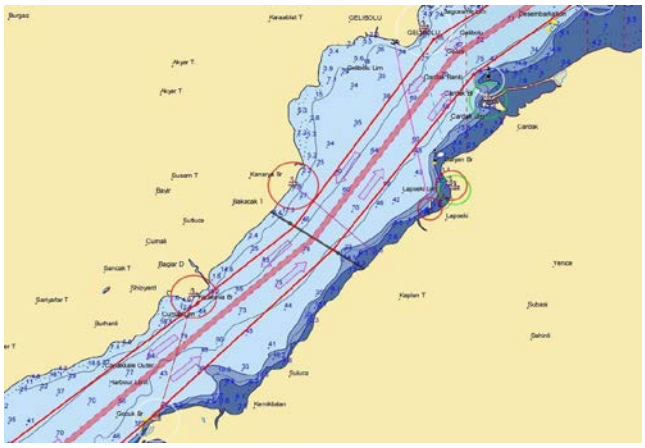
Kriterler	OPS-1v2	OPS-3v1	OPS-3v2	OPS-5v1	OPS-6

1	En az 200 m. ayrım hat genişliği	-	√	√	√	-
2	En az 700 m seyir hattı genişliği	-	√	√	√	-
3	15⁰'den az rota değişimi	√	√	-	√	-
4	En az dönüş noktası	√	√	√ / -	√	-
5	Yanlış anlama ihtimalinin olmaması	-	-	√	√	-
6	Yeterli tepki süre ve mesafesinin varlığı	-	√ / -	√	√ / -	-
7	En fazla seyir yapılabilir alan	√	-	-	√	√
8	Seyir engellerinin pruvaya alınmaması	-	√	-	√	-
9	Kaptan, zabitler ve kılavuz kaptanlar açısından uygulanabilir /anlaşılabilir olması	-	√	√ / -	√	-

Yukarıdaki ölçütler doğrultusunda seçeneklerin değerlendirilmesinden önce simülatör deneylerine alınmayan diğer seçenekler çalışmalara katılan uzmanlar tarafından temel emniyet ölçütlerine aykırı bulunmuştur. Bu matris ile test edilmeye uygun bulunan ve test sonrasında seyir ve köprü yapısı açılarından en emniyetli ve uygun seçeneğin belirlenmesi amaçlanmıştır. Bu doğrultuda hazırlanan matris ile belirlenen ölçütlere en uygun olanın OPS-5v1 olduğu görülmüştür. Belirlenmiş olan tüm ölçütlere neredeyse tam olarak uyan bu seçeneğin 1915 Çanakkale Köprüsü yapımı süresince ve sonrasında uygulanmaya konulmasının uygun olacağı değerlendirilmiş ve ilgili otoriteye sunulmuştur. Şekil 7'de uygun bulunan seçeneğe ait görsele yer verilmiştir.

Sonuç olarak; uzman görüşlerine de başvurularak oluşturulan bilimsel karar verme sürecinde, seçeneklerin değerlendirilebilmesi amacıyla karar ölçütleri geliştirilmiştir. Her bir seçenek yukarıda belirtilen karar verme ölçütleri kapsamında, Çanakkale Boğazı kaza istatistiklerine, deniz trafiği analizlerine, deniz kazaları ile ilgili daha önceden yapılmış akademik araştırma sonuçlarına ve gerçekleştirilen simülasyon deneylerinden elde

edilen bilgilere göre karşılaştırılmıştır. Seçenekler, karar verme matrisi üzerinde değerlendirildiğinde en uygun seçeneğin OPS5v1 olduğunun bilimsel olarak tespiti yapılmıştır.



Şekil 7: Karar Matrisi Sonucu Belirlenen OPS5v1 Görseli

Gerçekleştirilen çalışma sonrasında can, mal ve çevre emniyeti açılarından kısıtlı görüş koşulları ve GTH sektörleri açılarından da önerilerde bulunmuştur. Kıyı yapılarının deniz trafiğini etkileyebileceği benzer alanlarda deniz trafiğinin ve inşa edilecek yapıların emniyetini sağlamak son derece önemlidir. Ancak bazı koşullarda belirlenmiş uluslararası kural ve açıklamalar yetersiz olabilmektedir. Bu durumlarda da teknolojinin el verdiği ölçülerde bilimsel kural ve yöntemler kullanılarak modelleme ve simülasyon çalışmaları geliştirilebilmektedir. Bu çalışmayla belirlenmiş temel ölçütlerin ileride benzer durumlarda kullanılmasının söz konusu olabileceği ve deniz trafiği konusunda çalışan araştırmacılarca değerlendirilebileceği düşünülmektedir.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Analysis of Marine Traffic by Simulation Method in Liquid Bulk Terminals

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ABSTRACT

Ships arriving to port area for getting service have to wait due to various reasons after giving Notice of Readiness(NOR). Increase of ships' waiting times cause costs to increase. In this study, it is aimed to analyze waiting times that occured in marine traffic of a liquid bulk terminal which provide service in Turkey.

For the analysis of the problem, simulation modeling which is frequently used method in analysis of complex systems was applied. Input data in the model are distributions of ships' interarrival time, distributions of service time in the berths, closing frequency distributions and downtime distributions of the berths due to weather conditions. These distributions were obtained from historical data of the system. In addition, there are various constraints in the system. Ships of all sizes can not be serviced in each berth. For this reason, the ships were classified according to their size in order to make a healthy analysis. Interarrival time distributions and service time distributions were obtained based on this classification. Another constraints are that the berths cannot serve due to bad weather conditions and ship berthing/unberthing maneuvers cannot be performed at night. These constraints determined by expert opinions were included in the model and a discrete event simulation model of the system was developed in Promodel simulation

software. It was determined that there is a difference between the results obtained from the simulation model and the actual system values. It was concluded that this difference is due to cargo operation constraints and that these constraints should be added to the model's algorithm.

Keywords: Discrete Event Simulation, Liquid Bulk Terminal, Marine Traffic, Port.

Sıvı Yük Terminallerinde Deniz Trafiğinin Simülasyon Yöntemiyle Analizi

ÖZET

Hizmet alımı için liman bölgesine gelen gemiler, hazırlık mektubu verildikten sonra çeşitli sebeplerden ötürü beklemek zorunda kalmaktadırlar. Gemilerin bekleme sürelerinin uzaması, maliyetlerin de artmasına neden olmaktadır. Bu çalışmada; Türkiye'de hizmet veren bir sıvı yük terminaline ait deniz trafiğinde meydana gelen bekleme sürelerinin analizinin yapılması amaçlanmıştır. Problemin analizi için, karmaşık sistemlerin analizinde sıklıkla başvurulan yöntem olan simülasyon modellemesi kullanılmıştır. Modeldeki girdi verileri; gemilerin gelişler arası süre dağılımları, iskelelerdeki servis süresi dağılımları, hava şartlarından dolayı iskelelerin kapanma sıklığı dağılımları ve kapalı kalma süresi dağılımlarıdır. Bu dağılımlar, sistemin geçmiş verilerinden elde edilmiştir. Ayrıca, sistemde çeşitli kısıtlar bulunmaktadır. Her iskeleden her boydaki gemiye hizmet verilememektedir. Bu nedenle, sağlıklı bir analiz yapabilmek için gemiler, boylarına göre sınıflandırılmıştır. Gelişler arası süre dağılımları ve servis süresi dağılımları bu sınıflandırma temel alınarak elde edilmiştir. Diğer kısıtlar ise, iskelelerin kötü hava şartlarından dolayı hizmet verememesi ve gece vaktinde gemi yanaşma/kalkış manevraları yapılamamasıdır. Uzman görüşleri ile belirlenen bu kısıtlar modele dahil edilmiş ve Promodel simülasyon yazılımında sistemin kesikli olay simülasyon modeli geliştirilmiştir. Simülasyon modelinden elde edilen sonuçlar ile gerçek sistem değerleri arasında bir fark oluştuğu tespit edilmiştir. Bu farkın ise, yük operasyon kısıtlarından kaynaklandığı sonucuna varılmış ve bu kısıtların da modelin algoritmasına eklenmesi gerektiği anlaşılmıştır.

Anahtar Kelimeler*:* Kesikli Olay Simülasyonu, Sıvı Yük Terminali, Deniz Trafiği, Liman.

1. Giriş

Liman tesisinden hizmet almak üzere gelen gemiler, hazırlık mektubu verildikten sonra hizmet alımı için çeşitli nedenlerle beklemek zorunda kalmaktadır. Gemilerin limandan hizmet almak için bekledikleri sürenin uzaması, yüksek maliyetlere neden olmaktadır.

Shahpanah ve diğerleri [1], konteyner terminallerinde yanaşma alanlarındaki gemi beklemelerinin liman yöneticilerinin karşılaştığı en büyük problemlerden biri olduğunu vurgulamıştır. Konteyner terminallerinde yanaşma alanındaki gemi bekleme sürelerine odaklanmış ve ortalama bekleme süresini azaltmak için römorkör operasyonundaki kuyruk problemini çözmeye çalışmışlardır. Sheikholeslami ve diğerleri [2], gemilerin bekleme süresinin azaltılmasında uygun yaklaşım kanalı derinliklerinin belirlenmesi ve rıhtım sayısının arttırılmasının önemli olduğuna değinmiş ve bu iki unsurun gemi beklemeleri üzerindeki etkisini incelemişlerdir. Tengku-Adnan ve diğerleri [3], Avustralya'da bulunan ve uzun bekleme sürelerinin yaşanmış olduğu iki dökme yük terminalini incelemiştir. Çalışmada, terminallerin dışında kuyrukta bulunan gemilerin rıhtımlara yönlendirilmesinde çeşitli öncelik kurallarının kullanılmasının etkisi araştırılmıştır. Wanke [4] ise, farklı rıhtım atama politikaları ve kuyruk önceliklerinin kuyrukta harcanan bekleme süresine ve toplam demuraj ücretlerine etkisini incelemiştir.

Bu çalışmada ise; Türkiye'de hizmet veren bir sıvı yük terminaline ait deniz trafiğinde meydana gelen bekleme sürelerinin analizinin yapılması ve gemilerin hizmet alımı için beklemelerini azaltacak çözüm önerilerinin geliştirilmesini amaçlayan bir çalışmaya alt yapı oluşturulması amaçlanmaktadır. Bu amaçla terminalden alınan veriler kullanılarak ve terminal yetkililerinin sistemin işleyişi ile ilgili verdiği bilgiler ışığında, terminalin mevcut durumunun simülasyon modellemesi yapılmıştır.

2. Metodoloji

Çalışmadaki problemin analizi için simülasyon yöntemi kullanılmıştır. Simülasyon, karmaşık sistemlerin analizi için güçlü ve sıkça kullanılan bilimsel bir yöntemdir. Karmaşıklık, stokastik ilişkiler vb. nedenlerden ötürü, tüm gerçek dünya sistemlerini

analitik olarak modellemek her zaman mümkün olmayabilir. Bu gibi durumlarda simülasyon modellemesi, çözüm alternatifi olarak karşımıza çıkmaktadır [5].

Simülasyon modellemesi ve analizi, fiziksel bir sistemin bilgisayarla işlenmiş matematiksel modelinin oluşturulması ve deneye tabi tutulması sürecidir [6]. Bu yöntem, bir sistemin mevcut davranışlarının analiz edilmesine ve anlaşılmasına imkan vererek, karar vermede yardımcı olmak için kullanılmaktadır. Aynı zamanda karar vericinin belirlediği bir dizi senaryo altında, sistemin performansını tahmin etmede yardımcı olmaktadır [7].

Bu çalışmada sistemin modellenmesi ve analizi için Promodel 2011 simülasyon yazılımı kullanılmıştır. Promodel kullanılarak kurulan simülasyon modeli, sisteme ait özellikleri ve değişimleri belli bir anda değil, zaman içinde değerlendirdiği için dinamik bir simülasyon modelidir. Ayrıca sisteme ilişkin deterministik olmayan birçok faktör bulunmaktadır. Gemilerin gelişleri, sistemden hizmet alma süreleri kesin olarak bilinmemektedir. Bu girdiler olasılıksal olduğundan kurulan simülasyon modeli olasılıksal bir simülasyon modelidir. Ayrıca Promodel, her bir gemi geliş ya da ayrılışında sistem saati değiştiğinden kesikli olay simülasyonu yapmaktadır.

Çalışmada, sıvı yük terminali; gemilerin olasılıksal kurallara göre geldiği, deterministik olmayan bir süre hizmet aldığı, hizmet alacak yer dolu olduğunda ise beklediği bir kuyruk sistemi olarak düşünülmüştür. Gemilerin ortalama bekleme sürelerini bulabilmek için çok kanallı kuyruk sisteminin simülasyon modellemesi yapılmıştır.

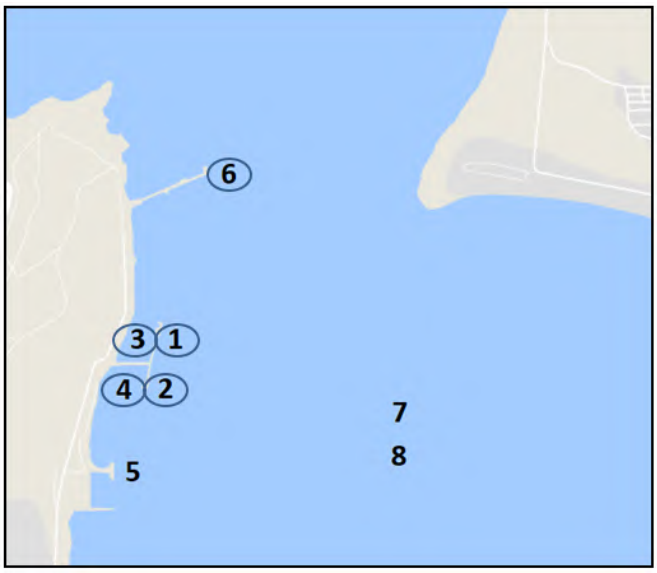
2.1. Sistemin Tanımlanması

Terminalde hâlihazırda kullanımda olan 8 adet iskele bulunmaktadır. Simülasyon modeli oluşturulacak sıvı yük terminal sistemi ve gemilerin yanaşabileceği iskelelerin numaraları Şekil 1'de verilmektedir.

Terminal yetkililerinden alınan bilgiye göre 1, 2, 3, 4 ve 6 numaralı iskeleler sistemde darboğaz oluşturmaktadır. Bu nedenle simülasyon çalışmasında, bu iskeleler dikkate alınmış ve analiz edilmiştir. 5, 7 ve 8 numaralı iskeleler çalışmaya dahil edilmemiştir.

Sistemde bazı kısıtlar bulunmaktadır:

- İskelelerde gemi boyu kısıtı vardır. Her boydaki gemi her iskeleye yanaşamamaktadır.
- Olumsuz hava koşullarında iskeleler hizmet vermemektedir.
- 3 numaralı iskelede, gece vaktinde gemi yanaşma veya kalkış manevrası yapılamamaktadır.



Şekil 1: Sıvı Yük Terminal Sistemi

2.2. Girdi Verileri

Terminal yetkililerinden sisteme ait veriler elde edilmiş ve 01.06.2016-31.10.2017 dönemine ait veriler kullanılarak iskelelerdeki gemi hareketliliği incelenmiştir.

Simülasyon modellemesinde kullanılan istatistiksel veriler; limandan hizmet almak üzere gelen gemilerin hangi sıklıkla geldiği, ne kadar süre iskeleleri meşgul ettiği ve iskelelerin hava şartlarından dolayı kapanma sıklıkları ve kapalı kalma süreleri ile ilgili verilerdir.

Sistemde, her boydaki gemi her iskeleden hizmet alamamaktadır. Sağlıklı ve doğru bir analiz yapabilmek için limandan hizmet talebinde bulunan gemiler boylarına göre

sınıflandırılmış; geliş sıklıkları (gelişler arası süreler) ve iskeleyi meşgul etme süreleri (servis süresi) bu sınıflandırma temel alınarak hesaplanmıştır.

Limandan hizmet alan gemiler, boylarına göre 6 gruba ayrılmış olup, bu gruplar ve her grup için gemi boyları Tablo 1'de verilmektedir. Ayrıca gemilerin boylarına göre yanaşabilecekleri iskeleler belirlenmiştir. Bazı gemi gruplarının birden fazla iskeleye yanaşması mümkündür. Bu gibi durumlarda yanaşılabilecek iskelelerin öncelik sıralaması, uygulamada yapılan tercihlere göre belirlenmiştir. Bu bilgiler de Tablo 1'de özetlenmektedir.

Tablo 1: Gemilerin Boylarına Göre Sınıflandırılması ve Öncelik Sırasına Göre Hizmet Alabileceği İskeleler

Gemi Grup No.	Gemi Boyu (m)	İskele No.
1	275-281	6
2	185-274	1, 6
3	150-184	2, 1, 6
4	133-149	2, 1
5	97-132	3, 2, 1
6	77-96	4, 3, 2, 1

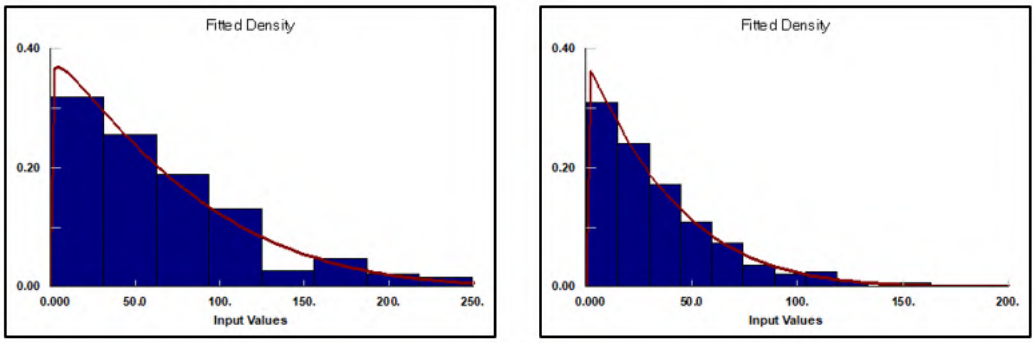
Örneğin boy sınıflaması Grup 5 olan bir gemi, uygun olması halinde öncelikle 3 numaralı iskeleden, bu iskele uygun değilse 2'den, o da uygun değilse 1 numaralı iskeleden hizmet alabilmektedir. Eğer yanaşabileceği iskelelerin hiçbiri müsait değilse, herhangi biri müsait olana kadar demirde beklemektedir.

01.06.2016 - 31.10.2017 tarihleri arasındaki verilere dayanarak, boyuna göre her gemi tipinin toplam veri içindeki sayısı ve yüzdesi Tablo 2'deki frekans dağılım tablosunda verilmektedir.

Tablo 2: Gemi Boylarına Ait Frekans Dağılım Tablosu

Gemi Grup No.	Frekans	Oran (%)
1	6	0,54
2	196	17,77
3	285	25,84
4	119	10,79
5	188	17,04
6	309	28,01
Toplam	1103	100

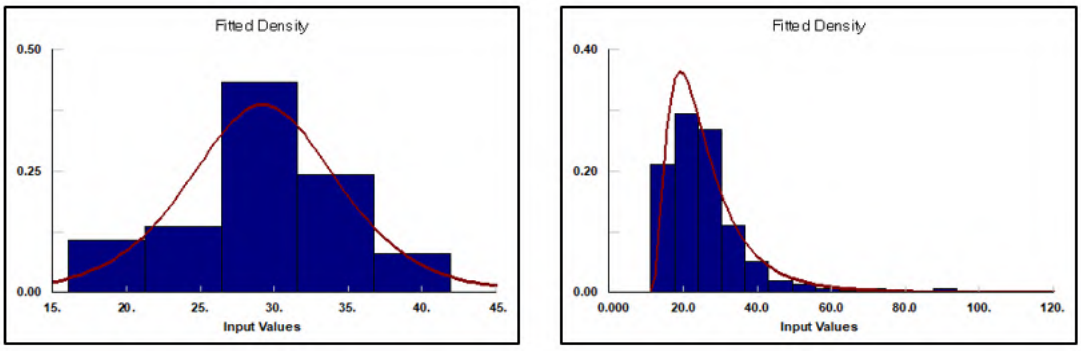
Gelişler arası süre dağılımı, gemilerin limana geliş sıklığını belirtir. Gemiler hazırlık mektubu veriliş tarihi itibariyle sisteme giriş yapmaktadır. Gemi boyu esas alınarak, gemilerin hazırlık mektubu verme tarihleri arasındaki farklar saat cinsinden hesaplanmış, bu sürelerin dağılımları StatFit programı yardımıyla tespit edilmiştir. Şekil 2'de, bu dağılımlardan bazıları örnek olarak verilmektedir.



Şekil 2: Gelişler Arası Süre (Saat) Dağılımlarına Ait Örnek Gösterimler; **a)** 2.grup Gemilere Ait Gelişler Arası Süre Dağılımı, **b)** 3.grup Gemilere Ait Gelişler Arası Süre Dağılımı

Gemilerin iskelede bağlı kaldıkları süre, kuyruk sistemlerindeki servis süresine karşılık gelmektedir. Servis süresi, iskeleden ayrılma ile iskele bağlama zamanları arasındaki

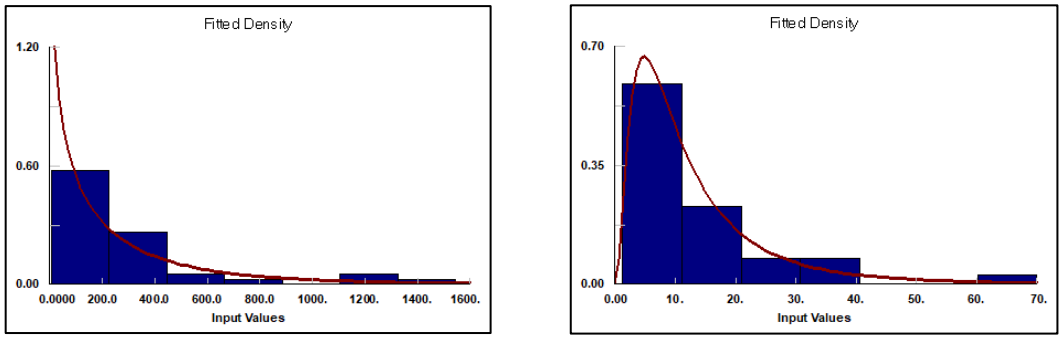
süredir. Servis süreleri dağılımları da, gemilerin boylarına göre yapılan sınıflandırma dikkate alınarak elde edilmiştir. Örnek olarak bu dağılımlardan bazıları Şekil 3'te verilmektedir.



a) **b)**

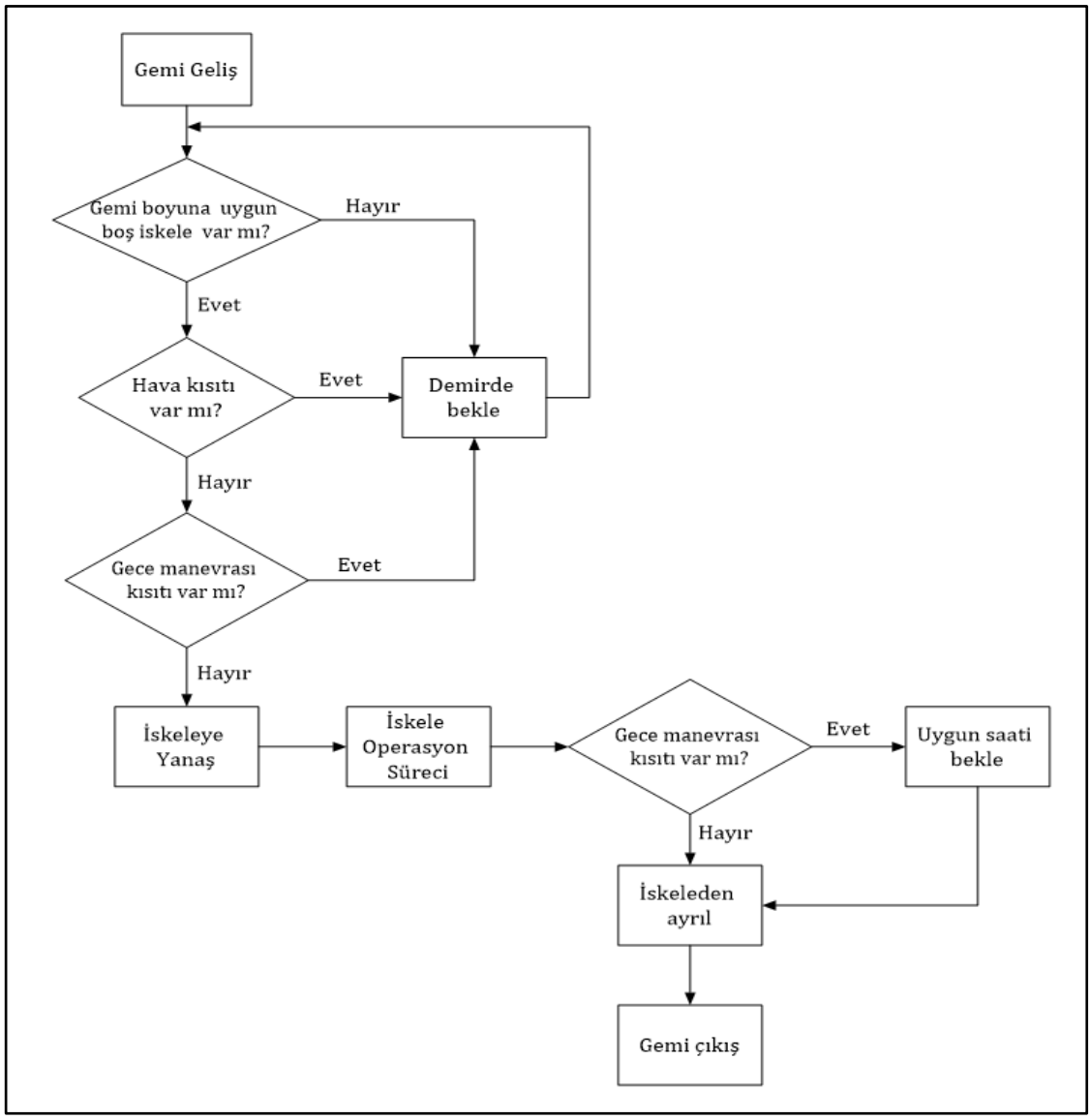
Şekil 3: Servis Süresi (Saat) Dağılımlarına Ait Örnek Gösterimler; **a)** 4.grup Gemilere Ait Servis Süresi Dağılımı, **b)** 6.grup Gemilere Ait Servis Süresi Dağılımı

1, 2, 3, 4 ve 6 numaralı iskelelerin hava şartları nedeniyle kapanma sıklıklarının (saat) ve kapalı kalma sürelerinin (saat) dağılımları elde edilmiştir. Şekil 4'te, bu dağılımlara örnek verilmiştir.



a) **b)**

Şekil 4. İskelelerin Hava Şartları Nedeniyle Kapanma Sıklıklarının (Saat) ve Kapalı Kalma Sürelerinin (Saat) Dağılımlarına Ait Örnek Gösterimler; **a)** 1 Numaralı İskelenin Hava Şartlarından Dolayı Kapanma Sıklığının Dağılımı, **b)** 1 Numaralı İskelenin Hava Şartlarından Dolayı Kapalı Kalma Süresinin Dağılımı



2.3. Simülasyon Modeli

Boylarına göre sınıflandırılan gemiler gelişler arası süre dağılımlarına uygun olarak sisteme giriş yapmaktadır. Gelen gemi, boyuna uygun olarak Tablo 1'de verilen öncelik sırasına göre yanaşabileceği iskelelerden müsait olan iskele varsa ve hava şartları ve gece manevrası ile ilgili kısıtlar o an için mevcut değil ise uygun iskeleye yanaşmakta, aksi takdirde demirde beklemektedir. Demirde bekleyen gemi ise tekrar iskele uygunluğunu, hava şartları ve gece manevrası ile ilgili uygunlukları arayacak ve koşullar sağlandığında

uygun iskeleye yanaşacaktır. İskeleye yanaşan gemiler, servis süresi dağılımlarına göre iskeleden hizmet almaktadır. İskele operasyon süreci biten gemi, o anda gece manevra kısıtı varsa uygun saati beklemekte, eğer bu kısıt yoksa doğrudan iskeleden ayrılmakta ve sistemi terk etmektedir. Modelin algoritması Şekil 5'te gösterilmektedir.

01.06.2016 - 31.10.2017 dönemine ait verilerden elde edilen girdi verileri modele dâhil edilmiştir. Modelde, geminin iskeleye yanaşırken ve iskeleden ayrılırken kılavuz kaptan eşliğinde yapılan manevra süreleri ihmal edilmiştir. Ayrıca; 3 numaralı iskele için 19:00 - 06:00 saatleri arasında gece manevrası kısıtı, programlanarak modele dahil edilmiştir. Promodel simülasyon yazılımında geliştirilen sistemin mevcut durumunun modeli 30 tekrarda çalıştırılmıştır. 30 tekrarda üretilen sonuçların ortalaması elde edilmiş ve bu sonuçlar yorumlanmıştır.

Şekil 5: Simülasyon Modelinin Algoritması

3. Bulgular

İskelelere yanaşan gemi sayıları ve iskele kullanım oranları ile ilgili çıktı istatistikleri Tablo 3'te verilmektedir.

Tablo 3: İskelelere Ait Sonuçlar

İskele	Toplam gemi sayısı (adet)	Kullanım oranı (%)	Boş kalma oranı (%)	Kapanma oranı (%)
İskele 6	212	55,38	40,75	3,87
İskele 1	275	70,64	25,14	4,23
İskele 2	290	68,42	27,26	4,32
İskele 3	127	32,51	52,46	15,02
İskele 4	178	38,54	45,60	15,86

Tabloda görüldüğü gibi kullanım oranı en yoğun olan iskele, 1 numaralı iskeledir. Daha sonra sırasıyla 2, 6, 4 ve 3 numaralı iskeleler gelmektedir. Hava koşullarından dolayı en yüksek kapanma oranına sahip iskeleler, 3 ve 4 numaralı iskelelerdir.

Boy gruplarına göre sisteme gelen ortalama gemi sayısı, gemilerin sistemde geçirdikleri ortalama süreler, ortalama bekleme süreleri ve hizmet aldıkları ortalama süreler ile ilgili çıktı istatistikleri Tablo 4'te verilmektedir.

Tablo 4: Gemilere Ait Sonuçlar

Gemi Grup No.	Gemi sayısı (adet)	Sistemdeki ortalama süre (saat)	Ortalama bekleme süresi (saat)	Ortalama operasyon süresi (saat)
1	8	56,33	19,56	36,77
2	189	46,61	10,60	36,01
3	364	35,63	6,85	28,77
4	36	41,22	12,15	29,07
5	183	39,03	5,91	33,13
6	302	29,49	2,43	27,06

Örneğin 1 numaralı gemi grubundan 8 adet gemi sisteme gelmiştir. Bu gemiler için, hazırlık mektubu verme tarihinden itibaren sisteme girdikten sonra ayrılıncaya kadar geçen ortalama süre 56,33 saattir. Bu sürenin ortalama 36,77 saati operasyonda geçerken, ortalama 19,56 saati beklemede geçmektedir.

Tablo 4 ile verilen sonuçların yüzdesel ifadesi Tablo 5'te verilmektedir. Gemilerin boy gruplarına göre bekleme oranları ve hizmet alma oranları gösterilmektedir.

Tablo 5: Gemilere Ait Yüzdesel Sonuçlar

Gemi Grup No.	Operasyon oranı (%)	Bekleme oranı (%)
1	67,33	32,67
2	77,38	22,62
3	80,88	19,12
4	70,74	29,26
5	84,92	15,08
6	91,77	8,23

Örneğin 4.gruba ait gemiler %70,74 oranında hizmet almakta, %29,26 oranında ise iskele uygunluğunu beklemek durumunda kalmaktadırlar.

3.1. Simülasyon Sonuçları ile Gerçek Sistem Değerlerinin Karşılaştırılması

Gerçek sistemin 01.06.2016 - 31.10.2017 dönemine ait geçmiş verilerinde, her bir gemi grubunun bekleme süreleri hesaplanmış ve ortalaması alınmıştır.

Simülasyon sonuçlarından elde edilen gemilerin bekleme süreleri (Tablo 4) ile gerçek sistemdeki gemilerin bekleme süreleri karşılaştırılmış ve Tablo 6'da verilmiştir.

Tablo 6. Simülasyon Sonuçları ile Gerçek Sistem Değerlerinin Karşılaştırılması

Gemi Grup No.	Gemilerin ortalama bekleme süreleri (saat)	
	Simülasyon sonuçları	Gerçek sistem değerleri
1	19,56	27,32
2	10,60	25,57
3	6,85	23,49

4	12,15	13,42
5	5,91	13,23
6	2,43	19,28

4. Sonuç

Gerçek sistemde gemilerin bekleme sürelerinin, simülasyon sonuçlarına göre daha yüksek çıktığı görülmüştür.

Terminal yetkililerinden alınan bilgiye göre, her yük tipi her iskeleden sağlanamamaktadır. Ayrıca bir gemi belli bir yük tipi ile ilgili hizmet almak için uygun bir iskeleye yanaşmış ise, bu yük tipinin sağlandığı diğer iskeleler uygun olsa bile, aynı anda başka bir gemiye aynı yük tipi için hizmet verilememektedir. Diğer bir deyişle, her yük tipinin her iskeleden sağlanamaması kısıtına ilaveten, yüklerle ilgili hat kısıtı da mevcuttur.

Bu kısıtların da modelin algoritmasına eklenmesi gerektiği anlaşılmıştır. İleride yapılacak olan çalışmada; gemilerin sadece boylarına göre değil, hem boylarına hem de hizmet alacağı yük türlerine göre sınıflandırılması yapılacaktır. Sonuç olarak gemilerin iskelelere atamalarının; boy kısıtı, her yük tipinin her iskeleden sağlanamaması kısıtı ve hat kısıtı dikkate alınarak yapılması hedeflenmektedir.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

A Review of Agent-Based Simulation in Maritime Transport

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ABSTRACT

Maritime transportation changes in the direction of safely, securily, protection of marine environment, optimal time and cost. Simulation is one of the effective methods for solving problems such as prevention of accidents and detection of security weaknesses. Simulations are also widely used to to analyze existing conditions, to understand behaviour, to design, to evaluate system through models. The simulation studies take place in the literature as Discrete Event Simulation, System Dynamics and Agent-based Simulation. Agent-based Simulation (ABS) models consist of the agents that implement defined rules, agent-agent relationships and interactions between agent and its environment. ABS is used in a wide variety of disciplines including physical, biological, social, engineering and management sciences. The aim of this study is to determine the simulation studies especially for the agent-based models in maritime transportation. For this purpose, it has been researched simulation/ modeling studies used in maritime transportation, and it has been tried to reveal the subjects and contents that are focused especially on the agent-based models. As a result of the literature review, it has been determined that the modeling/ simulation studies for maritime transportation are mostly concentrated in the analysis of maritime traffic, piracy, efficiency of port equipment and analysis of search and rescue operations.

Keywords; Agent-Based Simulation, Modelling, Maritime Transport, Literature Review

Deniz Ulaştırmasında Etmen Tabanlı Simülasyon Üzerine Bir İnceleme

ÖZET

Deniz ulaştırması, emniyetli, güvenli, deniz çevresinin korunarak, en uygun sürede ve uygun maliyetle gerçekleşmesi yönünde değişim göstermektedir. Simülasyon kazaların önlenmesi, güvenlik zafiyetlerinin tespiti gibi problemlerin çözümünde başvurulan etkili yöntemlerden biridir. Simülasyonlar ayrıca mevcut durumların analizi, tasarım veya modellerin test edilmesi için de yaygın şekilde kullanılmaktadır. Simülasyon çalışmaları temel olarak Kesikli Olay (Discrete Event) Benzetim, Sistem Dinamikleri (System Dynamics) yaklaşımları ve Etmen Tabanlı (Agent Based) Benzetim yaklaşımı olarak alanyazında yer almaktadır. Bunlardan Etmen tabanlı benzetim modelleri, belirli tanımlanmış kuralları uygulayan etmenlerin birbirleriyle ve çevreleriyle olan ilişkilerinden oluşur. Yöntem fizik, biyolojik, sosyal, mühendislik ve yönetim bilimlerini kapsayan çok çeşitli disiplinlerde kullanılmaktadır. Deniz ulaştırmasına yönelik etmen tabanlı modelleme / benzetim çalışmalarının tespit edilmesi bu çalışmanın amacını oluşturmaktadır. Bu amaçla deniz ulaştırmasında kullanılan benzetim/modelleme çalışmalarının araştırılması hedeflenmiş, özellikle etmen tabanlı modellerin odaklandığı konu ve içerikler ortaya çıkarılmaya çalışılmıştır. Gerçekleştirilen alanyazın taramasının sonucunda deniz ulaştırmasına yönelik modelleme / benzetim çalışmalarının çoğunlukla deniz trafiğinin analizi, deniz haydutluğu, liman ekipmanlarının verimliliği, arama kurtarma operasyonları başlıklarında yoğunlaştığı tespit edilmiştir.

Anahtar Kelimeler: Etmen Tabanlı Simülasyon, Modelleme, Deniz Ulaştırması, Alanyazın İncelemesi

1. Giriş

Simülasyon; sistemin davranışını anlamak veya sistemin işlemesi için gözönüne alınan değişik stratejileri değerlendirmek amacına yönelik olarak, gerçek sistem modelinin tasarımlanması ve bu model ile deneylerin yürütülmesi süreci olarak tanımlanabilir [46]. Sistemin gelecekteki davranışını, modeldeki ya da sistem çevresinde olan değişiklikleri gözlemleme, farklı senaryolarla sistemin geleceği hakkında bilgi edinmemizi sağlar. Modelleme ve Simülasyon disiplininde Kesikli Olay Simülasyonu (KOS), Sistem Dinamikleri (SD), Etmen Temelli Modeller (ETM) 3 temel yaklaşım olarak belirtilmiştir [34, 47].

Genel olarak modern simülasyon araçlarının çoğu kesikli olay simülasyonu paradigması uygular [4]. Varlıklar sisteme girer ve sistemden ayrılmadan bazı durumlara uğrar, genel olarak kesikli olay benzetimlerinin çoğu bir tür kuyruk sistemini içerir. Varlıklar, Nitelikler, Aktiviteler, Olaylar, Durumlar, Simülasyon zamanı modelinde kullanılan terimlerdir [34].

Diğer sık kullanılan yaklaşımlardan biri Sistem Dinamikleri, modelde stoklar, akışlar ve birbiri ile bağlantılı olan yardımcı değişkenleri içerir. Sistemi oluştıran değişkenler arasında geri bildirim döngüleri ve gecikmeler diğer yaklaşımlardan ayıran özelliklerdir [36].

Etmen Tabanlı Modellemenin ana fikri, dünyadaki birçok olayın, etmenler, çevre ve etmen-etmen ve etmen-çevre etkileşimlerinin tanımı ile etkin bir şekilde modellenebileceğidir [37]. Bir Etmen tabanlı modelleme 3 yapıyı içermektedir: Etmen, nitelikleri ve davranışları; etmenlerin ilişkileri; etmenlerin davranışı ve etkileşiminin benzetimi için bir platform. Etmenler kendi amaç ve davranışları, hafızası, öğrenme yeteneği olan varlıklardır [49].

Bazı araştırmacılar Etmen tabanlı modelleme geçmişinin 1940lara uzandığını belirtse de bilgisayarlı Etmen Tabanlı Modelleme, Santa Fe Enstitüsü'nün 1990 ların ortasında SWARM dilinin tanıtımı ile başlamıştır. 1990ların sonunda RePAST ile biraz genişledi ve 2000lerin başında NetLogo ile çok daha yaygınlaşmıştır [37]. MASON, NetLogo, Swarm

gibi popüler olan platformların dışında Starlogo, AnyLogic, GAMA, RePast Simphony gibi birçok Etmen Tabanlı simülasyon aracı; MATLAB, Mathematica gibi hesaplamalı ve C++, Java, Python gibi genel simülasyon araçları vardır [2, 47]. Bu araçlar sosyal bilimler, doğa bilimleri ve insan bilimleri gibi geniş bir alanda yapılan çalışmaları desteklenmektedir: İşletme, pazarlama, sosyoloji, psikoloji, ekoloji, havacılık, üretim planlama , örgütsel davranış, sağlık, ulaştırma /trafik [2, 37].

Çalışmada Web of Science, Science Direct ve Proquest veri tabanlarında, YÖK Tez Merkezi'nde "deniz ulaştırması" ve "etmen tabanlı" başlıkları kullanılarak aratılmıştır. Bulunan yayınlar içerik olarak incelenmiş; 13 Makale, 18 Bildiri, 6 Doktora ve 1 yüksek lisans tezi, çalışmanın odaklandığı "deniz ulaştırması" ve " etmen tabanlı" anahtar sözcüklerini içeren toplam yayın sayısı 38 tür. Genellikle aynı ülkeden farklı üniversite veya kurumlarından üretilen ulusal yayınlar çıkarılmıştır. Tablo 1'de ülkelere göre yapılan yayın sayısı gösterilmektedir. En çok yayın Çek Cumhuriyeti Çek Teknik Üniversitesinde Bilgisayar Bilimleri ve Sibernetik bölümlerinde yapılmıştır [3, 4, 5, 6,7].

Tablo 1: Ülkelere Göre Yapılan Yayın Sayısı

Ülkeler	Tek Uluslu Yayınlar (35)	Çok Uluslu Yayınlar (3)
Çek Cumhuriyeti	6	*
Çin	4	*
Birleşik Krallık	4	*
Amerika Birleşik Devletleri	4	*
Hollanda	4	*
Singapur	3	*
Türkiye	3	*
Almanya	1	*
İtalya	1	1

İsveç	1	*
Brezilya	1	*
Kanada	1	*
Fransa	1	1
İngiltere	*	1
Meksika	*	1

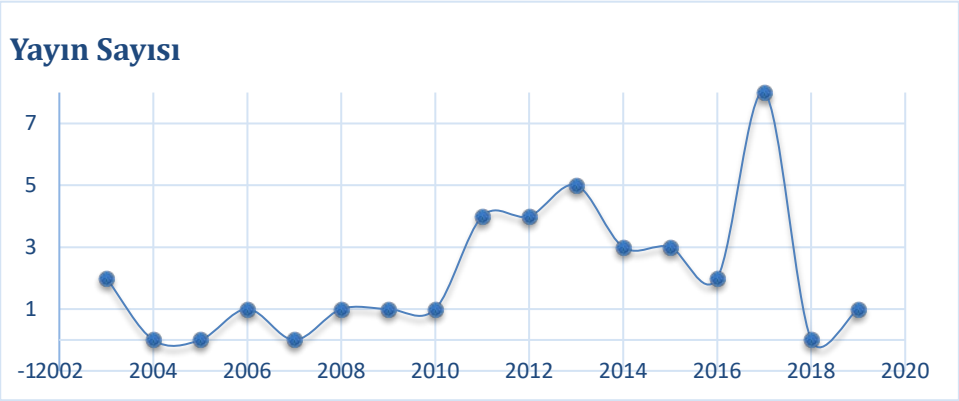
Tablo 2'de çalışmalarda kullanılan simülasyon araçları gösterilmiştir.

Tablo 2: Yayınların Kullanılan Simülasyon Araçlarına Göre Dağılımı

Kullanılan Yazılımlar, Programlama Dilleri		Makale- Bildiri	Lisansüstü Tezler
AnyLogic		[25,33]	
NetLogo		[10,23, 26, 31,32]	[26, 41,42,43,44]
Repast		[30]	
StarLogo		[15]	
Swarm		[15,21]	
Yazarların ürettiği	C++	[27, 28]	
	C #	[18]	
	Java	[6, 22, 45]	[18]
	Matlab	[12]	
	Diğer	[3,7,15,29]	[46]

Yayınlarda kullanılan araçlar makale- bildiri ve lisans üstü tezler olarak kaynaklarına göre belirtilerek ayrılmıştır. Makale-bildirilerde ve lisanüstü tezlerde en çok tercih edilen simülasyon aracı NetLogo platformu olduğu görülmüştür. Açık kaynaklı yazılım olması,

nispeten öğrenilmesinin kolay olması, eklentilerle diğer sistemlerle entegre edilebilmesi tercih nedenlerindendir [37,39]. Kullanım sıklıklarına göre Java, Matlab, C#, C++ genel programlama dillerinden oluşturulan modeller takip etmiştir.



Şekil 1: Yıllara Göre Yayın Sayısı

Çalışmada 38 yayının 2003-2019 yılları arasındaki dağılımı Şekil 1'de gösterilmektedir. 2011 yılından itibaren yayın sayısınında ciddi bir artış görülmektedir. 2008 yılından itibaren deniz haydutluğu saldırılarının güncelliğini koruması, deniz haydutluğuna karşı tedbirler, sosyoekonomik nedenleri makale, bildiri, lisansüstü tezlerin üretilmesinin yayınlara yansıdığı düşünülmektedir. Bir diğer en çok yayın üretilen konu olan deniz trafiğinde gemi trafik sistemi, çatışmadan kaçınma, liman giriş-çıkışlarında emniyeti artırmaya yönelik yayınlar % 80'i 2011 yılından sonra üretilmiştir.

2. Çalışmanın Bulguları

Deniz ulaştırmasında Etmen Tabanlı Modelleme çalışmalarının deniz trafiği, deniz haydutluğu ve güvenlik ile ilgili çalışmalar, liman ekipmanları, verimlilik ve arama kurtarma operasyonları üzerine yoğunlaşmıştır. Bu çalışmalar alt başlıklarda incelenmiştir.

2.1. Deniz Trafiği ile İlgili Çalışmalar

Deniz trafiği ile ilgili çalışmalarda gemi hareketleri, trafik sıkışıklığı yaratan şişe boynu problem, deniz koruma alanı için politika üretilmesi, çatışmadan kaçınma, rota belirlenmesi, deniz trafiğinin yönlendirilmesi konularında etmen tabanlı modellerin kullanıldığı görülmektedir. Çalışmaların odaklandıkları konular kronolojik olarak ifade edilmiştir.

Huet vd. Etmen teknolojisi ve dağıtık sistemlere dayanan bu çalışmalarında, gemi davranışlarını modellenmiş ve deniz trafiği benzetimi yapılmıştır. Çalışma gerçek ve benzetimi yapılmış gemi izlerini karşılaştırma fırsatı veriyor ve Gemi Trafik Sistemlerine katkı sunuyor [8].

Zhang vd çalışmalarında gemi rota belirlemesi için etmen tabanlı simülasyon çerçevesi önermiştir. Trafik politikalarını değerlendirmek için gerçek veriler girdi olarak kullanılmıştır. Doğru atanmış önlem alanı ile gemilerin için daha kısa bekleme süresi olacağını belirtmişlerdir [9].

Chion doktora çalışmasında , deniz koruma alanında yöneticilerin izlemesi gereken politikada ve çatışmayı riskini azaltmalarını desteklemek için Deniz Memelileri ve Deniz Trafiği Simülatörü (3MTSim) tasarlanmıştır. Bu masaüstü simülatörü "Java 1.5+Eclipse+Repast" programları kullanılmıştır. Seyir hareketleri için 3 ay süreli AIS verisi alınmıştır. Alt modelleri ile geçerlilik sağlanmıştır [41].

Xiao ve arkadaşları, sınırlandırılmış su yollarında deniz trafiğinin benzetimi için yapay güç alanlarının kavramı ve uygulamasını açıkladıkları çalışmada Yangtze Nehri gemi trafiği AIS verileri kullanmışlardır [10]. Bir diğer çalışmasında, bir otonom dinamik gemi manevra modeli ile benzetimi yapılmıştır. AIS Verileri, modeli kalibre etmek ve modelin geçerliliği için kullanılmıştır. Bu çalışma, farklı yerel çevre koşullarıyla karşılaşma durumlarında gelecekte trafik simülasyonu için çatışmadan kaçınmanın mümkün olduğunu göstermektedir [32]. Xiao, doktora çalışmasında, mikro ve makro olarak gemi trafiği seviyelerinde emniyet analizi, karar verme, liman ve su yollarının planlanması ve risk azaltma önlemlerinin tasarımı için simülasyon aracı geliştirmeyi amaçlamıştır. Gerçek gemi davranışını sağlamak için etmen tabanlı simülasyon ve yapay etki alanı

kullanılmıştır. Etmen tabanlı simülasyon NetLogo platformunda gerçekleştirilmiştir. AIS verileri modelin kalibrasyonunda kullanılmıştır [42].

Xiao Z., Deniz trafiği emniyet yönetimi geliştirmek için kara istasyonu-gemi, gemi-gemi, arasındaki dinamik etkileşimleri veri güdümlü çok etmenli bir prototip sistem geliştirilerek incelemiştir [11].

Cheng vd., gemiler karşılaştığında otomatik çatışmadan kaçınmayı gerçekleştirmek için potansiyel enerji tabanlı çatışma modeli oluşturmak amaçlanmıştır. Model Matlab 2014' te kurulmuştur. Önerilen yaklaşımın geçerliliği (Çin) Yangtze Nehri'nde test edilmiştir [12].

Teng vd. liman giriş ve çıkışlarında emniyeti ve verimliliği artırmak amacıyla gemi hareketlerinin koordine edilmesi, Eşgüdümlü Rota Bulma algoritması ile çözümlenmiştir. Singapur sularında 2 farklı bölgede 10 dan fazla geminin koordine edilmiştir [13].

Sang vd. Deniz trafiği açısından şişe boynu problemi olan Yangtze Nehri bölgesinde çözümü için etmen tabanlı model önerilmiştir. Model, bölgesel deniz trafiği hacmi verileriyle geçerliliği doğrulanmıştır. Simülasyon süresi, 24 saattir. Geçerlilik için 31 kez simülasyon tekrarlanmıştır [14].

Zhang vd. gemilerin hareketleri etmen olarak AnyLogic yazılımı ile modellenmiş ve etmenlerin etkileşimleri (karşılaşmaları) coğrafi bilgi sistemi tabanlı akıllı algoritmalar ile tespit edilmiştir. Tasarlanan simülatör tabanlı metot, işlevselliğini ve faydasını göstermek için Çin Bohai Denizi'nde uygulanmıştır. Çalışma, gelecekte deniz ulaştırması planlaması rehberi karar desteği sağlama potansiyeli olduğu belirtilmiştir [33].

2.2. Deniz Haydutluğu, Güvenlik ile İlgili Çalışmalar

Deniz Haydutluğu, güvenlik ile ilgili hazırlanan çalışmalarda etmen tabanlı modeller ile coğrafi bilgi sistemleri birlikte kullanılmıştır. Deniz haydutluğunun önlenmesi, kaçakçılıkla mücadele, deniz kuvvetlerinin hangi bölgelerde devriye gezmesi ile haydutluk amacıyla hareket eden gemilerle etkileşimi konularına değinilmiştir. Diğer

çalışmalardan Uluslararası ilişkiler disiplininde yapılan doktora tezinde deniz haydutluğunun önlenebilmesi için sosyoekonomik ve politik koşullara dikkat çekilmiştir.

Farias ve Leite, çalışmada coğrafi bilgi sistemleri ile etmen tabanlı benzetim sistemleri arasından tam bir bütünleşme sağlayan yazılım uygulamasına ihtiyaç olduğunu savunmuşlardır. Bu amaçla, Sistem Borland Delphi derleyicisinde uygulanmıştır. Deniz Alanının Kontrolü olarak bilinen deniz kuvvetleri operasyonlarının benzetimi amaçlamıştır [15].

Vanek vd. deniz haydutluğunun küresel deniz taşımacılığı üzerindeki etkilerini açıkladıkları etmen tabanlı modelde, etmenler ticaret gemisi, haydutların gemisi ve deniz kuvvetleri etkileşimlerini temsil eder. Model, Aden Körfezi grup geçişinin optimize edilmesi problemine uygulanır. Çoklu etmen modeli Java da uygulanmıştır. Uygulanan model geçerliliği verilerin mevcut olduğu alanlarda uygunluk göstermektedir [6]. Bir diğer çalışmalarında, dar Aden Körfezi'nde transit koridorda daha önce gerçekleştirilen çalışmaların, güvenli koridor tasarlanırken Hint Okyanusu'nda açık sulara doğrudan uyarlanamayacağı belirtilmiştir. Simülasyon geliştirme ve kalibrasyon süreci, deniz ulaştırmasında yapılan simülasyon çalışmalar için uygulanabileceği ifade edilmiştir [4].

Jakob vd. Denizcilik alanında deniz haydutluğu gibi yasadışı faaliyetlerin tespit edilmesi, öngörülmesi ve önlenmesi için AgentC platformunda binlerce farklı geminin benzetim çalışmasıyla birleştiren, veri güdümlü bir etmen tabanlı sistem oluşturulmuştur [7]. Başka bir çalışmalarında modelde Aden Körfezi'nde deniz haydutluğu riskini en aza indirmek, caydırıcılığı artırmak için AgentC platformunda oluşturulmuştur. Google Earth ile entegre edilmiştir, AIS verileri kullanılmıştır. Geçerlilik gerçekleşen deniz haydutluğu saldırıları ile gözlemlenenlerle karşılaştırılması olarak belirtilmiştir [16]. Bir diğer çalışmalarında, etmen tabanlı tekniklerin açık denizlerde deniz güvenliğinde ilk bütünleşmiş uygulamasıdır, AgentC benzetimi, daha sonraki araştırma ve geliştirmeler için geniş bir yelpazesi açmıştır. Hint Okyanusu koridor sistemlerinin üç olası düzenini incelemek için kullanılmıştır. Ticari gemi modelleri geçerliliği AIS verileriyle kalibre edilmiştir. Çalışma, çoklu etmen benzetimi ve optimizasyonun beraber kullanışlı

olduğunu kanıtlamıştır. What-if senaryolarında deniz haydutluğuna karşı tedbirlerin performansının değerlendirmesi ve optimize edilmesine imkân verir [5].

Varol ve Günal, deniz haydutluğu paydaşları (haydutlar, deniz ulaştırmacılar, deniz kuvvetleri) için ayrı ayrı Kesikli Olay Simülasyonu ve Etmen Tabanlı Simülasyon yaklaşımları birlikte kullanılmıştır. Deniz haydutluğunu önlemek amaçlı yapılan operasyonların etkinliğini ölçmek amacıyla hazırlanan çalışmada, Aden Körfezi'nde deniz kuvvetleri kaynaklarının tahsisi ve haydutluğun önlenmesinde neden sonuç ilişkisi varsayımsal senaryolarla benzetimi yapılmıştır. Hibrit Kesikli Olay Simülasyonu ve Etmen Tabanlı Simülasyon modeli C# tabanlı SharpSim, coğrafi bilgi sistemi olarak GreatMap GIS yazılımı kullanılmıştır [18]. Aynı yazarlar tarafından oluşturulan diğer bir çalışmada, silahlı güvenlik personeli bulunduran yük gemilerindeki olası etkiler, göz ardı edilmiştir [19].

Etmen tabanlı bir hesaplama platformu olan BANDIT, farklı yasadışı denizcilik faaliyetleri (soygun, deniz haydutluğu, kaçakçılıkla mücadele) davranış türlerinin ve etmenler arasındaki etkileşimin modellenmesi için senaryoları değerlendirmek üzere tasarlanmıştır. Platform etmen davranış modelleme sistemi ve çok etmenli deniz simülatörü içermektedir. Orta Amerika çevreleyen denizlerde, uyuşturucu kaçakçılığı problemi senaryolarında platformun kullanışlılığı gösterilmiştir. Afrika Boynuzu çevresindeki deniz haydutluğu ile ilgili simülasyonlara odaklanan AgentC, BANDIT'in öncülüdür [3].

Wang vd çalışmalarında, etmen tabanlı modelleme yöntemleri deniz haydutluğu faaliyetlerinin benzetimi için mükemmel olduğu belirtilmiş, deniz haydutluğu)hareketliliği için Etmen tabanlı dinamik veriye dayalı benzetim önerilmiştir. Ayrıca, sensörler ve gemi ajanları için, Random Sonlu Küme (RFS) tabanlı ölçüm modeli ve benzetim modeli tasarlanmıştır. RFS tabanlı veri azaltma algoritması, deneylerle etkinliği kanıtlanmıştır. Ortalama performansı yakalamak için her bir deneyde 1000 Monte Carlo denemesi yapılmıştır [20].

Fish, uluslararası ilişkiler alanında hazırladığı doktora tezinde diğer çalışmalardan farklı deniz haydutluğuna teşvik eden sosyoekonomik ve politik değişkenlere odaklanmıştır. NetLogo platformunda hazırlanan modelin amacı karadaki sosyolojik koşullar ile deniz haydutluğu arasındaki temel dinamikleri aydınlatmak amaçlanmıştır [44].

2.3. Liman Ekipmanları, Verimlilik ile İlgili Çalışmalar

Yapılan çalışmalar liman elleçleme ekipmanlarının etkin kullanılması, planlanması, depo tahsisi, depolama kapasitesinin artırılması, liman içi trafiğin azaltılması, konteyner alma protokolleri konuları üzerine yoğunlaşmıştır.

Sinha-Ray vd. Swarm platformunda kurulmuş modellerden oluşan büyük ölçekli bir benzetim projesi "Konteyner Dünyası" hazırlamışlardır. Proje, bir limanın depolama kapasitesinin artması, belirli bir rotadaki gemi sayısını değiştirmenin etkisi gibi makroskopik gözlemlerle ilgilidir [21].

Henesey vd. Geleneksel ve kaset tabanlı AVG (Automated Guided Vehicle-İnsanlar araçlar) sistemlerini değerlendirmek ve karşılaştırmak için etmen tabanlı bir simülatör geliştirilmiştir, Java programlama dili kullanılarak oluşturulmuştur. Simülasyon sonuçları Kaset tabanlı sistemin geleneksel AVGlere oranla maliyet etkin yapılandırmalar olduğunu, ayrıca çoklu etmen tabanlı benzetim bu tür uygulamalar için ümit verici bir yaklaşım olduğunu göstermiştir [22].

Wasesa vd. Bu çalışmada, konteyner alma sürecinde var olan ön bildirim onay protokolünü, konteyner terminali (CT) ve gelen kamyonlarını (DT) birleştirme prosedürünü geliştirmek için önlemleri analiz edilmişlerdir. Netlogo platformunda etmen tabanlı konteyner terminali benzetim modelini geliştirmişlerdir [23].

Sharif tez çalışmasında terminal operasyonlarındaki 3 kritik operasyon karar problemini ele almıştır: kamyon kuyruğu sorunu, saha vinci planlama, depo tahsisi. Kamyon yoğunluğu problemi, El Farol Bar probleminin oyun teorisindeki yaklaşımı, depo tahsisinde karınca kolonilerinin iz bırakma davranışını kullanmıştır. Modellerinde, NetLogo platformunu kullanmıştır [43].

Garro vd. Straddle taşıyıcılar, saha ile rıhtım arasında yükleme / boşaltma işlemleri sırasında bir dizi konteyner hareketi dizisi belirleyerek yönlendirmek, performansı artırmak amacıyla yaptıkları çalışmada matematiksel modelleme ile etmen tabanlı teknikler (Repast Yazılımı) birlikte kullanmışlardır [24].

Fang vd. Modelle LNG gemilerinin limana girişi limandan çıkışın olumsuz etkileri olduğu ve bu etkileri iyileştirme önlemleri analizlerle sağlanmıştır. AnyLogic yazılımı kullanılmıştır. Çin'de liman alanında gerçek bir vaka çalışmada incelenmiştir Modelin geçerliliği sağlanmıştır. Mevcut etmen tabanlı model, farklı gemilerin karmaşık ilişkilerin benzetimde uygunluğunu gösterir ve diğer liman ulaşım sistemlerinde de kullanılabileceğini belirtilmiştir [25].

2.4. Denizde Arama Kurtarma Operasyonları ile İlgili Çalışmalar

Baber vd. COP-Common Operational Picture (Ortak harekât resmi) kavramı, genel bir arama kurtarma operasyonu senaryosunda sosyal ağ analizi ve etmen tabanlı modelleme uygulaması aracılığıyla araştırılmıştır. Farklı COP biçimleriyle bilgi paylaşımının etkisini incelemek için etmen tabanlı bir model geliştirilmiştir. Model NetLogo platformunda kurulmuştur [26]. Wu vd. çalışmaları, arama-kurtarma zabitlerinin acil müdahale becerilerini geliştirmek için öncü bir çalışmadır. Denizcilik Acil Durum Simülasyon Sistemi (MESS) kurulmuştur. Çoğunlukla C++yazılımı kullanılmıştır Arama Kurtarma Gemileri Kurtarma koordinasyon merkezi için bilgisayarlar ve 3 server ile donanımı oluşturulmuştur, görsel olarak da yansıtılmıştır. Deniz trafiği akış benzetimi kısmında çok etmenli benzetim yaklaşımı kullanılmıştır [27]. Acil durumlarda, arama kurtarma faaliyetlerinde etmen tabanlı benzetim sosyal etki modeli, sosyal ağ modeli gibi yöntemlerle birlikte kullanılmıştır.

Ni vd. kurtarma verimliliği ile ilgili yapılan çalışmalarda yolcu gemilerinde kamaraların boş alan olarak değerlendirildiği, ancak bunun gerçeği yansıtmadığını belirtilmişlerdir. Kamaralarda bulunan eşyaları göz önünde bulundurarak yolcu gemilerindeki ileri

kurtarma analizi için etmen tabanlı sosyal etki modeli C++ kullanarak Microsoft Visual 2013'te kurulmuştur [28].

2.5. Diğer Çalışmalar

Model geçerliliğinin çalışmalarda nasıl kullanılacağı, içsu taşımacılığının gelecek ekonomik tahminleri, ağır yakıt kullanımından uzaklaşılmasının deniz çevresine etkileri, demirleme alanı gibi geniş bir yelpazede çalışmalar yapılmıştır.

Decraene vd. Demirleme Alanı Koruma Senaryo modeli etmen tabanlı benzetim platformu MANA (Map Aware Non-uniform Automata)'da gerçekleştirilmiştir. Deneyler askeri bir vakadan alınan veriler kullanılarak gerçekleştirilmiştir [29].

Onggo ve Karataş, Bu çalışmada, Etmen Tabanlı Simülasyon deniz arama faaliyetlerini analiz etmek için alternatif, uygun bir modelleme yaklaşımı olduğu ve Etmen Tabanlı Simülasyonda model geçerliliği özellikle zor olduğu belirtilmiştir. Modelin geçerliliği için test-odaklı benzetim modellemesinin (TDSM) nasıl kullanılabileceği göstermek amaçlanmıştır [30].

Öztanrıseven 2016 MarTranS (Deniz Ulaştırması Simülatörü) ile etmen tabanlı model, kesikli olay benzetimi ve sistem dinamikleri bileşenlerini içerir ve MarTranS (Deniz Ulaştırması Simülatörü) ile potansiyel gerçek dünya içsu yolu taşımacılığı sisteminin davranışını ve gelecek ekonomik tahminleri anlamak için, etmen tabanlı model, kesikli olay benzetimi ve sistem dinamikleri bileşenlerini bütünleştirilmiştir [46].

Bas vd. Deniz yakıt sistemi ve etmen tabanlı modelin (MarPEM), Politika araçlarının HFO'dan uzaklaşma sürecindeki etkilerini incelemek için kullanılabilecek kapsamlı bir sistem perspektifini sunulmuştur. Model NetLogo platformunda kurulmuştur. Deneylerin sonuçları, önceki çalışmalarla ve endüstriyel uzmanların görüşleriyle uyumlu olduğu için model deniz yakıt sisteminin geçerli bir temsili olduğu belirtilmiştir [31].

3. Sonuç

Yapılan alanyazın taraması sonucunda deniz ulaştırmasında etmen tabanlı benzetim özelinde yapılan çalışmalar deniz haydutluğu, güvenlik, deniz trafiği, liman elleçleme

ekipmanları, arama kurtarma çalışmaları üzerinde yoğunlaşmıştır. Deniz trafiğinde sıkışıklık, çatışmadan kaçınma, rota belirlenmesi, trafiğin yönlendirilmesi, emniyet konularından; deniz yollarının güvenliği, deniz haydutluğunun önlenmesi; liman ekipmanları ve liman içi trafiğin düzenlenerek verimliliğin ve maliyetin minimize edilmesi; acil durum, arama kurtarma faaliyetlerinde zabitlerin acil müdahale becerilerinin geliştirilmesi konularında, oldukça geniş bir alanda etmen tabanlı modeller kullanılmıştır. Coğrafi bilgi sistemleri, sosyal etki modeli, sosyal ağ modeli gibi yöntemlerle birlikte kullanılmıştır.

Etmen Tabanlı Modelleme, geçmişi 1940lara uzansa da 1990lardan sonra yaygın kullanılmaktadır. Alanda, deniz ulaştırmasında etmen tabanlı benzetim ve modelleme ile ilgili yapılan başka bir alanyazın çalışması ile karşılaşılmamıştır. 2003 yılından sonra çalışmalar ile karşılaşılmış, özellikle 2010 yılından sonra daha fazla kullanıldığı görülmüştür. Çalışmada bu modelleme yaklaşımının en çok deniz haydutluğu ve güvenlik çalışmalarında kullanılmış olması, deniz haydutluğun 2008 yılından sonra artış göstermesiyle ilişkilendirebilir.

Kullanım sıklıklarına göre bildiri ve makalelerde Netlogo platformu kullanılmıştır. AnyLogic, Swarm, RePast, Starlogo platformları ve yazarların problemlerin çözümü için Java, Matlab, C#, C++ genel programlama dillerinden oluşturdukları modeller kullanılmıştır.

Yazarlar deniz arama faaliyetlerini analiz etmek için alternatif, uygun bir modelleme olduğunu; diğer çalışmada liman ulaşım sistemlerinde de kullanılabileceğini; simülasyon geliştirme ve kalibrasyon süreci, deniz ulaştırmasında yapılan simülasyon çalışmalar için uygulanabileceğini ifade edilmiştir [30, 25, 4].

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

An Application of Agent-Based Modeling for the Maritime Transportation

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ABSTRACT

Simulation software's can be used primarily to evaluate design and plans that do not actually exist, or to evaluate models and theories in complex systems and to reveal the effects of variables. In this respect, models are created with the data obtained from the targeted system and predictions or explanations can be made by means of data produced in the models. Today, an increasing number of scientific disciplines from archeology to medicine benefit from simulations in order to decentralize of decision making, to determine the local-global relationship or to identify differences within the system. Agent Base Models are also active simulation methods for such research and analysis. Agents work in an autonomous structure and can conduct independent operations without user intervention. Agents also have the ability to perceive and respond to variables within the framework of defined behavioral criteria. In this study, different situations in a port area have been tried to be explained by using Python language based MESA agent-based modeling software. Ships defined as agents in the system and port area works as a base model. The quay usage time, the waiting time in the anchor, the effect of the increasing berth length/quay number are some of the data obtained from the model. In this study, it is shown that agent-based models can be used more effectively in the managerial decisions regarding the design of the maritime transportation elements and in the administrative decisions for the operations. Along with increasing technology and information exchange, it is expected to be used more widely in future research and analysis.

Keywords: Agent-Based Modeling, Python, MESA, Maritime Transportation, Port Operation.

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Deniz Ulaştırması için Etmen Tabanlı Modelleme Uygulaması

ÖZET

Simülasyon yazılımları öncelikli olarak mevcut olmayan tasarım ve planları değerlendirmek veya karmaşık sistemlerdeki modelleri ve teorileri değerlendirmek ve değişkenlerin etkilerini ortaya çıkarmak için kullanılabilir. Bu bağlamda, hedeflenen sistemden elde edilen verilerle modeller oluşturulur ve modellerde üretilen verilerle tahminler ve açıklamalar yapılabilir. Günümüzde, arkeolojiden tıp alanına kadar giderek artan sayıda bilimsel disiplin, karar vermenin merkezden uzaklaşması, yerel-küresel ilişkilerin belirlenmesi veya sistemdeki farklılıkları tespit etmek için simülasyon yazılımlarından yararlanmaktadır. Etmen tabanlı modeller (agent-based models) bu tür araştırma ve analizler için aktif simülasyon yöntemleridir. Etmenler/ajanlar özerk bir yapıda çalışır ve kullanıcı müdahalesi olmadan bağımsız işlemler yapabilir. Ajanlar ayrıca tanımlanmış davranış ölçütleri çerçevesinde değişkenleri algılama ve cevaplama yeteneğine de sahiptir. Bu çalışmada, Python yazılım dili tabanlı MESA etmen tabanlı modelleme yazılımı kullanılarak bir limandaki farklı durumlar açıklanmaya çalışılmıştır. Sistem ve liman bölgesindeki aracılar olarak tanımlanan gemiler temel model olarak çalışmaktadır. Rıhtım kullanım süresi, demirde bekleme süresi, artan rıhtım uzunluğu / rıhtım sayısının etkisi modelden elde edilen verilerden bazılarıdır. Bu çalışmada, deniz taşımacılığı elemanlarının tasarımına ilişkin yönetsel kararlarda ve operasyonlar için idari kararlarda etmen tabanlı modellerin daha etkin kullanılabileceği gösterilmiştir. Artan teknoloji ve bilgi alışverişinin yanı sıra gelecekteki araştırma ve analizlerde daha yaygın olarak kullanılması da beklenmektedir.

Anahtar Kelimeler: Etmen Tabanlı Modelleme, Python, MESA, Deniz Ulaştırması, Liman Operasyonları

1. Giriş

Deniz ulaştırması zaman zaman karmaşık yapıları ve birbirleri ile etkileşim içerisindeki kullanıcıları nedeniyle pek çok farklı değişkenin bir arada olduğu yapıda bir sektördür. Özellikle konteyner taşımacılığının hızlı gelişimi ile birlikte limanların etkin kullanımı üzerine pek çok araştırma yapılmış, rıhtım sürelerinin en aza indirilmesi için yeni yöntemler kullanılır hale gelmiştir. Bir geminin limana geliş öncesinde verdiği bildirimle başlayan süreç uygun rıhtımın ayrılması, yanaşma için yeterli mesafe olup olmaması, yükleme ve/veya tahliye donanımlarının belirlenmesi, gemi limana ulaştığında hazır olması gibi pek çok süreci barındırmaktadır. Geminin limana geliş süresindeki sapmalar limanların planlamasında da önemli değişiklikler yapılmasını gerektirebilmekte ve doğrudan ticareti etkileyecek durumlarla karşılaşılabilmektedir. Bu durumlar karşısında liman operatörü liman etkinliğini maksimize etmeye çalışırken gemi işleticisi ile anlaşması gereği geminin de limanda kalış süresini minimize etmeye çalışır. Tüm süreç boyunca mümkün olan en yüksek faydanın elde edilebilmesi çoğunlukla ticari olarak üretilmiş yazılımlarla sağlanmak zorundadır. Yazılım sistemleri ise belirli değişkenler ve karar verme ölçütlerine göre çalışmaktadırlar. Karar ölçütleri ise operatörlerin, liman işleticilerinin, gemi sahiplerinin ve diğer liman kullanıcılarının limandan beklentilerini tam olarak karşılayabilmesi amacıyla tasarlanmakta ve uygulanmaktadır. Beklentilerin tam olarak karşılanabilmesi için ise doğru ölçümlerin yapılması, sistemin çalışma prensiplerinin tam olarak belirlenebilmesi önem arz etmektedir.

Son yıllarda artan sayıda çalışmada özellikle konteyner taşımacılığına yönelik olarak modelleme/simülasyon yazılımları kullanılmaya başlandığı görülmektedir. Bu çalışmada da deniz ulaştırması alanında etmen tabanlı modelleme yöntemi kullanılarak bir konteyner limanının çalışmasının benzetiminin yapılması hedeflenmiştir. Bu sayede hem etmen tabanlı modelleme yönteminin deniz ulaştırmasında limanlar özelinde kullanılması hedeflenmekte hem de bu modelleme yönteminin liman yöneticileri için karar vermeye yönelik nasıl önemli olabileceği aktarılmaya çalışılacaktır. Çalışmanın ikinci kısmında literatürde yer alan deniz ulaştırmasına yönelik etmen tabanlı modelleme

çalışmalarına yer verilmekte, üçüncü kısmında ise bu çalışmada kullanılmış olan MESA etmen tabanlı modelleme yazılımı hakkında bilgi verilmektedir. Çalışmanın dördüncü kısmında model ve modelin çalışmasına ilişkin bilgilere değinilerek modelin kurgusuna ve ajanların davranış özelliklerine esas kod yapısı aktarılmıştır.

2. Literatür Taraması

Etmen tabanlı modelleme yazılımları son yıllarda çok farklı disiplinlerde kullanılmakta olan modelleme/simülasyon yazılımlardandır. Diğer yazılımlardan farklı olarak model içerisinde kendine özgü özellikleri ile kendi kararlarını veren ajanlar çalışmaktadır. Ajanlar özellikle bireysel bazda ve davranışsal temelde çalışarak yerelden genele doğru sistemin bütününe yönelik süreçlerin veya işlemlerin ortaya çıkmasına nasıl yol açtığını keşfetmek için kullanılabilmektedir.

Ajan temelli modeller, bireysel temelli yaklaşımlardan ve ademi merkeziyetçi yöntemlerden gelmektedir. 1990'larda Gilbert ve Doran (1994), Gilbert ve Troitzsch (2005), Wooldridge (1994) ve Jennings (1995) gibi araştırmacılar sayesinde kullanılmaya başlanmıştır. Bu yaklaşımlar, bir sistemin bileşenlerini bağımsız varlıklar olarak modellemekten ibarettir. Ferber'e (1999) göre, modellemedeki ajan tanımlaması kuruluşlar, bireyler veya bir ülke gibi modellenmeye konu olacak herhangi bir aracı tanımlayabilmektedir. Fiziksel veya sanal varlıkları temsil edebilirler, ama her şeyden önce, ajanlar özerktir. Ajanlar kendi iç özelliklerine, davranışlarına ve kapasitelerine sahiptir. Bir ajan, çevresini algılama ve / veya manipüle etme becerisine sahiptir, aynı zamanda diğer ajanlarla da etkileşime girebilir. Ajanların bulunduğu ortam bir topolojiye (sürekli bir yüzey, bir grafik, ... gibi) sahiptir ve zorunlu olarak ajan olmayan nesnelere (örneğin bir duvar) de sahiptir. Dolayısıyla bu yaklaşım, modellenen sistemin mekânsal boyutunun ve dolayısıyla coğrafi verilerinin eklenmesini de desteklemektedir. Ajanlarla çalışan modeller, ajanlar arasındaki etkileşimin modellenmesini de sağlamaktadır. Ayrıca, ajanlar heterojen olabilir: farklı içsel davranış ve özelliklere sahip olabilirler ve bu nedenle farklı şekillerde etkileşime girebilirler. Etmen tabanlı modeller, her parametre için (tipleri, bölgedeki ilk konumları, vb) duyarlılık analizini elde etmek amacıyla ayrıntılı

ve yapılandırılabilir. Böylece modellenen sistem, kullanıcı tarafından tanımlanan yerel veya küresel kurallara duyarlı hale gelebilir [1].

Literatürde etmen tabanlı modelleme kullanılarak yapılmış çok sayıda araştırmaya rastlamak mümkündür. Ancak denizcilik sektörü için bu çalışmaların sınırlı sayıda olduğu görülmektedir. Davidsson vd [2] yaptıkları çalışmada ulaştırma sektöründeki etmen tabanlı modelleme çalışmalarını analiz etmiş ve deniz ulaştırması alanına yönelik olarak yapılan az sayıdaki çalışmanın da terminal operasyonlarına yönelik olduğunu tespit etmiştir. Literatürde sınırlı sayıda bulunan ve deniz ulaştırması açısından önemli ve ulaşılabilen ilgili çalışmalara aşağıda değinilmiştir.

Sun vd. [3] özellikle konteyner terminallerine yönelik simülasyon destekli çalışmaları araştırmış ve yedi çalışmanın çoklu-ajan sistemi ile üretildiğini belirtmişlerdir. Bunlardan ikisinin liman konteyner terminal yönetimi ile ilgili iken, birinin terminal operasyon odaklı, bir diğerinin plan ve koordinasyon için hazırlandığını ve birinin de konteyner terminalinde Pazar odaklı çalışma amaçlı yapıldığı belirtilmiştir. Bir diğer çalışmada ise Dullaert vd [4], multimodal taşımalar için iletişim destek platformunu etmen tabanlı modelleme yöntemi ile kurgulamış ve ajanlar sayesinde iletişim etkileşimindeki artışı ortaya çıkarmıştır. Bir diğer çalışma ise Parrotta vd. [5] tarafından yapılmış olan etmen tabanlı karar destek sistemi ve modellemesi kullanılarak St. Lawrence nehri ve çevresindeki hareketliliği üzerinde çalışan bilim insanları ve yöneticiler için olası yönetim ve politika senaryolarını uygulayabilecekleri sistem çalışmasıdır. Sistemde nehirde kullanılan teknelerin ajan olarak tanımlaması yapılmış diğer trafik, balinalar ve çevresel değişkenler ile etkileşimleri modelde yer almıştır. He vd [6] tarafından yapılan çalışma ise tedarik zinciri içerisindeki perakendecilerin kararlarına yönelik olarak yöneylem araştırmaları temelli simülasyonlar yerine etmen tabanlı model kullanmanın karmaşık sistemler açısından önemine işaret etmektedir. Çalışmada üç farklı ajan sınıfı kullanılarak iki farklı ürün için fiyat, depo kontrolü, fiyat ve talebi etkileyen unsurlar, gelişme süreci ve talebin süreci nasıl etkilediği araştırılmıştır. Deniz ulaştırmasında konteyner gemi trafiği ve yük operasyonları üzerine etmen tabanlı modelleme kullanılarak yapılmış bir diğer çalışma ise Parthibaraj vd [7] tarafından yapılmıştır. Özellikle bekleme

zamanlarının azaltılması ve istif planlamaları üzerine karar veren ajanların tasarlanması çalışmanın amaçları olarak belirtilmiştir. Roordai vd'nin [8] yaptıkları çalışma ise taşımacılık sektöründe işletmelerin oynadığı rollerin ve işlevlerin çeşitliliğini, pazarlar arasında nasıl etkileşimde bulunduklarını ve kuruluşlar arasında etkileşimlerin sözleşmeler yoluyla nasıl kurulduğunu açık bir şekilde temsil eden, etmen tabanlı bir mikro simülasyon çerçevesi sunmaktadır. Démare ve arkadaşları [1] tarafından yapılan çalışmada etmen tabanlı modelleme ile lojistik sistemlerin modellenmesi ve simülasyonu ele alınmıştır. Sistemdeki her yapı ajanlarla temsil edilmiş, kullanıcıların yerel parametreleri değiştirmeleri ve bunun etkilerinin makro düzeyde gözlemlenmesi sağlanmıştır. Baindur ve Viegas'ın [9] çalışmasında ise iki veya daha fazla ticaret bölgesi arasında şehirlerarası yük taşımacılığını modellemek için etmen tabanlı modelleme yaklaşımı kullanılmıştır. Bu çalışmada ayrıca etmen tabanlı modellemelerin planlama, trafik yönetimi, tahmini ve kontrolü gibi ulaştırma lojistiğine yönelik alanlarda kullanıldığı ancak çok az çalışmada ajan tabanlı sistemler kullanılarak stratejik karar verildiğine de işaret edilmiştir. Garro vd'nin [10] yapmış olduğu çalışmada özerk, proaktif ve reaktif davranışlarda bulunabilecek ve bireysel ve küresel hedeflere ulaşmak için hem işbirliği yapabilecek hem de rekabet edebilecek, etkileşimli varlıklar açısından problem algılandığında ve doğal olarak modellendiğinde ajan temelli yaklaşımların faydalı olabileceği belirtilmiştir. Bu doğrultuda yaptıkları çalışmada gemilere atanacak olan rıhtım vinçleri ve konteyner taşıyıcılarına yönelik optimizasyona odaklanmışlardır. Vanek vd'nin [11] yapmış olduğu çalışma ise Hint Okyanusundaki deniz haydutluğunun yoğun olduğu sularda seçilmiş sınıflardaki gemilerin hareketleri ve diğer operasyonlarına odaklanarak olası saldırıların tespiti ve karşı önlemlerin araştırılmasına yöneliktir. Onggo ve Karataş [12] tarafından yapılan çalışma denizdeki arama kurtarma faaliyetleri ile ilgili olarak etmen tabanlı modelleme tekniği kullanımı ve modellemenin geçerliliğinin test edilmesine yönelik hazırlanmıştır.

Yukarıda literatürde yer alan araştırmaların içeriğinden de görüleceği üzere etmen tabanlı modelleme çalışmaları farklı amaçlar doğrultusunda kullanılabilmekte ve operasyonel, taktiksel veya stratejik açılardan ele alınarak değerlendirilebilmektedir.

Özellikle genelden yerele yaklaşımlarla tam olarak anlaşılamayan kaotik ve/veya karmaşık işlevlere/ilişkilere dayalı çevresel koşullar altında ajan olarak tanımlanan araçlara davranış kalıpları verilerek kendi kararlarını vermeleri sağlanabilmektedir. Bu şekilde hem bütüne olan etkisini görmek hem de bütün içerisindeki rolünü anlamak/analiz etmek daha da kolaylaşmaktadır. Bu amaçla üretilmiş olan çok sayıda bilimsel ve ticari yazılım kullanıldığı görülmektedir. Bunlardan en sık kullanılanları NetLogo, Anylogic, MASON, FlexSim, SWARM, vb olarak sıralanabilir. MESA ise artan sayıda kullanımı ve alternatiflerine oranla kolay öğrenilebilen bir dil olan Python sayesinde gelişmekte olan etmen tabanlı modelleme yazılımı olup bu çalışmada da MESA kullanılmıştır.

3. MESA Etmen Tabanlı Modelleme Yazılımı

Mesa, gömülü çekirdek bileşenler (ajan zamanlayıcı, uzamsal ızgaralar gibi) veya özelleştirilmiş uygulamalar kullanılarak etmen tabanlı modeller oluşturulmasını sağlayan yeni açık kaynak kodlu, Apache 2.0 lisanslı Python paketidir. İnternet tarayıcıları tabanlı bir ara yüz kullanarak model görselleştirilirken, Python'un pek çok modülü ve veri analiz araçları kullanılarak da analizlerin yapılmasını sağlayabilmektedir [13]. Mesa diğer etmen tabanlı modelleme yazılımları ile benzer özelliklere sahip olmakla birlikte farklılıklar da sunmaktadır. Bu farklılıklardan biri ajanların farklı zamanlayıcılarla çalışabilmesidir. Bir diğeri modelin analizlerinin yapılabilmesi için veri toplayıcı (data collector) kullanabilmesidir. Ayrıca modelin çalışması sürecinde değişkenlerin kullanıcı tarafından değiştirilmesi ve değişikliğin görselleştirilmesine olanak vermektedir.

Mesa, farklı tür modeller oluşturmak için kolayca birleştirilebilen ve genişletilebilen bir dizi bileşen sunmayı amaçlamaktadır. Mesa, modelleme, analiz ve görselleştirme olarak tanımlanan üç ayrı modülden oluşmaktadır. Modelleme modülü modelin tanımlandığı en temel bileşendir. Bu modülde; parametreleri saklanması ve bileşenlerin geri kalanını tanımlayan bir Model (model) sınıfı; ajanları tanımlamak için bir veya daha fazla Ajan (agent) sınıfı; ajanları kontrol eden ve modeldeki zaman ile içinde bulunduğu alanı ve / veya ağı tarif eden bileşenleri ele alan bir programlayıcı/zamanlayıcı (scheduler) bulunmaktadır. Analiz modülü ise veri toplayıcı (data collector) yoluyla modeldeki

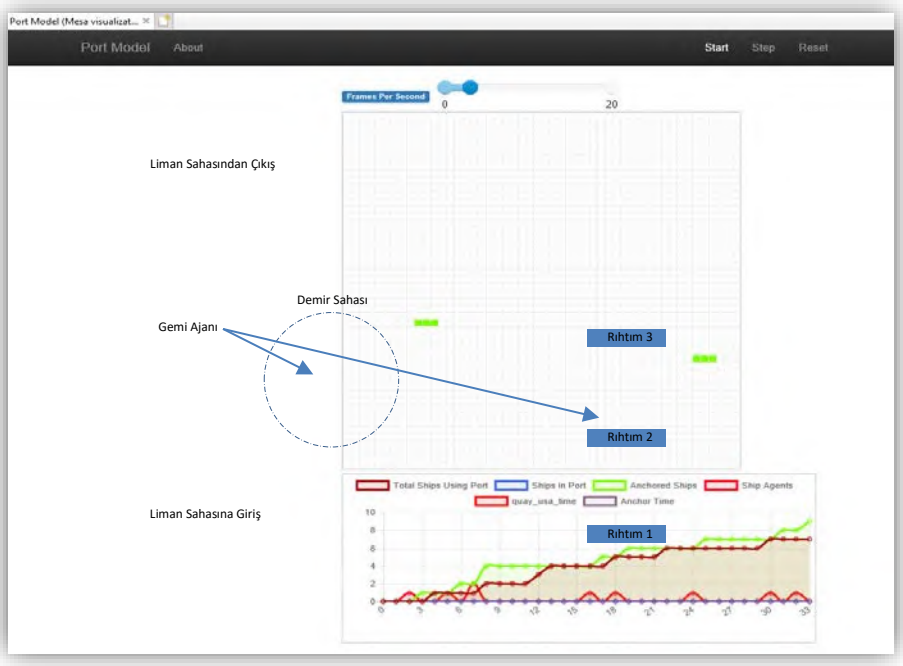
verileri toplamakta, yığın dağıtıcı (batch runner) yoluyla da parametreleri taramakta ve çoklu hareketi sağlayabilmektedir. Görselleştirme (visualization) modülü ise oluşturulmuş sınıfların etkileşimli gösterimini Java dili yoluyla çalıştırılan bir server üzerinden görsel hale getirmektedir [14].

4. MESA ile Konteyner Liman Modellemesi

Python dilinde yazılmış Mesa etmen tabanlı modelleme yazılımı kullanılarak bir konteyner terminalinin modellemesinin yapılması ve farklı koşulların incelenebilmesinin denenmesi bu çalışmanın amaçlarındandır. Etmen tabanlı modelleme kullanılarak oluşturulacak modelin deniz ulaştırması alanında kullanımına bir örnek verilmesi de ayrıca bu çalışmanın hedeflerindendir. Bu doğrultuda yukarıda Mesa'nın temel prensipleri kullanılarak basit bir terminal modeli oluşturulmuştur.

Mesa içinde oluşturulan liman modelinde; N sayıda ve poisson dağılımına uygun şekilde limana gelen gemilere hizmet vermek üzere 600, 450 ve 235 metrelik üç ayrı rıhtımı barındıran bir liman baz alınmıştır. Ayrıca yine Mesa yapısı içerisinde bulunan StagedActivation modülü kullanılarak ajanların aktivasyonları sağlanmış, MultiGrid seçeneği ile de internet tarayıcısı üzerinde gösterimi sağlanan görselde ızgaralara ayrılmış bir saha oluşturulmuştur. Modelin çalışmasına ilişkin temel bir gösterimi Şekil 1'de sunulmuştur.

Modelde ayrıca gemilerin gelişlerinin belirlenmesi için step fonksiyonu kullanılarak poisson dağılımına uygun gelişler belirlenmiştir. Python dilinin bir özelliği olarak bu dağılımın çalışması için numpy modülü çağırılmış ve kullanılmıştır. Liman modellemesinde kullanılan step fonksiyonunda her bir adımın gerçek zamandaki her bir saat için tasarlandığı da belirtilmelidir. Modeldeki limanın yıllık ortalama 1600 gemiye hizmet verdiği kabuller arasındadır. Oluşturulan modele ait kod Şekil 2'de gösterilmiştir.



Şekil 1: MESA Liman Modeli Görseli

Modelleme çalışmasının ikinci aşaması ise ajanların belirlenmesidir. Bu modelde gemiler ajan olarak seçilmiştir. Her bir ajan kendi kimliği ile oluşturulmakta ve görsel olarak da ızgara üzerinde belirlenmiş bir sahada rastgele konumda oluşmaktadır. Modeldeki limanı kullanan gemilerin 128 metreden 300 metreye kadar değişik boylara sahip olabilecekleri düşünüldüğünden gemilerin oluşturulmasında bu özellik rastgele (random) olarak belirlenmiştir. Ayrıca ajanların demirde bekleme süreleri ve rıhtım kullanım süreleri kaydedilerek Mesa veri toplama (data collector) özelliği ile saklanmıştır.

Şekil 2: Mesa Model Modülü ve Agent Modülleri Kod Örneği

Modelin üçüncü aşamasında ise görsel olarak modele ait ajan hareketlerini görebilmek amacıyla sunucu (server) modülünde gemilerin büyüklüklerine göre farklı özelliklere sahip olması veya limanda, demirde, seyirde olmasına bağlı olarak farklı renklerde gösterilmesi için portrayal modülü kullanılmıştır. Görsel panelde ayrıca model içerisinde saklanan toplam çalışma zamanı, gemilerin toplam demirde kalma süreleri, hizmet verilen gemilerin sayısı gibi veriler ile gemiye ait rıhtım kullanım süresinin gösterilebilmesi için de batchrunner modülü kullanılmıştır. Bu sayede grafik olarak verilerin daha anlaşılır şekilde sunulması hedeflenmiştir.

Modelin çalıştırılması ile istenen değişkenlere bağlı olarak verilerin değişimi gözlemlenebilir hale gelmiştir.

5. Sonuç

Etmen tabanlı modelleme yazılımı kullanılarak bir limanın modellenmesinin hedeflendiği bu çalışmada bir limana ait en temel fonksiyon olan gemilere hizmet fonksiyonu

çalıştırılarak kullanıma hazır hale getirilmiştir. Mesa modelleme/simülasyon yazılımı kullanılarak gerçekleştirilen bu çalışma ile temel bir liman modeli kurgulanmış, poisson dağılımına uygun olarak gelen gemilerin yanaşma ve yük operasyonu kararlarının verildiği simülasyon geliştirilmiştir.

Gelen gemilerin boyları ve sahip oldukları yük miktarları rastgele olarak sistem tarafından belirlenmekte olup yine ajan olarak çalışan gemilerin limanda boş olan rıhtımlara genel kabul görmüş kurallar çerçevesinde atanarak yanaşması ve yük operasyonunu gerçekleştirmesi sağlanmıştır. Rıhtımların dolu olması veya rıhtımdaki boş mesafenin yeterli olmaması halinde gemiler demir sahasına yönlendirilmiş ve liman faaliyetlerine bağlı olarak demirde kalış süreleri hesaplanabilmiştir. Ayrıca limanı kullanan gemilerin limanda kaldıkları süre rıhtım kullanma zamanı olarak kaydedilmekte böylece ortalama rıhtım kullanma süreleri de hesaplanabilmektedir. Rıhtım üzerinde faaliyet gösteren vinç sistemlerinin kullanıcı tarafından sayılarının belirlenmesi ile rıhtım kullanım sürelerindeki ve limanı kullanan gemi sayılarındaki değişmeler hesap edilerek bir grafik yardımıyla gösterilebilmektedir.

Modelleme çalışması sayesinde rıhtımdaki vinçlerin operasyon hızlarındaki veya rıhtım uzunluklarındaki değişikliklere bağlı olarak liman verimliliğinin ne yönde ve ne oranda değişeceği hem hesap hem de grafik gösterimi ile görselleştirilmiştir.

Kullanılan modelleme çalışması bir limanın tüm fonksiyonları (örneğin römorkör sayısı, kılavuz kaptan sayısı, kamyon sayısı, yük istif sahası gibi) ile çalışır hale getirilmek üzere geliştirilmeye devam etmektedir. Ancak bu çalışma ile etmen tabanlı modellemelerin deniz ulaştırması açısından nasıl kullanılabileceğine ilişkin çok temel bir örnek oluşturularak sunulmuş ve gelecekteki benzer veya daha kapsamlı araştırmalara temel olabileceği düşünülmüştür. Ayrıca liman kullanıcıları, liman idareleri veya yöneticileri tarafından da planlama aşamasında ortaya çıkan soruları yanıtlayabilecek potansiyele sahip olduğu değerlendirilmektedir. Özellikle karar vericilerin karar almalarını destekleyici veya yatırım planlamaları aşamasında yatırımların daha hedefe yönelik

olarak belirlenmesinde önemli bir destek aracı olduğu ve gelecekte MESA ve benzeri yazılımların çok daha fazla araştırma için kullanılabileceği de değerlendirilmiştir.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

A Review of International Standards of Environmental Noise and Its Adverse Effects on Port Workers

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ABSTRACT

Environmental noise has always been a social and occupational concern for people. Adverse effects of different types of ambiance noise may cause both short-and long-term health problems. As it may not be directly noticeable, when noise exceeds tolerable limits, without being noticed can cause a variety of unwanted consequences in terms of occupational health. Information gathered through the study shows that annoyance, sleep disturbance, cardiovascular disease, cognitive impairment, hearing impairment and tinnitus are the main adverse effects of noise on human health. In maritime field there are a vast range of sources that could create unwanted noise levels in work places. Especially during port operations, either continuous or intermittent, various noise sources may cause these occupational health problems. In this paper, existing data on noise related problems, methods for assessing and evaluating noise level and international standards on the issue reviewed. Results of the study provide supportive information on noise evaluation. The study contributes to enhancing environmental noise awareness as well as promoting efforts of researchers who are aiming to manage noise issue in port facilities. It also indicates that there is a relation between technological developments and noise levels in ports.

Keywords: Environmental noise, Noise exposure, Port workers, Noise standards.

1. Introduction

One of the environmental problems arising from industrialization and the development of modern technology is noise pollution. It is a growing environmental concern arising from a variety of sources. Recent studies have shown that noise have adverse effects on human health. This calls for a necessity to consider noise not only as an element of nuisance but also a serious health concern for the public. In most cities this pollution originates mainly from traffic related sources such as airports, road and rail traffic as well as industrial areas. However, when it comes to port cities the picture becomes more complicated. In those areas, shipping traffic and harbor activities becomes major sources of noise pollution [1].

People are exposed to noise pollution mostly in their work places. Some working sectors are more affected while others are less affected. Maritime sector is very much affected by the nature of the heavy business, mostly in port areas. As ports are heterogeneous considering their specialty of being hub and complex structures, they are significant noise sources for residential area as well as port workers. Especially in container terminals the levels of noise generated by the ships, straddle carriers, cranes, forklifts and trucks pose a great problem.

Hence, in order to understand the nature of this specific pollution, firstly the term *noise* needs to be clearly defined. Very briefly noise can be defined as unwanted sound or sound that is "out of place". Derived from the Latin word "nausea", the word besides meaning unwanted sound, also involves loud, unpleasant or unexpected sound [2].

The term *environmental noise*, on the other hand, can be identified as being unwanted sound arising from human activities which is harmful to human health and quality of life [3]. According to WHO (World Health Organization) [4], it is also defined as noise emitted from all sources except industrial workplaces. However, the EU Directive on environmental noise includes industrial sites too.

Environmental noise has been disregarded as an unavoidable fact of life and has not been pointed out and controlled. Even Murphy & King [5] has referred environmental noise as

the "forgotten pollutant" recently recognized and added that is an environmental and public health issue. Also, Singh & Davar [2] stated that environmental noise is becoming omnipresent, yet there is not enough awareness on the issue. So, as environmental noise has adverse effects on human health, it is a latent danger that shouldn't be disregarded.

Exposure to noise can be considered as one of the most common occupational hazards in the world [6]. Urbanization, economic growth and motorized transport are some of the driving forces for environmental noise exposure and health effects [4]. It is known that environmental noise pollution causes many physiological and psychological effects on people. Therefore, noise management is a factor that directly affects the quality of life, as noise has a long-term impact on health. Some of these impacts are tinnitus, annoyance, distraction, insomnia, mental stress, high-blood pressure, cardiac diseases and loss of hearing. These adverse effects of noise will be presented in the second section of this study.

These adverse effects of noise on human health are the fundamental reasons why environmental noise should be considered as a pollutant that needs to be avoided and controlled [3]. Due to its effects on human health, standards have been set for ameliorating environmental noise pollution which will be presented in the third section.

By examining these standards and the studies on environmental noise pollution that was executed according to the standards, methods for assessing and evaluating noise pollution are determined and explained in the fourth section.

As the study intends to be descriptive, the aim of this study is to raise awareness on environmental noise pollution by collecting/collating existing data on health impacts of environmental noise. Furthermore, this study puts forward the international standards on the issue and explains the methods for assessing and evaluating noise pollution. From this perspective this study is actually a pre-study of a large-scale research project aiming to describe and evaluate noise issue within the scope of port areas.

2. Health Impacts of Environmental Noise

Hearing deterioration due to noise is a direct consequence of the effects of sound energy on the inner ear. However, the levels of environmental noise, except industrial noise, are much lower and effect on non-auditory health. This cannot be explained as a consequence of sound energy. So, the consequences of noise exposure may depend on characteristics of the sound, including intensity, frequency, complexity of sound and duration.

There is a large amount of scientific literature evaluating the effects of environmental noise on human health. In sum, the health effects caused by environmental noise pollution are as follows: loss of hearing, nervous breakdown, mental disorder, heart troubles, high blood pressure, dizziness, insomnia and a general reduction in the quality of life [7, 8, 9, 10, 11].

OSHA (Occupational Safety and Health Administration) [3] states that, loud noise can create physical and psychological stress, reduce productivity, interfere with communication and concentration, and causes workplace accidents and injuries by making it difficult to hear warning signals. OSHA [3] also underlines that the effects of noise induced hearing loss can limit your ability to hear high frequency sounds, understand speech, and seriously damage your ability to communicate.

Short-term exposure to loud noise problems like temporary change in hearing or ringing in ears (tinnitus) may go away within a few minutes or hours after leaving the noise. However, repeated exposures to loud noise can lead to permanent tinnitus and/or hearing loss. Permanent hearing loss, most severe result of exposure to high levels of noise, cannot be corrected by surgery or a hearing aid. For example, exposure to noise pollution exceeding 85 decibels for more than eight hours daily for a long period of time can cause loss of hearing [12]. Hence, it can be said that the threat increases with the intensity of the noise and the period of exposure.

In figure 1, sound pressure levels of common environmental sounds are shown in dBA. As for in figure 2, health effects of noise can be seen regarding the number of people effected in general.

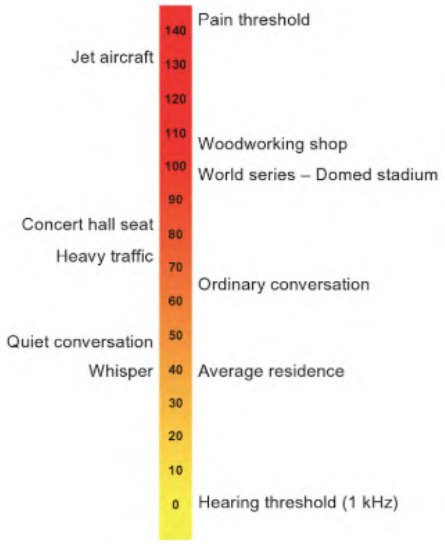

Figure 1: Typical Sound Pressure Levels of Noise Sources [13].

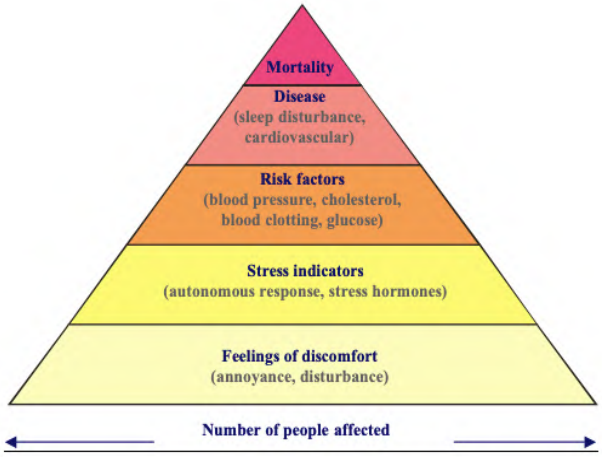

Figure 2: Severity of Health Effects of Noise and Number of People Affected [4].

Then again, in figure 3 exposure to noise pollution effects can be seen with the division of auditory and non-auditory noise effect reactions.

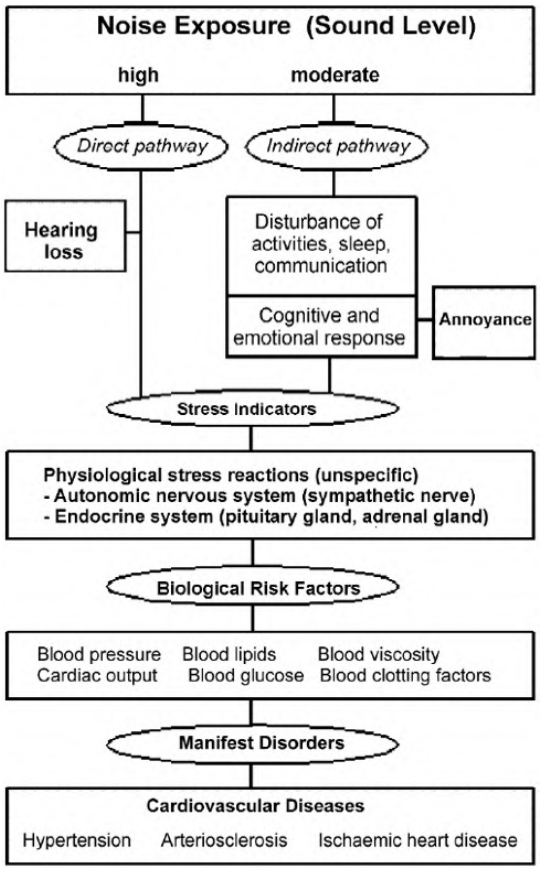

Figure 3: Noise Effects Reaction Schema [14].

Excessive noise is a global occupational health hazard with significant impacts as well as NIHL (noise-induced hearing loss) [5]. Occupations at highest risk for NIHL involve those in manufacturing, transportation, mining, construction and maritime sector such as ports, shipyards and ship recycling yards. The workers in these sectors exposed to continuous noise of 85–90 dBA and some equipment even exceeds 90-95dBA. In this regard, environmental noise sources that port workers exposed to are ships, trucks, cranes and forklifts. Especially in container terminals these sources cause even more pollution during loading/discharging operations. The consequences of environmental noise pollution that port workers are in danger of include impaired communication with coworkers, decreased ability to monitor the work environment (warning signals, equipment sounds) which increases the injury risk.

3. International Standards on Noise

In order to ameliorate environmental noise pollution, standards have been set as in noise limits, measurement and assessment methods. The emphasis in this part of the study is on international standards related to the environmental noise management. These standards set limits, specify measurement and assessment methods and define strategic actions to take. Apart from international standards on the matter there are also many country-specific and numerous European norms too.

Guidance for protection of human health from harmful exposure to environmental noise are set by the WHO. The organization gives a brief summary of recent developments and changes concerning the effects of noise on health, and establishes primary recommendations for handling environmental noise. From this perspective, noise matters started to be included in environmental impact assessment both in industry and in transport infrastructures. Noise regulations are being created and continuously updated and the in many cities noise mapping is being considered as a useful tool to manage this problem [4].

EU (European Union) on the other hand, took the subject in the year 2002 by producing the European Environmental Noise Directive (Directive 2002/49/EC, also known as END). This document establishes the basis for noise management in the Member States. It also sets the basis for the how to create of Strategic Noise Maps which actually can be used as the main tool to fight against environmental noise. The END by setting concrete criteria, makes the guidelines for the production of noise maps uniform as well as presenting a list for noise maps to be produced across the union [15].

To begin with, ISO 9612:2009 Acoustics — Determination of occupational noise exposure — Engineering method specifies an engineering method for measuring workers' exposure to noise in a working environment and calculating the noise exposure level [16]. It provides an approach to the determination of occupational noise exposure from noise level measurements. The procedure contains major steps as work analysis, selection of measurement strategy, measurements, error handling and uncertainty evaluations,

calculations, and presentations of results. There are three different measurement strategies presented task-based measurement, job-based measurement and full-day measurement. It gives guidance on selecting an appropriate measurement strategy for a particular work situation and purpose of investigation.

In the United States, NIOSH (The National Institute for Occupational Safety and Health) and OSHA set occupational regulations and standards to protect workers against the health effects of environmental noise exposure. NIOSH establishes REL (Recommended Exposure Limits) for noise. The NIOSH REL for noise is 85 decibels, using the A-weighting frequency response (often written as dBA) over an 8-hour average, usually referred to as TWA (Time-Weighted Average). Exposures at or above this level are considered hazardous. OSHA, on the other hand, sets PEL (Permissible Exposure Limit) to 90 dBA for all workers for an 8-hour day. In table 1it can be seen the decibel levels which a person can safely be exposed for its corresponding time without risk of NIHL according to NIOSH and OSHA [17, 18].

Table 1: Permissible Noise Exposures [17, 18].

Time to reach 100% noise dose	Exposure level per NIOSH REL	Exposure level per OSHA PEL
8 hours	85 dBA	90 dBA
4 hours	88 dBA	95 dBA
2 hours	91 dBA	100 dBA
1 hour	94 dBA	105 dBA
30 minutes	97 dBA	110 dBA
15 minutes	100 dBA	115 dBA

These strategic policies have already demonstrated a high degree of efficiency regarding environmental protection, and must lead to the creation of a trend towards the continuous and progressive reduction of environmental noise levels in the long-term. In

this long-term goal, noise mapping plays a prominent role, as it is a diagnostic tool provided to alert the policy- maker, inform the public, and make the stakeholders aware of noise-related problems.

4. Methods for Assessing and Evaluating Noise

The recommendation of END is to create noise maps for assessing and evaluating noise. A noise map is a graphical representation of sound levels in a region. Noise maps can be used for the assessment of sound levels either in the long-term or the short-term. They are useful for the pre-evaluation of action plans and noise control measures, or the estimation of people's exposure to noise [15]. According to WHO, the most accurate assessments of health impacts at the national level are obtained from local exposure data, since population exposure distributions can vary between countries. The most commonly used methods to assess health impacts are area surveys, dosimetry and engineering surveys. In area surveys noise levels are measured at different sites across an area. With dosimetry, a person's cumulative exposure to noise over a period of time is measured. And in engineering surveys, noise is measured using a range of instruments [12]. A number of measurement strategies for occupational exposure assessment are listed in ISO 9612-2009 Acoustics Determination of Occupational Noise Exposure: Engineering method. These strategies are task- based, job-based and Full-day measurements. Task-based measurement strategy recommends to conduct noise measurements for the tasks which expose a worker to noise. It is appropriate when the worker conduct the tasks, which are well-defined and the noise conditions are well defined. Job-based measurements are relevant when typical work patterns and tasks are difficult to define or not practical to perform a detailed work analysis. Full-day measurement strategy is recommended when work patterns are not well defined and noise levels, which workers are exposed to, are varying [16, 19].

5. Conclusion

The characteristics of the noise have changed with economic and technological change. There are no longer steam whistles but these have been replaced by other sources of noise such as high-powered engines which means that noise has always been a problem. It is

not similar to other environmental health problems. It does not look like other pollutants; it does not smell, does not have residues and does not pollute soil, water and/or air. The effects of environmental noise pollution show itself in small steps and sneakily. The leading factors in environmental noise pollution are industrial pollution, unplanned urbanization, rapid population growth, lack of awareness and economic barriers. The noise levels especially in developing countries may be increasing because industrialization is not always accompanied by necessary rules, regulations and equipment required for protection. Therefore, in those countries occupational noise is a widespread risk factor which has serious health impacts. Ports as one of the significant noise sources for port cities, they are also risky areas for the workers. With the recent developments in technology, in developed countries ports are becoming more autonomous. Hence, the land-based workers at ports are reducing in number and there seems that the number of workers who can be exposed to environmental noise sources in the area will be lessened. However, because of the economic constraints, developing countries follow modern technology behind which in return sustains the exposure of workers for longer periods of time. For this reason, those countries just by following the international standards on the noise matters, can handle the issue and reduce the risks for port workers more easily. Creating noise maps of ports periodically, measurements with dosimetry for port workers and raising awareness by trainings on the matter will be the actions taken to ameliorate the current status.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Technological Advancements and Innovation in Logistics Industry: Perspectives of Maritime Faculty Students

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ABSTRACT

It is getting more difficult to satisfy consumers as consumers' satisfaction has been determined by the overall experience a product and/or service delivery. Thus, organizations realize that they should differentiate not just their products or services, but the overall customer experience. One way of accomplishing this is fostering innovation. However, in order to accomplish that, organizations need coordination, corporation and accordingly good information flow between all departments of an organization and also between the partners in their supply chain. One of the primary drivers of supply chain innovation is the recent advances in technology. For example, advances in transportation and communication industry result with reduced costs, and higher customer satisfaction levels as they are, for instance, allowed to trace their delivery. Despite the higher number of previous research on supply chain innovation and technology, to our knowledge, not much attention is given to the perceptions of undergraduate students of maritime faculties. However, the students of these faculties will be using, and possibly improving these innovations and/or Technologies. Thus, it is significant to acknowledge the perceptions of these students especially on the importance and effectiveness of these innovations. This study, therefore, aims to acknowledge the perceptions of undergraduate students of a maritime faculty located in Western Turkey. In order to achieve this objective, the study uses a free association technique for gathering data from these students. According to the preliminary results, the most repeated innovations for

students who will be working in land bound operations are drones, robots, and driverless vehicles, whereas cranes, developments in ship parts, and port operations are the most frequent developments mentioned by students who will be working in sea-bound operations. Furthermore, according to the students, these innovations lead to increased overall efficiency, and development and/or improvement of long-term relationships with other partners in the supply chain.

Keywords: Innovation, Technological Developments, Logistics, Maritime Faculty Students, Supply Chain

1. Introduction

Logistics aims to provide the right product with right quantity, quality, form, and cost at the right place and time for customer (1). To achieve this, collaboration is required as "no organization is an island" (2), which is associated with the supply chain concept. Supply chain is "a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer" (3), and thus it requires the integration and coordination of all organizations and activities through "*consistent, high-quality logistics services*" (4). Therefore, SCM and Logistics are interrelated and inseparable.

For logistics service providers, traditional ways of doing business is not enough to generate value for customers. For maintaining customer satisfaction, they need to innovate and follow technological advancements as well as increase collaboration and coordination with partners in supply chain. The value is created through time and place utility in logistics (5), and thus, most innovations and technological advancements in the industry focuses on these aspects of the service. For instance, innovations in logistics and SCM include, but not limited to, transportation scheduling software, automation in diverse parts of operation, robotics, bar code technology, radio frequency identification (RFID), electronic data interchange (EDI), enterprise resource planning (ERP), warehouse management systems (WMS), transportation management systems (TMS), intelligent transportation systems (ITS), just in time (JIT) practices (6; 4; 7; 8; 9; 10; 11; 12; 13). Along with these innovations, the developments in the Internet such as the availability and use of big data have created a shift in the way of doing and managing businesses (14). Due to this shift, most of the innovative business solutions for logistics are focused on adoption and utilization of appropriate information technologies (15) as these systems help increase the effectiveness of logistics services (16).

Although the literature on innovation and technological advancements in logistics industry is rich in terms of customer perspective, the studies focusing on users' perspective is insufficient although they are the ones who are or are going to use these technologies. Users' perspective is essential to understand in terms of the availability, user-friendliness, and applicability of these innovations and technologies. Therefore, the aim of this study is to shed further light on the perspective of our students who are the future users of these technological advancements in the industry.

2. Research Methodology

The aim of this study is to understand the perceptions of undergraduate students regarding the innovations fostering the development of logistics and supply chain management (SCM). The undergraduate students have diverse majors in Department of Marine Engineering, Department of Marine Transportation Engineering, Department of Maritime Business Administration, Department of Logistics Management. Since the aim is to explore the perceptions of undergraduate students on the innovations fostering the development of logistics and SCM, an exploratory approach is followed through free-association technique.

Free-association technique is considered appropriate due to the aim of the study. Free-association technique is used in several studies on psychology, and marketing especially in research on brands (17). With a free association technique, we gathered opinions of a total of seventy-seven students majoring in Department of Maritime Business Administration and Department of Logistics Management through convenience sampling method. The students majoring in Department of Marine Engineering, and Department of Marine Transportation Engineering are also selected through convenience sampling and a total of 59 students provide perspectives. The students have completed at least two internships where some are still working part-time jobs in the field. We believe that students who are majoring in Marine Engineering, and Marine Transportation Engineering may have diverse perspectives than students majoring in Maritime Business Administration and Logistics Management as they spend their internships in ships.

Moreover, these students have selected these majors as they are interested in these fields, and perceptions of these students are important to investigate as they are going to be the users of these technologies and innovations.

Free association and written stories are common methods for gathering verbal and/or explicit knowledge (17). Free-association technique was selected as "free association probabilities index the relative accessibility of related words in memory" (18). Students receive a stimulus1, they were asked to spontaneously write the first three technologies and/or innovations that come to their mind that was related and/or strongly associated to the development of logistics and SCM. The objective with this stimulus was to uncover easily accessible verbal associations (19) and lexical knowledge shaped through experience (18). The created associations are dynamic since they are derivatives of everyday experience (e.g. norms, culture, current trends) changing gradually with time (18).

After the stimulus, we give students 10 minutes and a piece of paper to write down their answers, and they were asked not to talk to each other. For analysis, we followed the suggestions of Strauss and Corbin (1990) (20). Firstly, one code (axial coding) used for each association students elicited. After axial coding, selective coding was employed to group and compare the data for identification of similarities and differences. The coding process is conducted simultaneously by two researchers to increase objectivity. With this triangulation across researchers' approach, we were able to produce diverse perspectives during data analysis. Moreover, through exchange of viewpoints, we obtained various explanations of the findings that in turn increase the validity of the results (21).

3. Findings and Discussion

The study helped us to better understand the perceptions of students regarding the technologies and/or innovations they consider relevant for the development of logistics and SCM. We believe that the perceptions of students could be gathered and compared as

[1] Before receiving the stimulus, the students were informed that the contribution to the study is on a volunteer basis. As a result, some of the students (7 students in total) do not choose to participate.

they are majoring in Administrative Sciences or Engineering as the prospective work fields are different from each other. However, the prospective work fields are similar for students majoring in Maritime Business Administration and Logistics Management. Therefore, for a better comparison, perceptions of students majoring in Maritime Business Administration and Logistics Management were unified, and compared to the unified perceptions of Marine Engineering, and Marine Transportation Engineering students.

It is possible to classify the technologies and/or innovations affecting or will affect the (further) development of logistics and SCM into four headings for students of Administrative Sciences (See Table 1).

Table 1: Perspectives of Administrative Sciences Students on Technologies and/or innovations affecting development of logistics and SCM

Second-Order Codes from Selective Coding	First-Order Codes from Axial Coding	Frequency of occurrence
Transportation		64
	Drones	26
	Driverless vehicles, processes	31
	Containers (e.g. collapsibles or 10 ft. ones)	7
Manufacturing		20
	Automation	16
	ERP	2
	3D Printers	2
SCM Processes		76

	Robots	15
	Artificial and Virtual Intelligence, Coding Algorithms	20
	RFID-Barcode	9
	Tracking	5
	Service Finder	5
	Increasing number of applications (e.g. Uber)	5
	Industry 4.0	6
	Internet of Things	7
	Big data	4
Space Logistics		9

According to students of Administrative Science, drones are the most mentioned technology and/or innovation leading the development of logistics and SCM. The usage of drones increases the speed in delivery, and as Amazon started the trials, it is one of the most acknowledged technologies for students. Due to their majors, nearly half of them wrote down driverless vehicles (e.g. trucks, ships, trains, etc.). The second classification is labelled as manufacturing as students mentioned automation, Internet of Things, and Industry 4.0 during production processes. This highlights that the perception of Administrative Sciences students is positive regarding the effect of Industry 4.0, even though Turkey is located between Industry 2.0 and 3.0 (21). The reason of this acknowledgement may be due to a conference held right before the data collection process regarding Industry 4.0. Furthermore, due to the presence of TechnoPark in the university, students associated coding algorithms, big data artificial intelligence and service finders with the development of logistics and SCM. The last classification is rather an interesting one. Despite not being exposed to information regarding space logistics during their education, students believe that this may have a positive effect on the

development of the field. The reason of this may be related with the efforts of Elon Musk. Right before data collection, Elon Musk launched Tesla to Mars and the information regarding this was everywhere. We believe that the effect of social media enhanced students' awareness regarding this subject, therefore they also associated space logistics with the development of logistics and SCM.

The perspectives of Engineering students are gathered in four headings as Transportation, Operations, SCM processes and Network Security (See Table 2).

Table 2: Perspective of Engineering Students on Technologies and/or innovations affecting development of logistics and SCM

Second-Order Codes from Selective Coding	First-Order Codes from Axial Coding	Frequency of occurrence
Transportation		31
	Drones	3
	Driverless vehicles, processes	12
	Ship parts (e.g. engine, fuel, tank, pump)	9
	Containers (e.g. collapsibles or 10 ft. ones)	6
	Underwater transportation	1
Operations		37
	Ship operations (e.g.lashing, barge, sludge, new routes)	5
	Port Operations (e.g. craines)	14
	Automation	11

	Electronic Order	7
SCM Processes		33
	Robots	10
	Artificial and Virtual Intelligence, Coding Algorithms	6
	Increasing number of applications	2
	Big data	5
	Block chain	1
	Internet of Things	7
	Industry 4.0	2
Network Security		13
	Cyber security	3
	Tracking	10

According to Engineering students, the most frequently mentioned category was Operations focusing on port operations and automation. The reason for his common perspective of Engineering students is that these innovations and development may influence their prospective ways of doing their jobs. The second most mentioned category is SCM processes including robots, coding algorithms, and big data. Similarly, the reason for this may be related with the presence of TechnoPark, and the companies working on big data to create value. Moreover, the high level of SCM process awareness among Engineering students may be due to the high level of attendance of Engineering student to the conferences held in Maritime Faculty and within the university. Transportation category, on the other hand, demonstrates a difference between two groups of students as Engineering students will be working on ships, and thus their focus is primarily concentrated on water-borne transportation. Lastly, another interesting finding from

Engineering students is that they mentioned network security. The reason for this awareness is that Maersk Shipping recently had suffered from a cyber-attack which is most probably discussed during lectures as a case study.

4. Conclusion

The objective of this study is to shed further light on the perceptions of undergraduate students who will be graduated from Maritime Faculty regarding the technologies and/or innovations used or are going to be used in logistics and SCM fields. With this aim, we followed an exploratory approach by employing free association technique.

The results demonstrate some similarities and differences among students with diverse majors. For instance, all students associate robots, drones, artificial intelligence, driverless vehicles, Industry 4.0, big data, automation and, Internet of Things with technologies and/innovations affecting development of logistics and SCM. Differences occur due to their interests. For instance, students with Administrative Sciences majors have higher awareness regarding manufacturing therefore they mention ERP and 3D printers. However, students with Engineering major focus on operations as they will be working part of a service supply chain, and thus mention ship operations, port operations, and electronic order in a business-to-business manner. Another difference mentioned by Engineering students is related with transportation. Since these students will be working in a ship, they mention ship parts as technologies affecting the development of logistics and SCM. Besides, as they come across with the cyber-attack Maersk Shipping experiences, they mention network security as a leverage for the development of the field. Related with this, they also Block Chain since it would make the payments and operations easier and safer in sea transportation.

Moreover, as students majoring in Administrative Sciences focus more on technologies which would have positive influence on consumers such as RFID and bar-code, however these technologies were never mentioned by Engineering students. For practical purposes, thus, Engineering students would benefit from courses focusing on consumer-oriented courses related with logistics and supply chain management, whereas

Administrative Sciences students could use sea-borne operations' courses emphasizing a macro perspective to provide them with an integrated understanding of the overall process.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Overview of the Newly Opened Arctic Routes in Terms of World Maritime Shipping

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ABSTRACT

Global climate change has begun to offer new opportunities for international maritime transportation networks and related land side technical and economic structure with advantages as well as disadvantages, notably with a trend of receding ice around the North Pole. If this trend continues, parts of the Arctic Region can be used for navigation, which is suitable around 3 months for navigation activities because the temperature in winter gets as low as -40 degrees Celcius and the ice returns in that season. Sea ice around the North Pole reaches its biggest area at the end of the winter in March, and thaws to an annual minimum in September. Besides all these arctic shipping, numerous additional factors, including dearth of services and infrastructure, high insurance and ice breaker/tug escort fees, unknown competitive response of the Suez and Panama Canals, change of bunker rates, poor charts, impact on the environment and natural life, maritime pollution, unpredictable consequences of possible accidents at sea and other socio economic considerations, remain significant impediments to maritime activity in the region. Especialy the number of ships operating in the Arctic ares is increasing day by day so International Maritime Organisation (IMO) has released the adoption of the International Code for Ships Operating in Polar Waters (Polar Code), which strongly regulates the safety implementations and helps to avert a catastrofical results of this new arctic routes and related challenges on maritime industry. However, detailed investigation and research studies of regional, global and sectoral impacts and projections of arctic shipping routes and related impacts will help us to predict the impact of environmental changes on future world trade.

Keywords: Arctic Routes, Ice Navigation, Arctic Corridors, Climate Chang

1. Introduction

The world has changed unpredictably with the 20th century and this change continues at full speed. The region, which has not undergone any significant changes for millennia, has begun to melt rapidly with the global warming, which has an impact on the world, and the polar region, which was suitable for sledding and allowed travel on ice only but today, this has become suitable for the different size of vessels. Scientific studies show us that, unfortunately, our world will not have a backward changes and the melting of the polar region will continue in full swing. The main purpose of this study is to present the developments to the attention of the maritime industry by forming a general framework for new arctic transportation routes and related issues that arise with global warming.

2. History and Impacts of Climate Change

Today the Arctic region is warmer than before and it is still getting warmer day by day. Over the past 30 years, arctic area has warmed more than any region on earth. Scientists started to notice changes in the Arctic climate from the 1970s, indicating that the trend over this 50-year period is for an increase in air temperature of more than 2° C (3.6° F) (2) across much of the Arctic, which is larger than for other parts of the globe. Since 1970s, 35% of the ice on average, 3000 km3/decade of sea ice at the North arctic region has been lost. This rate is faster than the average, depicted from climate model simulations which was made for the same period. This data is fuelling debate about whether this higher loss rate will continue or it is due to temporary climatic fluctuations (5).

The Arctic region releases more heat to space than it absorbs from outside, which supports for cooling the earth. That means if arctic area has a climate change, other regions in the world will be effected directly. If global warming proceeds at the same speed the physical, biological and human systems will be effected dramatically. Scientists study the data collected by satellites and at ground stations and also use sophisticated computer models.

The main source of climatel and weather change is human, as expected. The arctic warming causes the reduction of ice thickness and ice sheets. Extent of permafrost, snow

coverage percentage depends on annual changes, polar melting and the rising up in temperature is caused the empowers the greenhouse effect. In the first half of 2010, air temperatures in the Arctic were 4° Celsius (7° Fahrenheit) warmer than 1968 to 1996 reference period, according to NOAA (1). The melting of the North arctic region is directly related to the increase in greenhouse gas emissions, particularly carbon dioxide (CO2). Taking into account that each tonne of CO2 emitted to the atmosphere causes the disappearance of 3 square meters of ice in the Arctic during the warmest months.

We will examine whether these dramatic changes will create new and effective business opportunities and whether they will outweigh some of the threats that climate change brings to the North arctic area.

3. Impact of Global Climate Change on Maritime Activities in The Northern Arctic Region

The Arctic shipping routes are the shortest routes linking East Asia and Europe but in the last 60 years, this region has attracted the attention of the maritime transport industry due to global warming which caused ice loss in the arctic region (3). The new arctric routes, which are the result of the global warming have started to be seen as an alternative for the solution of the maritime problems about freight rates, running cost, consumption, shorten the distance, time etc. Besides the advantages, new route has created extra costs. Changes in monthly sailing conditions and therefore costs and transit time also affect the results and the variability of sailing condition in the arctic has also been the subject of extensive studies (4). The fact that the arctic routes were not used by the maritime industry for a thousand years so it requires detailed research on navigational safety condition and related issues of the region and also the infrastructure situation of shore facilities and continuous change in ice structure. It also requires detailed investigation to avoid catastrophic events on environment and shipping safety. With all these challanges, the maritime industry has begun to build the ice class ships that are suitable for arctic routes, and some of shipping companies have started to use these routes even at low levels.

The impact of the new arctic routes is not only the shortening of the voyages and the related costs, also it has huge chain reaction effect on economical life and economical parameter of arctic region.

The commercial opportunities of this has already attracted the interest of countries with an Arctic coastline, such as the United States, Canada, Russia, Norway, and Denmark (Greenland). The (new) Arctic shipping routes could during summer months' rival or complement the old conventional routes through the Suez-Canal or the Panama-Canal. For trans-Arctic shipping to be commercially viable and accommodate the higher volumes seen on established shipping routes, would require most of the following: additional en route ports and infrastructure, ice-breaking services, bunkering service and also related with above vessel services land side that currently have low population and there have been a few facilities, will develop rapidly bases on economy and socio-economically. The region will take investment for the development of infrastructure projects, logistics hubs and effective tourism need (5).

Mainly The Russian government and other countries Canada, USA, Denmark, Norway, Iceland, Finland wish to develop the arctic route region as a commercial enterprise, and although they charge fees for its use. They do offer substantial services such as ice-breaking support and pilotage because they would like to create new silk road. Arctic economic growth is focused in four key sectors – mineral resources, fisheries, logistics and tourism – all of which require shipping and could generate investment reaching billions of USD or more in the Arctic region over the next decade. For these reasons, this region presents realistic economic opportunities for the development for all related countries (5). As a final Word for this topic is that, the new existing routes and potantial future routes in the arctic region, which are formed as a result of global warming, will affect the countries of the region and the cooperation platforms to be created by these countries politically, economiclly, social, technological, environmentially and legally. Table 1 shows that some of the implications give positive impacts or positive benefits which tend to be laudable to the maritime sectors. Vice versa, negative impacts to the

global or as countries economy will have disadvantageous impact to community or surrounding environment.

Table 1: A Comparative Of Two Shipping Routes For The Asia-Europe Trade(17)

Element	Maritime Routes (via)		Statement
	Suez Canal (SC)	Northern Sea Route (NSR)	
Distance (nm)	11585	7356	[Far East vs. N.W. Europe] Yokohama - Hamburg Suez Route (11,585 N.M.) vs. NSR Route (7,356 N.M./- 36%) The navigation distance from Northwest European port to Far East via NSR is an approximately 36% shorter compared Suez Canal route.
Fuel Consumption	High	Low	Norway to China: Shipping via the NSR save $550,000 in fuel costs compared to the journey via Suez Canal (Bulk Ship named MV Nordic Barents)
Journey Time	32 days (15 knots)	18 days (15 knots)	North West Europe (London) to Far East (Yokohama) Shipping via the NSR save 14 days on the journey compared to via the Suez Canal by using same speed
Speed (Knots)	15 knots 32 days	9 knots 32 days	North West Europe (London) to Far East (Yokohama) Shipping via the NSR using speed only 9 knots on the journey compared to via the Suez Canal by using 15 knots on speed

Piracy	Yes	No	There is also much reduced level of piracy through this northern route, compared to the risk of piracy for ships in the Indian Ocean that are using the Suez Canal
Fee	Low	High	A maritime route with transshipment (T/S) includes T/S charges at T/S ports. NSR Fee USD 674 per TEU Suez Canal Fee (SDR/GT) for the 1st 5,000GTx USD7.88+ 2nd 5,000GTx USD5.15+; 3rd 10,000GTxUSD4.12+; 4th 20,000GTxUSD2.88+; 5th 30,000GTxUSD2.6+ 70,000GT(+)xUSD2.11
Transport Cost	High	Low	North West Europe (Hamburg) to Far East (Yokohama) Transport cost via NSR (USD/TEU) <1,123 Via Suez Canal (USD/TEU) 1,299
Cost Saving	Low	High	Cost analysis may heavily depend on changes of bunker oil and ship-building prices as well as NSR, and Suez Canal fees. Thus, the shipping scenarios including navigation conditions would be a key factor to the cost analysis here. Severe competition will be expected among NSR and Suez Canals in the near future

4. Arctic Corridors and Analysis of New Artic Routes

Figure 1 shows that there are two existing arctic routes; Northern sea route (along the Russian Arctic coast) and Arctic bridge (from Churchill Canada to Murmansk-Russia). Figure 2 shows existing routes and two other routes are not yet navigable for cargo vessels. These are the North-West Passage (along the Canadian Arctic coast) which is expected to open up sometime between now and within a few decades, and the Central

Arctic route/transpolar route (across the center of the Arctic ocean) which will likely open up only in the more distant future (6).

Figure 1: An Overview of These Routes On a Map of The Northern Part Of The Earth (7).

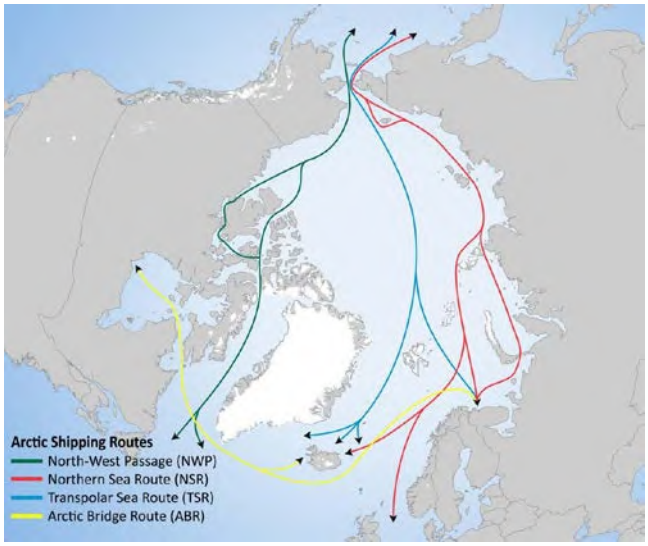

Figure 2: General Overview for Current and Future Arctic Routes (22)

4.1. Northern Sea Route:

The Northern sea route is officially defined by Russian Goverment as a shipping line from the Kara Sea to the Pacific Ocean, it's starting the Russian Arctic coast which is from Kara Gates strait between the Barents Sea and the Kara Sea, along Siberia, to the Bering Strait. This route was formerly named the Northeast Passage, but is now more often using name the Northern Sea Route. The Northern Sea Route establish all routes from the Barents to the Chukchi Sea and the Bering Strait is suitable for shipping activities(8). The Russian goverment want to establish more cargo flows in this region. For this reason, it has invested heavily in shipbuilding and projects so as to enhance support of navigation (for example, it has updated the respective nautical charts and already established operational the muchneeded search and rescue (SAR) centers), increased logistic support, and even put forward plans to establish a land network that will connect the northern route ports with other markets(10). The Northern sea route's some parts have ice free zones for only two months a year. This area is shown with the blue lines in figure 3 (9).

Russia has an atomic icebreaker fleet consisting of 7 icebreakers that are used to patrol the Northern Sea route, pilot (break ice for-, and guide for-) other transit ships under contract through required route segments, and assist with scientific expeditions. Northern sea routes can offer great savings in distance and thus potentially also in time and expenses for transport between Europe and East Asia, with no countries being more conveniently located than the Nordic ones. According the figure 4 in theory, distance savings can be as high as 50% compared to using the current shipping lanes via Suez or Panama Canal.

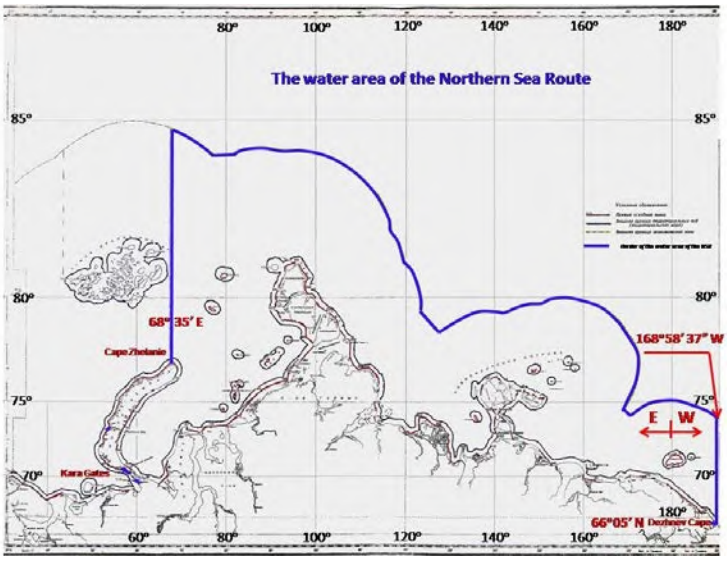

Figure 3: Ice Free Zones For 2 Months Period (9)

Figure 4: Comparison of Traditional and New Actic Routes Distance (12)

Table 2 distance calculation from Rotterdam to Yokohama, Shanghai and Vancouver clearly showed that the most optimistic scenario is that of the route from Rotterdam to Yokohama by the Northern Sea route. The distance is roughly cut in half (7).

Table 2: The Distances from Rotterdam To Yokohama, Shanghai And Vancouver Distance Calculation Result (18).

	Suez Canal	Panama Canal	Northern Sea Routes

Rotterdam-Yokohama	20.600 km		8.500 km
Rotterdam-Shanghai	19.300 km		14.875 km
Rotterdam-Vancouver		16.400 km	12.850 km

4.2. Arctic Bridge:

This route is a seasonal route that connects the ports of Murmansk-Russia (or Narvik-Norway) to Churchill-Canada, and is open for about four months a year. The route is shown on a chart in figure 5. However, the Hudson bay is often frozen over most of the remainder of the year, making it an unreliable shipping route. As the climate warms, it could become a more and more viable route. The port of Murmansk is located on the ice-free Koala Bay. The Arctic Bridge route is an alternative route between America and Asia or Europe. The Arctic bridge route could be a useful link for the export of grain from Canada to the European or Russian markets.The port of Churchill is the northern terminal of the Hudson Bay Railway. Grain could be transported by railway to the port of Churchill, by ship via the Arctic bridge route to Murmansk, and by railway to Europe or further into Russia using the Murmansk Railway (6).

In the late 1990s an agreement was reached between the Russian and Canadian authorities that allows the usage of the arctic bridge route, mostly for the export of grain. The first inbound shipment (of fertilizer) from Russia however, arrived in Churchill in 2007. Both public and private parties from both countries now continue to endorse visions, strategies and plans to further develop a divers two way transport by this route (11).

Manitoba's minister of infrastructure and transportation says in an article: "A key element of the bridge's ability to attract international freight traffic results from capitalizing on the time and cost efficiencies associated with the notably shorter shipping distances between Murmansk and Churchill, as compared to other North American ports. The distance from Murmansk to Churchill is 3,763 nautical miles, or 13 days, two hours,

whereas the route from Murmansk to Thunder Bay is 5,030 nautical miles, or 17 days, 11 hours. Similar distance and time savings can be realized between Churchill and Copenhagen and Algiers, making Manitoba's sea port the clear choice when seeking a shorter shipping route" (12).

Figure 5: Artic Bridge Route (20).

The use of the North Pole bridge will make the Churchill port more popular and will lead to future prominence compared to other ports. In addition, this route will allow smaller tonnage vessels to play a larger role in transport. Of course, land transportation will come to the indispensable part to transport to cargos to other American ports. This can be a cost-cutting factor in cost analysis.

The new arctic routes, which are expected to be opened apart from the existing arctic routes, still have decades. Mentioned routes Nortwestern artic route which is currently seasonally open with ice-breaking support. The transpolar route (TSR) across the central Arctic Ocean should become available around mid-century

4.3. The Northwest Arctic Route:

The Northwest Passage is the name given to the various marine routes between the Atlantic and Pacific oceans along the northern coast of North America that span the Canadian Arctic Archipelago (13). The Northwest Passage (NWP), a sailing route on the Arctic Sea crossing northern Canada and connecting the Pacific and the Atlantic oceans. There are plenty of recorded trials of crossing the passage, such as, the super tanker Manhattan. The ship was refitted with an ice-breaker bow, and crossed the NWP under the escort of a Canadian Coast Guard ice-breaker in 1969; it was the first commercial vessel to test the Passage. there were arguments about the transit of oil and gas carriers, due to the risk of pollution and the consequences on the ecosystem, and hence, it was finally seen that the Trans-Alaska Pipeline was more feasible mean for transporting oil (15).

Although within the Nortwest artict a few sailing alternatives (Figure 6) exist, it is roughly described as starting in the Bering Strait between the Chukchi Peninsula (Russia) and Cape Prince of Wales (USA), through the Beaufort Sea, across a variety of straits depending on a specific route (M'Clure, Barrow and Prince of Wales Straits) and out through the Baffin Bay and Labrador Sea to the North Atlantic Ocean near southern Greenland. Many challenges exist in considering the NWP for regular commercial use and the most obvious one is its availability regarding ice conditions. Although many studies point towards a larger open-water season for arctic shipping in the future, most still foresee a short window of time and work more in terms of probability of navigating in a specific period (usually between July – October) than actually forecasting the window itself. Nonetheless, regularly sailing through the Arctic Ocean will become a reality in upcoming decades (14). The Passage, in the sense of a commercial sea lane, would require significant investment in costly escort ice-breakers, ice-strengthened vessels, navigation supporting information systems and staging ports in order to satisfy current IMO requirements. Accordingly, the route is not anticipated to become a competitive alternative to the Southern routes within the next decade, or even decades, as per the Canadian commercial marine transport industry (14).

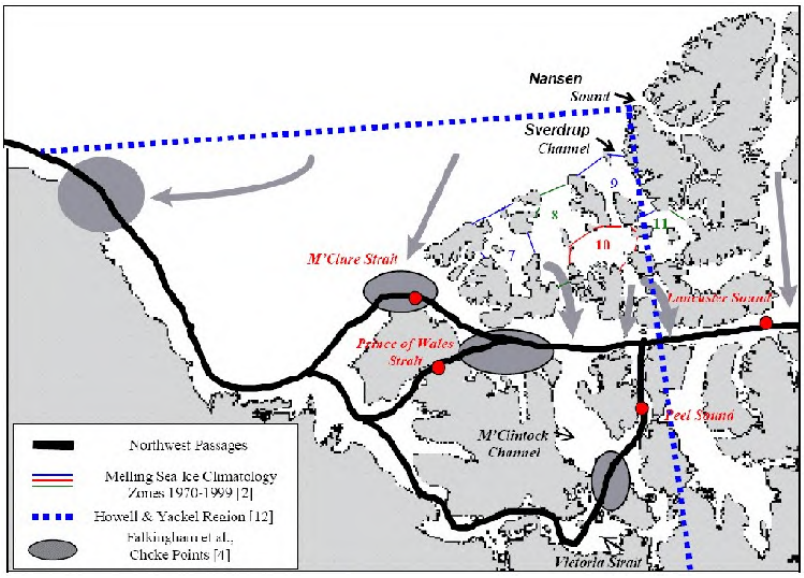

Figure 6: Northwest Arctic Three Major Routes (6).

4.4. Central Arctic Route (Trans Polar Route)

The Central Arctic route, (also called trans arctic route, or trans polar route) is the shortest possible link between the Atlantic Ocean with the Pacific Ocean, that runs across the center of the Arctic ocean (Figure 7). It passes close to the north pole. It might be a future shipping lane. Figure 6 shows the route on a chart.The easiest time to use this route would be in September, because the ice extent is at the lowest then. The TPR's legal situation is considerably less complex than that of the NWP and NER as it lies outside any Arctic coastal state's national jurisdiction. Regulations for shipping on high seas and specific guidelines related to Arctic shipping already provide a regulatory framework for the region. Currently the central arctic route is only accessible for heavy icebreakers. The ice free conditions that would be necessary to be able to follow this route with Cargo vessels have not been observed yet. The Central Arctic route avoids most of the territorial waters that the Northern Sea route and the North-west Passage cross. This could be an advantage (6).

Figure 7: Central Arctic Route (Trans Polar Route) (21).

5. Facilities in Arctic Regions

Sailing via the Northern Sea Route water area requires the assistance of an Ice-pilot and there are a number of rules a vessel should know. Ice pilotage of vessels is to prevent accidents at sea and ensure safe navigation. Ice pilotage is also to protect the marine environment in the Northern Sea Route water area. In maritime areas with bad weather, deepwater ports and the services which are available are relatively close to worldwide maritime shipping and are mostly seen as normal. The situation in the Arctic is completely different. Deepwater ports, adequate port reception facilities for ship-generated waste, marine salvage and towing services are almost not available. There are a few deepwater ports in Russia or American waters near the Bering Strait. The northern coast of the Russian Federation has a number of deepwater ports that have been supported by the arctic authority and the Russian fleet of icebreakers for several years. Murmansk is the largest deepwater port north of the Arctic Circle. The facilities in the Arctic are unsatisfactory at the moment. It is important to have good emergency, communication and medical facilities. But risks in the Arctic could also be reduced by better rules and

regulations. It might be better to decrease the chance of an accident as to improving the SAR facilities.

6. Conclusion

The earth's rapidly changing climate will continue to affect the Arctic environment and contribute to major physical, ecological, social, and economic changes. Melting of the Arctic sea ice will soon allow for extended periods of navigation in the Arctic Ocean, and will remain unique compared to all other global shipping operations. The opening of the Northern Sea Route as an alternative route for transporting cargoes from the Far East and Europe will affect the maritime sector. The most important governing idea that stands out in this study, which describes the arctic routes in general and the land and maritime structures associated with these routes is vital importance that the preliminary preparations for the efficient and safe use of transport routes, which may or may not occur due to global warming or for different reasons, should be made on time and in full agreement by the countries concerned. Polar code work is one of the most important steps in this sense.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

A Brief Comparison of International and National Regulations on Preparedness Response and Co-Operation to Pollution Incidents by Oil, Hazardous and Noxious Substances (HNS): Status of Pollution Response Organization

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ABSTRACT

This study makes effort to compare the existing international conventions, rules and regulations with Turkish regulations. As Turkey already took many steps in terms of legislation, main goal of this paper is to comparatively assess how efficient Turkey's pollution response organization is. Through the comparison, the study tries to assess to what extend the domestic legislation corresponds to international ones. Besides the comparison from utterance aspects, compliance of procedures and assets, as well as equipment capabilities and training aspects are also included in the study. This way, efficiency of Turkish managerial organization for response to pollution of marine environment by oil and other harmful substances is evaluated. After discussing the shortages Turkey faces, the main focus is set on the importance of initial response action together with direct effect of real time integration and information flow between all related parties. Regional efforts and practises like, European Emergency Response Capacity (EERC) and Common Emergency Communication and Information System (CECIS) are also taken into consideration. It is evaluated that Turkey has made a substantial forward way with the legislation issues both in participating in international conventions and reflecting them on the domestic regulations. Yet, there is still space for improving the existing regulations and available assets. Heuristic comparison of the

legislations and overall assets shows that there is a need for consolidation of the response operations by providing a network system that will provide real time situational awareness to all stakeholders. From decision-making support aspect, in order to have a complete system against oil and Hazardous and Noxious Substances (HNS) pollution, a need for simulating the response operations found to be the major difference between domestic and western systems.

Keywords: Oil and HNS, Marine pollution, Pollution response organization, Pollution information flow.

1. Introduction

The increasing need for oil and its products has also affected the transport of these between supply and demand points in parallel. In terms of cost efficiency, the role of maritime transport, which is the most efficient transportation mode, has also increased similarly. Based on "United Nations Conference on Trade and Development (UNCTAD) 2018", the total cargo transported by sea in the world was around 4 billion tons in 1980 and reached 11 billion tons in 2017. When we look at the statistics related to the oil and its derivatives transported by sea, it is seen that the load transported in the 1970s was around 1.4 billion tons and reached 3.15 billion tons by 2017 [1]. It is also possible to say that the similar trend is for the amount of oil and chemical cargo carried through the Turkish Straits. As Şıhmantepe and Aşan states; throughout the past decade, although there has been a decrease in the number of ships passing through the Turkish Straits, amount of oil and chemical cargo is increasing [4]. This determination is accompanied by the increase in the size of oil and chemical tankers. This increase in ships size proportionally increases the risk of marine accidents in Turkish Straits. Possible damages to human health, ecological balance and property caused by the pollution sourcing from these accidents might be enormous. Due to the extent of hazards posed by possible accidents, Turkish straits can be considered as dangerous waterways in many respects.

2. Legislation on Oil and Hazardous and Noxious Substances (HNS) Spill

2.1. International Maritime Organization (IMO) and Regional Regulations

Enviromental disasters sourced by oil and hazardous, noxious substances (HNS) as consequences of marine accidents, exposed the necessity of taking precatuions for ships design, outfitting, safety and security matters. In this context, especially in 1989, the environmental disaster caused by the Exxon Valdez tanker, who was stranded near Alaska, revealed the necessity of effective and coordinated intervention to the pollution caused by these types of accidents as soon as possible. And Exxon Valdez pioneered the implementation of the International Convention on oil pollution Preparedness, Response and Cooperation (OPRC) convention [2], by International Maritime Organization (IMO) in

November 1990. The Convention put contracting parties under obligation to take all necessary measures to prepare for and intervene oil pollution incidents individually or together with the other parties.

Oil, which has a certain scope in terms of its chemical structure and variety, can also standardize certain methods in terms of response when it is spread over the sea. On the other hand, HNS have a greater diversity in terms of their chemical structure and risks to human health and ecological balance and require different precautions and response methods if they are spread over the sea. In this context, IMO has worked on expanding the objectives of the OPRC convention to include HNS other than oil, and Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances, (OPRC HNS 2000) was issued in March 2000. The Protocol provides a framework for the development of cooperation at local, regional and global levels for the preparation, response and coordination against oil and HNS pollution, as well as for the development of special training programmes, in line with the main convention OPRC 90 [2].

Owing to its geography, history and effects of globalization, maritime transport plays an important role in the development of European Union (EU) trade. In particular, OPRC's recommendations for the common use of capabilities against marine pollution via local and regional cooperation directed the EU to establish such organizations. Marine accidents in Union seas have shown that there is a need not only for prevention of pollution but also for concerted action in the area of pollution response. In this context, the EU enacted the civil protection mechanism in 2013. The mechanism rises on three important foundations. [3]

- Emergency Response Coordination Centre, ERCC
- Common Emergency Communication and Information System, CECIS) (a web-based alert and notification application enabling real time exchange of information)
- European Emergency Response Capacity, EERC.

The mechanism also cooperates with the European Maritime Security Organization (EMSA) in case of emergency marine pollution. Member states make requests for assistance in large-scale oil and HNS spills via the ERCC. [3]

As a brief glance shows, oil pollution aspect has been well covered in the EU. They seem to have a concrete system for communication, monitoring and required assets for responding. Although there will always be a space for further improvements to the established system, the existing one can be considered satisfactory compared to none or very little. However about Hazardous and Noxious Substances the main reference comes from European Maritime Safety Agency's (EMSA) HNS Action Plan (2007) .The actual name of the plan is "*Action Plan for Hazardous and Noxious Substances Pollution Preparedness and Response*". The plan covers both oil pollution and HNS pollution preparedness and response issues. Within the plan HNS is defined as "*any substance other than oil which, if introduced into the marine environment, is likely to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the Sea*". The plan is intended to be used in accordance with the "OPRC-HNS Protocol (2000)". [4]

Although there is a plan, HNS safety, preparedness and response capabilities of the EU members do not seem to be sufficient. The plan indicates that at national level, contingency actions are developed to accompany response efforts in case of a possible oil spill. But when it comes to response plans for a possible HNS incident, plans seem to present a level that is far less prepared. This stems from the variety of risks posed by HNS and in parallel, diversity of required techniques for responding to such incidents. HNS Action Plan also states that "OPRC-HNS Protocol 2000" requires participating states shall cooperate to overcome individual inefficacy issue. That is, even though each member state is required to have in place procedures, if individual efforts do not suffice to handle a pollution incident, according to the plan, close cooperation is required. However, in terms of HNS preparedness, status of individual countries are widely different and some already express that they are not fully equipped and ready for a large-scale HNS incident that may occur in their area.

These efforts by the EU on to challenge against marine pollution played a leading role not only in the region but also in the global scale, and in particular led IMO to take more comprehensive measures in this regard. To provide appropriate national regulatory framework in these areas, IMO has actualised significant implementation strategy in the manner of capacity building and institutional strengthening. [5] Additionally, various guidelines, manuals and model courses have been adopted by IMO to support establishment of national and regional regulatory systems in appropriate structure and to enhance the capabilities of personnel through relevant capability-building activities [6].

2.2. Turkey's Regulations on Oil and HNS Spill

Turkey, following her prime approach of contributing to common goals of humanity, has already participated in the two conventions-"International Convention on Oil Pollution Preparedness, Response and Co-operation, (OPRC) 1990" and "Protocol on Preparedness Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances 2000 (OPRC-HNS PROTOCOL)"- which place environmental and human life protection in the centre as core goals. One other contributing factor to Turkey's timely decision is the fact that international tanker traffic has become too dense in Turkish Straits. Maritime accidents do happen even though rules and regulations for navigation safety. Mass transportation while presenting benefits, may also pose threat of unwanted consequences of possible maritime accidents such as grounding, fire on board, collision. Consequences of those accidents, besides the imminent threat to human life on scene, may cause irreversible damage to environment in the mid or long term. Length of Turkish coastline, together with densely operated domestic ports and their approaches will keep risk of tanker accidents and environmental pollution as one of the top priorities. This undoubtedly requires having well-defined national legislation in place to manage all aspects of the pollution incidents. [4]

Turkey following her principles and needs became a party to both OPRC Convention and OPRC-HNS Protocol in 2003. Turkey following her principles and needs became a party

to both OPRC Convention and OPRC-HNS Protocol in 2003. Following this action, Turkey put the "Law Pertaining to Principles of Emergency Response and Compensation for Damages in Pollution of Marine Environment by Oil and Other Harmful Substances" (OSRL) (Law No:5312) in force in the year 2005 [7]. One additional legal step taken by Turkey was to prepare and put in force an implementation document of the Law in 2006. This document presents comprehensive information on the setup of national preparedness and response system, designated responsibilities of national organizations and their authorized personnel who have comprehensive information on national preparedness and response system, responsibilities of the organizational bodies and their authorized [4].

In parallel to efforts for developing OPRC-HNS capabilities, Turkey also made a series of legislative arrangements for setting up required assets. Emergency Response Centres Project was one of the significant move towards this goal. Within this aspect in 2006 Turkey started a project for establishing a system for OPRC-HNS capacity building. The project involves setting up a National Marine Safety and Emergency Response Centre (in Marmara Ereğlisi), Regional Emergency Response Centre (in Antalya) and 19 Local Emergency Response Stations (equipment storage areas) to be used in times of accidents. The project has been managed under Ministry of Transport and Infrastructure (TMTI). Ultimate goal of the whole system is to make sure that Turkish system can timely and efficiently intervene pollution caused by oil and other noxious-harmful substances in Turkish emergency response liability areas. [8] Figure-1 ıllustrates planned locations of emergency response centres and stations in Turkish emergency response liability areas.

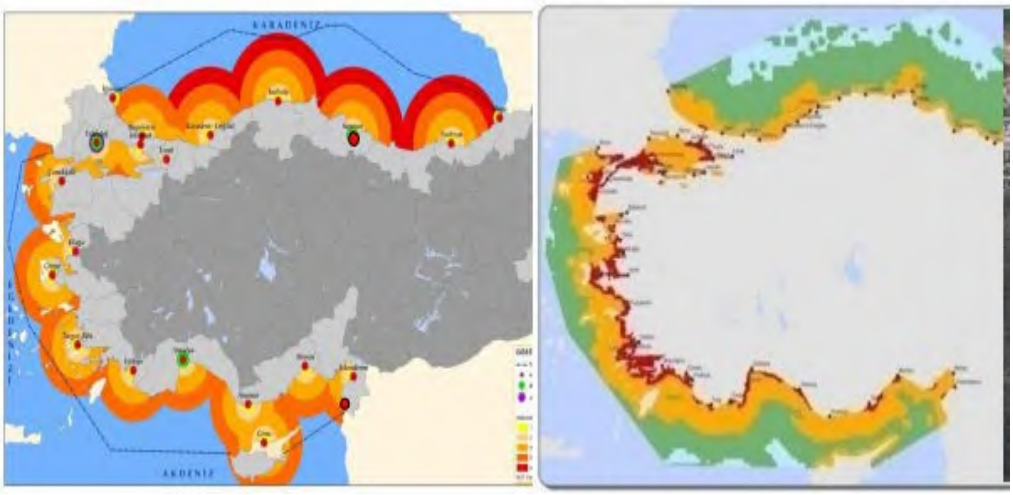

Figure 1: Turkish Emergency Response Liability Areas And Locations Of Emergency Response Centres And Stations [8].

After becoming party to an international convention and making necessary parallel legal arrangement in national level, the next step is to establish required self-sufficient infrastructure and set a well-defined management organization with sufficient trained human source and assets. The management then should make sure that risk assessment is appropriately completed. This in turn will call for scenario-based simulations and hands-on training as well as updating the overall system as the conditions change. When we add HNS into the equation, intervention and response efforts together with fighting the whole pollution problem becomes more complicated. [4]

On national scale, all of the above-mentioned aspects such as, pollution preparedness and response mechanisms and capabilities, competent authorities, required assets and inventory are regulated by the procedures in the Turkish Law no 5312 [7].

3. Conclusion

As in the world, Turkey has been affected by environmental disasters and economic losses caused by major oil pollution. After major accidents, Europe and America has immediately

initiated challenge with oil pollution while legal infrastructure works in Turkey were started in 2005 with the Law No. 5312 [7].

Uncertainty about pollution is not only the possibility of major oil pollution, it is also the existence of existing strategies to minimize the impact of this pollution.

Having well-established and running organisation with appropriate assets and always being ready for different pollution scenarios is surely the best possible way in pollution prevention area. This means it is possible to fight oil spillage or other HNS pollution by establishing and running emergency response centers which are optimally located, adequately equipped and manned and can be deployed quickly anywhere in the area of responsibility.

From this perspective, we can come to an encouraging conclusion that Turkey has made best of its efforts to make sure legislative arrangements are in place and necessary steps are being taken. However there still seems to be shortages to fully achieve the goal. In spite of the fact that Emergency Response Stations are being established is promising, assets for response and sufficient trained crew to handle possible pollutions are yet to be fulfilled. To add, a comprehensive inventory of readily deployable assets needs to be done as it was done in the EU. Turkey like many other states, seems to have a long way to go when it comes to HNS related pollution and response.

As long as the liability and compensation aspects are concerned, there also seems to be some critics on the Act 5312. Demir finds the Act inconsistent with the International Law. He discusses that focus and core of the act is wrongly placed and the act deals more with preparedness and response than civil liability. His recommendations include separating the compensation issues from the act and revising the focus only to deal with urgent intervention only. [9]

As far as the future infrastructure for emergency response system is concerned, a well-organized decision support system integrated with real time meteorological and oceanographic data seems to be inevitable. The system also should facilitate an information network established amongst all responsible stakeholder institutions as in

western example. The network should be integrated into emergency response system and Common Emergency Communication and Information System (CECIS).

Turkey's Act 5312 (OSRL), which is the most comprehensive legal legislation in the challenge against both oil and HNS pollution, has determined the authority and responsibilities of all institutions within the organization [7]. Within the scope of the Act 5312, the Ministry of Environment and Urbanism is responsible for the pollution sourced by coastal facilities while the Ministry of Maritime Affairs and Infrastructure is for the pollution sourced by ships. In the prevention and response organization to be implemented within the scope of the current legislation, there is a multi-headed structure and the more the size of pollution increases, the participants of the Coordination Committee are changing and increasing. This legislation should be developed so as to eliminate multi-faceted, speed up the decision-making mechanism and achieve a simple and functional structure for implementation.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Analysis of Marine Traffic Density Using AIS Data: An Application in the Iskenderun Bay

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ABSTRACT

Marine traffic density is increasing day by day with the increase in the number of vessels. The analysis of the marine traffic density become crucial in terms of safety of human, environment and ship. There are various methods for conducting marine traffic analysis in the literature. Automatic Identification System (AIS) data is very important for analyzing the instant marine traffic with instant transmission of the data and marine traffic analysis with the historical AIS data of the vessels. In this study, marine traffic analysis in Iskenderun Bay was analyzed by using AIS data. The aims of marine traffic analysis are to map the vessel movements and to determine distribution of the ship's according to the types, frequency, draught, SOG and COG in the study area.

Iskenderun Bay 2016 marine traffic AIS data was taken for the study from the BOTAŞ Petroleum Pipeline Corporation. It is determined that the some of the data 2016 are inadequate for analysis. For this purposes, the AIS data sets were first made available for analysis. After that in order to make analyzes, algorithms were developed and marine traffic analyzes were made. During the analyzes, the marine traffic density in the İskenderun bay was mapped. Then, cross sectional lines were taken and the distribution of ships in 50 meter slots was revealed. As a result, ship distributions in the separation lines, high density areas in the İskenderun Bay and the ships that affect tanker vessels were revealed.

Keywords: Automatic Identification System, Marine Traffic, İskenderun Bay

III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
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Deniz Trafik Yoğunluğunun OTS Verileri Kullanılarak Analizi: İskenderun Körfezi'nde Bir Uygulama

ÖZET

Gemi sayısının artmasıyla birlikte deniz trafiği de günden güne artmaktadır. İnsan, çevre ve gemi emniyeti için bu trafiğin analiz edilmesi hayati öneme sahip olmaktadır. Literatürde, deniz trafik analiziyle ilgili birçok yöntem bulunmaktadır. OTS (Otomatik Tanımlama Sistemi) verileri de bu yöntemlerde çok kullanılan önemli verilerden biridir. Anlık alınan OTS verileri ile anlık deniz trafiği analiz edilebildiği gibi geçmiş OTS verileri kullanılarak geçmişe yönelik deniz trafik analizleri de gerçekleştirilmektedir. Bu çalışmada OTS verileri kullanılarak İskenderun Körfezi'ndeki deniz trafiği analiz edilmiştir. Yapılan analizlerin amacı, körfezdeki gemi hareketlerini haritalandırmak ve gemilerin tip, frekans, draft, SOG (Speed over Ground) ve COG (Course over Ground)'a göre dağılımlarını ortaya çıkarmaktır.

Çalışmanın gerçekleştirilebilmesi için İskenderun Körfezi 2016-2017 yılına ait OTS verileri BOTAŞ Boru Hatları ile Petrol Taşıma Anonim Şirketi'nden alınmıştır. Veriler üzerinde yapılan incelemeler sonucunda bazı verilerin analizde kullanıma uygun olmadığı tespit edilmiştir. Bu nedenle öncelikle OTS veri setleri analize hazır hale getirilmiştir. Daha sonra analizler gerçekleştirilmiştir. Yapılan analizlerde, İskenderun Körfezi'ndeki deniz trafik yoğunluğu haritalandırılmış, daha sonra da kesitsel hatlar üzerindeki 50'şer metre aralıklardaki gemi dağılımları ortaya çıkarılmıştır. Sonuç olarak da körfezde bulunan trafik ayrım düzenindeki gemi dağılımları, İskenderun Körfezi'ndeki gemi trafiğinin yoğun olduğu bölgeler ve tanker gemilerinin manevralarını etkileyecek gemiler açığa çıkarılmıştır.

Anahtar Kelimeler: Otomatik Tanımlama Sistemi, Deniz Trafiği, İskenderun Körfezi

1. Giriş

Otomatik Tanımlama Sistemi (OTS) sayesinde gemilerin anlık olarak hareketleri takip edilip, analiz edilebildiği gibi geçmiş veriler kullanılarak deniz trafik analizlerinin yapılması da mümkün olmaktadır. OTS verileri ile gemilerin çatışma ve karaya oturma olasılıklarının hesaplanması, deniz trafik yoğunluğunun haritalandırılması gibi hesaplamalar yapılabilmektedir. [1][2][3][4][5][6][7][8][9].

Deniz trafik analizleri sayesinde gemi hareketleri takip edilebilmekte ve gerekli önlemler alınabilmektedir. Bu analizler için kullanılan OTS verileri, kullandıkları VHF (Very High Frequency) menzili nedeniyle belirli kısıtlamalara sahiptir. OTS aygıtının kullandığı VHF radyo frekansının yayıldığı mesafe dünyanın şeklinde, bölgedeki adaların varlığına, dağların durumuna ve radyo dalgasının yayılımına göre farklılık gösterebilmektedir [10][11]. OTS aygıtları tarafından gönderilen veriler gemiden gemiye olabildiği gibi gemiden sahil istasyonuna ve sahil istasyonundan gemiye de olabilmektedir. Bu veri alışverişi ile deniz trafiğinin izlenmesi ve kontrol edilmesiyle denizdeki emniyet de artmaktadır [12].

OTS aygıtının gemilerde bulunması günden güne artmış ve günümüzde, balıkçı gemileri de dahil olmak üzere birçok gemide bulunur hale gelmiştir. Gemilerde kullanılan temelde 2 tip OTS aygıtı bulunmaktadır. Bunlar Klas A ve Klas B şeklindedir [11]. Klas A OTS aygıtı, uluslararası seyir yapan 300 GRT üzeri ve boyutuna bakılmaksızın yolcu gemilerinde bulunurken, Klas B OTS aygıtı ise daha çok balıkçı gemileri, özel gezinti tekneleri gibi küçük teknelerde bulunmaktadır [13][14]. Her iki tür aygıtın da statik, dinamik ve seyirle ilgili bilgileri düzgün bir şekilde göndermesi gerekmektedir [15]. OTS aygıtı ile gönderilen statik bilgiler IMO numarası, çağrı işareti, gemi adı, boyu ve eni, gemi tipi MMSI numarası gibi bilgilerken, dinamik bilgiler ise geminin pozisyonu, zaman bilgisi, COG, SOG, pruva değeri gibi bilgilerdir. Seyirle ilgili bilgiler geminin draftı, tehlikeli yük tipi, varış limanı ve tahmini varış zamanı gibi bilgilerken seyirle ilgili bilgiler ise emniyetle ilgili gelen mesajlar gibi bilgilerdir.

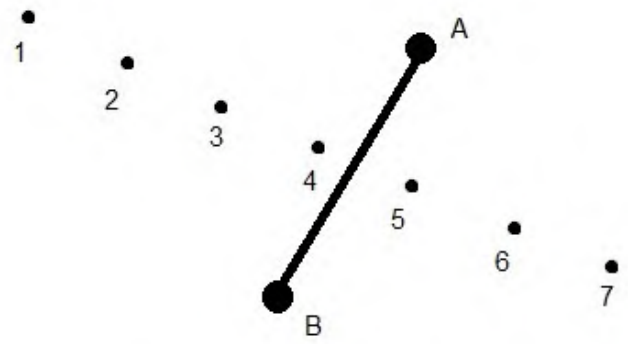
Statik, dinamik ve seyirle ilgili bilgilerin gönderim aralıkları, geminin üzerine yol olup olmasına, geminin demirde ya da limanda bağlı durumda olmasına, geminin süratine, rota değiştirip değiştirmediğine göre değişmektedir. Örneğin statik bilgiler ya da seyirle ilgili bilgiler 6 dakikalık aralıklarla ya da veri güncellemesi olduğunda gönderilirken dinamik bilgilerin gönderim aralıkları geminin süratine ve rota değiştirip değiştirmemesine göre değişiklik göstermektedir. Örneğin Klas A OTS aygıtı bulunan gemi, demirde ya da limanda bağlı olup sürati 3 kts altında iken veri gönderme aralığı 3 dakika iken üzerine 14-23 kts arası sürat olup rota değiştiriyorken veri gönderim aralığı 2 saniye kadar düşmektedir [15].

OTS aygıtı ile gönderilen veriler sensörlerden elde edilerek otomatik olarak gönderildiği gibi kullanıcılar tarafından girilen veriler de otomatik olarak gönderilmektedir. Aygıt tarafından gönderilen bazı verilerde hatalı ya da farklı veriler de bulunabilmektedir. Örneğin Harati-Mokhtar vd. (2007) tarafından yapılan çalışmada gemiler tarafından Gemi Trafik Hizmetlerine raporlanan veriler ile OTS aygıtından alınan veriler arasında özellikle gemi boyu, draftı gibi bilgilerde ciddi farklılıkların olduğu görülmüştür [16].

OTS aygıtı tarafından gönderilen veriler araştırmacılar için oldukça değerlidir çünkü gemilerin geçmiş pozisyon verileri elde edilebilmektedir [17]. Elde edilen geçmiş pozisyon verileri kullanılarak geriye dönük gemi hareketleri ile deniz trafiği hakkında bilgi sahibi olunabilmektedir [18]. Literatürde OTS verileri kullanılarak yapılan deniz trafik analizleriyle ilgili birçok çalışma bulunmaktadır. Bu çalışmaların bazıların bölgesel deniz trafiği haritalandırılmış ve analiz edilmişken [6][13][14][8] bazı çalışmalarda çatışma ve karaya oturma kazalarının olasılıkları analiz edilmiştir [4][1][2][3]. OTS verileri kullanılarak kanal genişliği ile gemi hareketlerinin incelendiği çalışmalar da bulunmaktadır. Örneğin Hollanda'daki dar bir kanal ile Çin'de bulunan geniş bir kanaldaki gemi hareketleri Xiao vd. (2015) [19] tarafından incelenmiştir. Kanalda bazı noktalardan kesitler alınmış ve kanaldaki gemi dağılımları sürat, gemi tipi gibi birtakım değişkenlere göre incelenmiştir.

2. Metodoloji

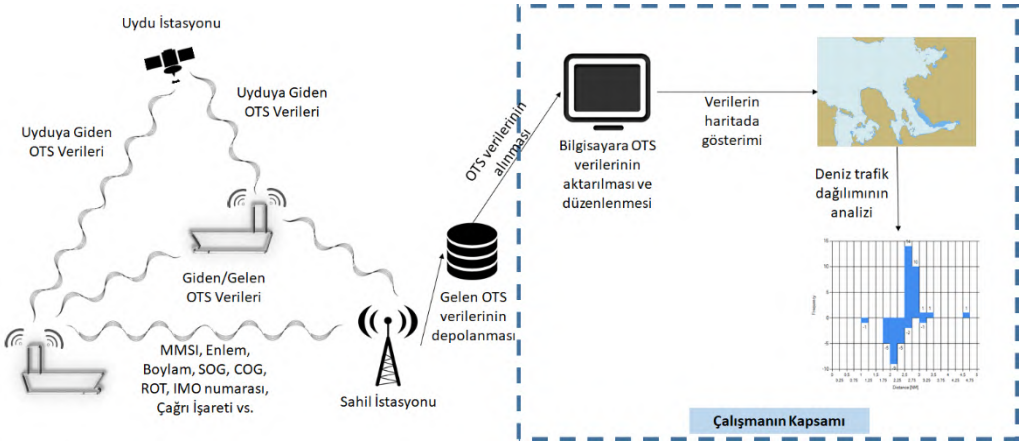
Gemilerin hareketleri Şekil 1'deki gibidir. 1'den 7'ye numaralandırılmış noktalar herhangi bir geminin harita üzerinde yapabileceği hareketleri göstermektedir. Bu gemilerin belirli hatlar üzerindeki hareketlerinin, dağılımlarının analiz edilebilmesi için A ve B hattı gibi kesitsel bir hat belirlenerek bu hat ile geminin kesişim noktasının hesaplanması gerekmektedir. Hangi hatlardan kesitler alınacağına karar vermek için de deniz trafiğinin haritalandırılmasına ihtiyaç duyulmaktadır.



Şekil 1: OTS Verilerinin ve Kesitsel Hattın Gösterimi

Bu çalışmada gemilerin belirli hatlar üzerindeki dağılımlarının analiz edilebilmesi ve gemi hareketlerinin gemi tipine göre haritalandırılması için Kundakçı ve Nas (2018) [9] tarafından geliştirilen masaüstü uygulaması kullanılmıştır.

2016-2017 yılına ait 1 yıllık OTS verilerinin kullanıldığı çalışmanın modeli Şekil 2'deki gibidir.



Şekil 2: Çalışmanın Modeli

Çalışmada öncelikle 1 yıllık OTS verileri analize hazır hale getirilmiştir. Veriler içerisinde bulunan eksik, hatalı veriler çıkarılarak analizde kullanılacak veri seti oluşturulmuştur. Daha sonra masaüstü uygulaması kullanılarak gemi tipine göre gemi hareketleri haritalandırılmıştır. Ardından bölgede bulunan LNG ve Tanker terminallerine yaklaşım kanalındaki gemi dağılımları incelenmiştir.

Gemi hareketlerinin haritalandırılmasına kullanılan harita Şekil 3'teki gibidir. Harita, 36,5° N – 36,93° N enlemleri ile 035,6° E – 036,3° E boylamları arasında kalan alanı kapsamaktadır.

Şekil 3: İskenderun Körfez Haritası

Haritadaki gemi hareketleri Şekil 4'teki renk kodlarına göre kodlanarak oluşturulmuştur.

Kargo Gemileri	
Tanker Gemileri	
Balıkçı Gemileri	
Bütün Tip Gemiler	

Şekil 4: Gemi Tipine Göre Renk Kodları

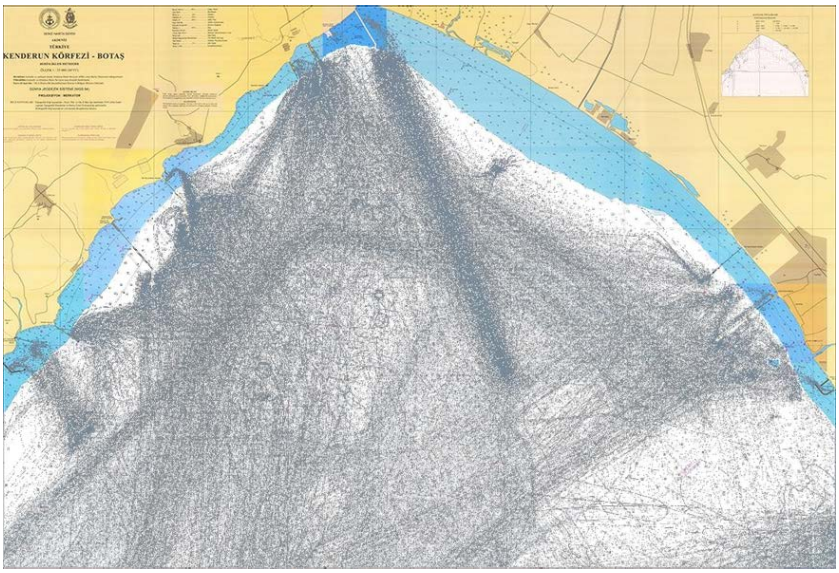
Çalışmada birtakım kısıtlamalar da bulunmaktadır. OTS verilerinin sınırları çalışma alanının sınırlarını belirlemektedir. Sahil istasyonları tarafından toplanan OTS verilerindeki eksiklikler de çalışmanın kısıtlarından biridir. Kıyı Emniyeti Genel Müdürlüğü'nden alınan OTS verileri incelendiğinde Ocak ve Şubat 2017'deki verilerin eksik/hatalı/yetersiz olduğu tespit edilmiştir.

3. Bulgular

Geliştirilen uygulama ile yapılan analizlerde 2016 ve 2017 yılına ait 11 aylık deniz trafik yoğunluğu haritalandırılmıştır. Bu yoğunluk haritaları kargo gemileri, tanker gemileri, balıkçı gemileri ve bütün tip gemiler olmak üzere hazırlanmıştır.

Şekil 5 ve 6, körfezdeki 11 aylık gemi hareketlerini göstermektedir. Şekil 5'te, İskenderun Körfezi'ndeki gemi trafiği gösterilirken Şekil 6'da ise İskenderun Körfezi Kuzey bölgesindeki gemi trafiği gösterilmektedir.

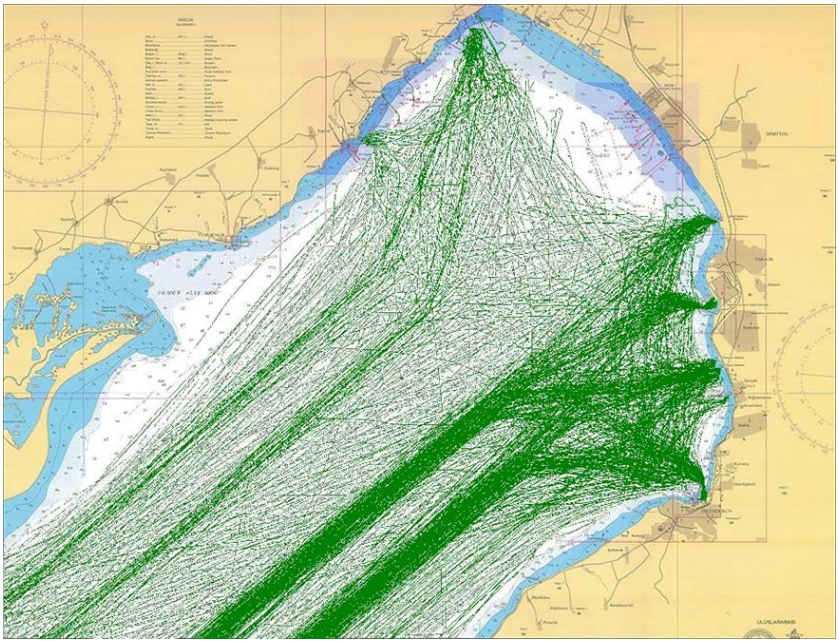
Şekil 5. İskenderun Körfezi Bütün Tip Gemilerin Deniz Trafik Yoğunluğu



Şekil 6: İskenderun Körfezi Kuzey Bölgesi Bütün Tip Gemilerin Deniz Trafik Yoğunluğu

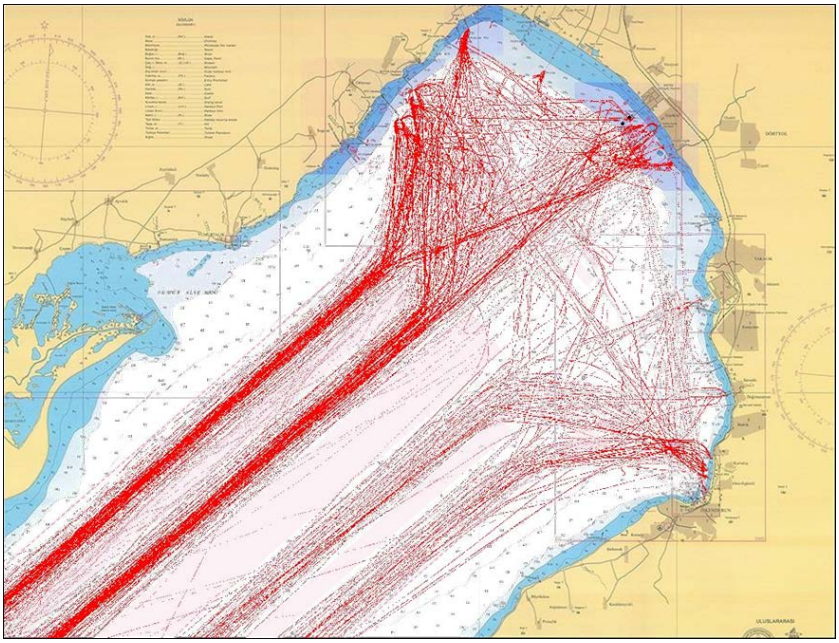
Şekil 5 ve 6 incelendiğinde, gemilerin körfezdeki birçok bölgede seyir yaptıkları görülmektedir. Şekil 6'da görülen, terminal/iskele yaklaşımlarındaki trafik yoğunluğu yanaşma/ayrılma manevrası yapan gemilerden kaynaklandığı gibi bölgede hizmet veren kılavuz kaptan botu ve römorkörlerden de kaynaklanmaktadır. Bu nedenle deniz trafik yoğunluğunun gemi tipine göre incelenmesi daha doğru sonuçlar vereceği düşünülmüştür.

Şekil 7'de körfezdeki kargo gemilerinin 11 aylık hareketleri gösterilmektedir.

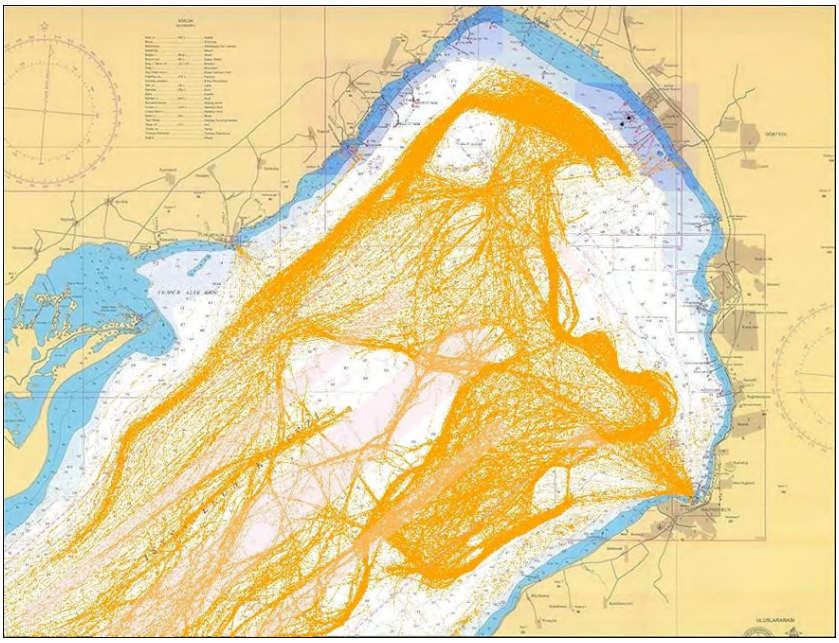


Şekil 7: İskenderun Körfezi Kargo Gemilerinin Deniz Trafik Yoğunluğu

Şekil 8'de körfezdeki tanker gemilerinin 11 aylık hareketleri, Şekil 9'da ise balıkçı gemilerinin 11 aylık hareketleri gösterilmektedir.

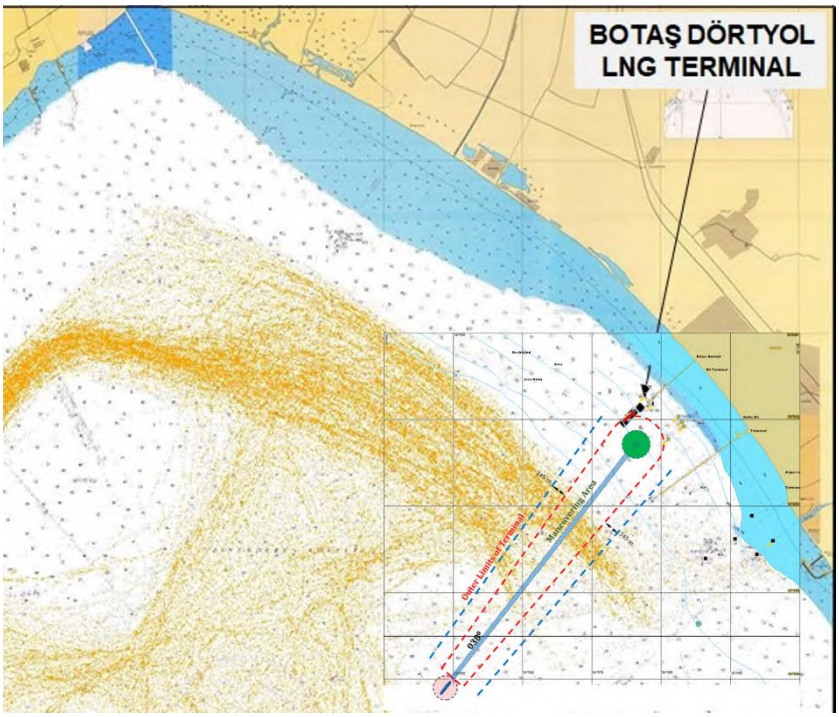


Şekil 8: İskenderun Körfezi Tanker Gemilerinin Deniz Trafik Yoğunluğu



Şekil 9: İskenderun Körfezi Balıkçı Gemilerinin Deniz Trafik Yoğunluğu

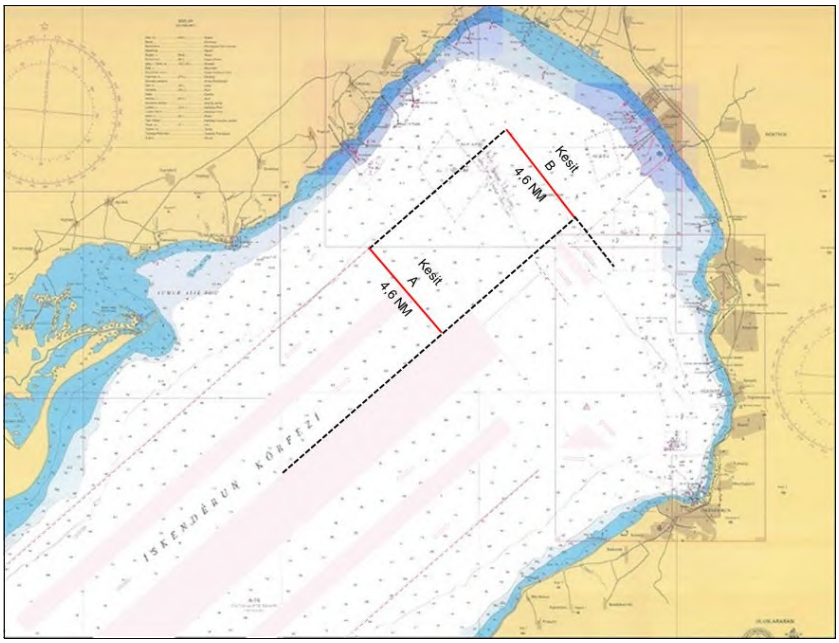
Yoğunluk haritaları incelendiğinde bölgedeki LNG ve tanker terminallerinin yaklaşım koridorlarındaki gemi trafiğini etkileyecek trafiğin balıkçı gemilerinden kaynaklandığı görülmüştür. Bu kapsamda İskenderun Körfezi Kuzey Bölgesi'nde seyir yapan balıkçı gemileri için oluşturulan Deniz Trafiği Yoğunluk Haritası Şekil 10'daki gibidir.



Şekil 10: İskenderun Körfezi Kuzey Bölgesi Balıkçı Gemilerinin Deniz Trafik Yoğunluğu ve LNG Gemileri Yaklaşım Koridoru

İskenderun Körfezi'ndeki trafik ayrım düzenindeki gemi hareketlerinin incelenebilmesi ve Şekil 10'daki LNG gemilerinin yaklaşım koridorundaki gemi hareketlerinin incelenebilmesi için trafik ayrım düzeninden ve devamındaki yaklaşım koridorundan kesitsel hatlar alınarak gemi dağılımları incelenmiştir. Şekil 11'de görüldüğü gibi ilk kesit trafik ayrım düzeninden alınmış ve bu "Kesit A" şeklinde isimlendirilmiştir. Daha sonra trafik ayrım düzeni ile aynı hatta ve ölçüde, trafik ayrım düzeninin dışında, tanker

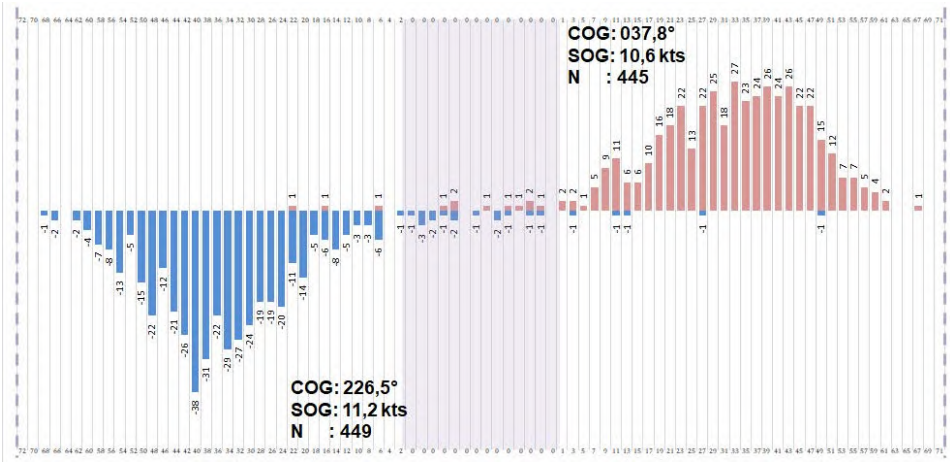
yaklaşım kanalı içerisinde yeni bir kesit alınmış ve bu da "Kesit B" şeklinde isimlendirilmiştir. Her iki kesitsel hattın uzunluğu da 4.6 NM'dir.



Şekil 11: İskenderun Körfezi Trafik Ayrım Düzeni ve Alınan A ve B Kesitsel Hatları

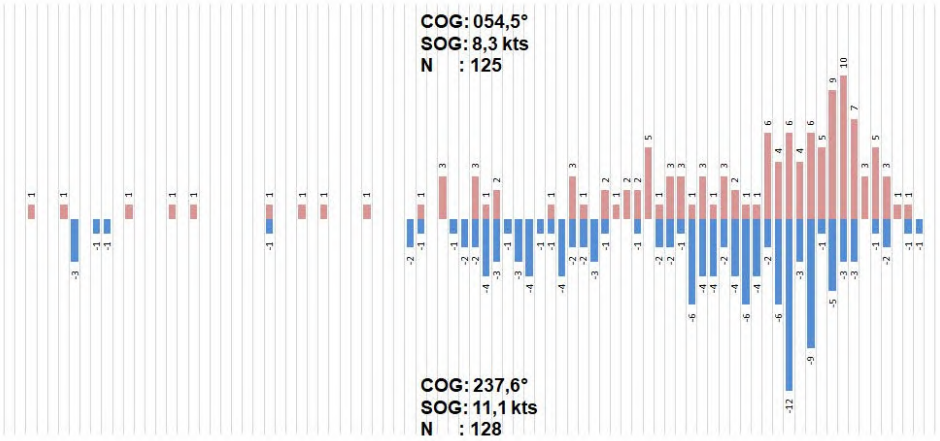
Bölgedeki tanker terminallerine seyir yapacak olan gemiler tanker gemileri olacağı için her iki kesitteki tanker gemilerinin dağılımları incelenmiştir. Ayrıca trafiği etkilediği görülen balıkçı gemilerinin gemi dağılımları da ortaya çıkarılmıştır.

Kesitsel hatlardaki tanker gemilerinin dağılımları Şekil 12 ve 13'teki gibidir. Toplamda 894 tanker gemisinin A kesitinden geçtiği görülmüştür. A kesitinde görülen ve bölgedeki tanker terminallerine doğru ilerleyen gemilerin ortalama COG değerlerinin 038^0 olduğu, ortalama SOG değerlerinin de 10,6 kts olduğu görülmüştür.



Şekil 12: A Kesitindeki Tanker Gemilerinin Dağılımı

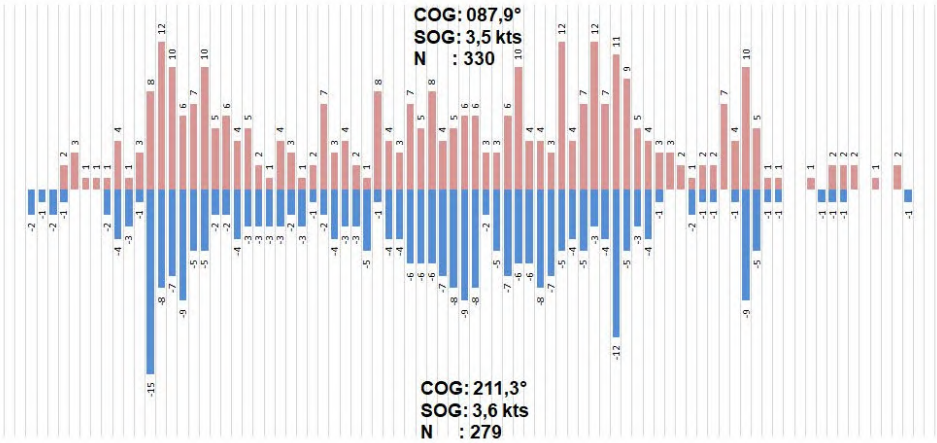
B kesiti ise bölgedeki tanker terminallerine ilerleyen gemilerin dağılımlarını göstermektedir. Toplamda 253 tanker gemisinin B kesitinden geçtiği görülmüştür. Bu gemilerin ortalama COG değerinin 055^0 ve ortalama SOG değerinin 8,3 kts olduğu görülmüştür.



Şekil 13: B Kesitindeki Tanker Gemilerinin Dağılımı

B kesitindeki değerlere bakıldığında, gemilerin yaklaşım sırasında hızlarının 10,6'dan 8,3'e düştüğü ve yaklaşım rotalarının da 17 derece değişerek 055^0'e geldiği görülmüştür.

Çalışmada ayrıca tanker terminallerinin yaklaşım kanalındaki balıkçı gemilerinin dağılımları da incelenmiştir. Şekil 14'e göre, toplamda 609 balıkçı gemisinin B kesitinden geçtiği görülmüştür. Balıkçı gemilerinin hat üzerindeki dağılımlarına bakıldığında, tanker gemilerinin terminallere yaklaşım kanalında, göze çarpan boyutta balıkçı gemi trafiği olduğu görülmüştür.



Şekil 14: B Kesitindeki Balıkçı Gemilerinin Dağılımı

Balıkçı gemilerinin rotalarına bakıldığında ise daha çok doğu yönlü ortalama 3.5 kts ile hareket ettikleri görülmektedir. Bu durum, balıkçı gemilerinin yaklaşım kanalına çapariz verecek şekilde geçiş yaptıklarını göstermektedir.

4. Sonuç

Bölgedeki kargo gemilerinin hareketlerine bakıldığında bölgedeki tanker trafiğini tehlikeye atmayacak şekilde seyir yaptıkları görülmektedir.

Tanker terminallerinin yoğun olduğu bölgelerde, tanker gemilerinin benzer rotalarda seyir yaparak yaklaşım gösterdiği görülmektedir.

Ancak, LNG gemilerinin yaklaşım koridoru için geliştirilen geometrik düzeni tehdit eden deniz trafiğinin balıkçı gemilerinden kaynaklandığı tespit edilmiştir. Bu tehdit,

yaklaşmakta olan LNG gemilerinin manevra düzenlerini etkileyerek yanaşma manevrasını tehdit edebilecek düzeydedir. Bu nedenle bu tip LNG gemisi manevralarında kolluk kuvveti olarak Sahil Güvenlik botlarının gemi etrafında tehdit unsurlarını bertaraf ederek görev yapması konusu ilgili birimlere bildirilmiştir.

5. Teşekkür

Çalışmada kullanılan OTS verileri, Kıyı Emniyeti Genel Müdürlüğü tarafından toplanan veriler olup, çalışma kapsamında BOTAŞ Boru Hatları ile Petrol Taşıma Anonim Şirketi tarafından sağlanmıştır. Bu nedenle çalışmaya katkısından dolayı BOTAŞ Boru Hatları ile Petrol Taşıma Anonim Şirketi'ne ve bu kurumun seçkin görevlilerine teşekkür ederiz.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Shipmaster Evaluation System for the Safety of Navigation and Fleet Management

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ABSTRACT

Today's maritime transportation expects a high level of success from Seafarers, especially the captains of the ship. However, accident analysis has shown that sometimes basic information or correct attitudes/behaviors are not developed or applied at the right time. The maritime education, which has become standardized all over the world, ensures that the individual obtains the proficiency, but does not provide competence. The concept of competence is now being questioned for captains and captain candidates. It is an indisputable element for the captains who have the highest level of knowledge and attitudes and behaviors expected of him, especially for himself, his ship, his fleet and his company in emergencies. With regards to this knowledge, the main purpose of this study is to determine and analyze the differences between the expectations of managers and the actual experience, knowledge, and skills of fleet captains. To this end, in the simulator environment, potentially dangerous scenarios that may be experienced in only the course of navigation were developed. These risky and dangerous simulation scenarios have been developed based on real-life events and accidents occurring in the fleet of ship management companies. With this method, successful captains identified acceptable risk solutions for high-risk scenarios and developed the competence, knowledge, and skills necessary for similar extreme situations. Emergency Response, Communication, and Leadership Skills, Psychometrics, Competence and Decision Making are some of the data collected through simulation experiments. These data are data that can be used as a

proactive management tool to reduce future risks of fleet ships. In practice, emotions of captains, high stress, loss of situational awareness, or emotions in real life such as anger have been seen and evaluated in simulation.

Keywords: Shipmaster, Evaluation, Simulator, Fleet Management, Maritime Transportation

Seyir Emniyeti ve Filo Yönetimi için Kaptan Değerlendirme Sistemi

ÖZET

Günümüz deniz taşımacılığında gemi kaptanları başta olmak üzere, denizcilerden yüksek başarı beklenmektedir. Ancak, kaza analizleri temel bilgilerin veya doğru tutumların/davranışların doğru zamanda geliştirilmediğini veya uygulanmadığını göstermektedir. Tüm dünyada standart hale gelen denizcilik eğitimi, bireyin yeterliliği elde etmesini sağlamakta ancak yeterlilik sağlamamaktadır. Yetkinlik kavramı artık kaptanlar ve kaptan adayları için sorgulanır hale gelmiştir. Özellikle kendisi, gemisi, filosu ve acil durumlarda şirketi için doğru bilgiye, tutum ve davranışlara sahip olmak kaptanlar için tartışılmaz bir özelliktir. Bu doğrultuda çalışmanın temel amacı, yöneticilerin beklentileri ile filo kaptanlarının gerçek deneyim, bilgi ve becerileri arasındaki farkları belirlemek ve analiz etmektir. Bu amaçla, simülatör ortamında, sadece seyir sırasında yaşanabilecek potansiyel tehlikeli senaryolar geliştirilmiştir. Bu riskli ve tehlikeli simülasyon senaryoları, gemi yönetim şirketlerinin filosunda meydana gelen gerçek olaylara ve kazalara dayanarak geliştirilmiştir. Bu yöntemle başarılı kaptanlar yüksek riskli senaryolar için kabul edilebilir risk çözümleri belirlemekte ve benzer durumlar için gerekli olan yetkinliği, bilgiyi ve becerileri göstermektedirler. Acil durumlar, iletişim ve liderlik becerileri, psikometri, yetkinlik ve karar verme simülasyon deneyleriyle toplanan verilerden bazılarıdır. Bu veriler filo gemilerinin gelecekteki risklerini azaltmak için proaktif bir yönetim aracı olarak kullanılabilecek verilerdir. Simülasyon uygulamalarında kaptanların yüksek stres, durumsal farkındalık kaybı veya öfke gibi gerçek hayattaki duygular yaşadıkları görülmüş ve değerlendirilmiştir.

Anahtar Kelimeler: Kaptan, Değerlendirme, Simulatör, Filo Yönetimi, Deniz Ulaştırması

1. Giriş

Çalışan olarak insan, şirketler için en önemli varlık olarak görülmüştür ve kuruluşların insan kaynakları uygulamalarının örgütsel performans üzerinde önemli bir etkisi olduğu bilinmektedir. İnsan kaynakları yönetimi süreci planlama ve seçme ile başlar ve oryantasyon, eğitim, performans değerlendirme, kariyer gelişimi, ücretlendirme ve fayda sağlama süreçleri ile devam eder. İşe uygun adayın seçilmesi kadar önemli olan bir diğer süreç çalışanın performansının değerlendirilmesi sürecidir. Bazı işletmeler bu süreçler için formlar, yazılı sınavlar, tutum testleri, yüzyüze görüşmeler, özgeçmiş araştırması, fiziksel yeterlilik testleri veya şirket içi eğitimler, oryantasyon (uyum) eğitimleri gibi teknikleri kullanmaktadır. Ancak deniz ulaştırma sektörü gibi bir alanda faaliyet göstermekte olan işletmelerde özellikle Kaptan olarak görevlendirilecek bireylerin yeterlilik ve yetkinliklerinin tespitinde bu yöntemlerin yetersiz kaldığı ortaya çıkmıştır.

Son yıllarda milyon dolarlık gemilerin, yükü ve/veya yolcusu ile birlikte emanet edildiği Kaptan'ın yetkinliğine karar vermek için önce başka bir firma altında Kaptan'lık yapması gibi örnekler de görülmüştür. Bu durum özellikle Kaptan'dan beklenen meziyetlerin ne derece önemli olduğunu göstermekle birlikte yeterli değildir. Bir diğer yaklaşım yalnızca belirli okullardan mezunların Kaptan olarak görevlendirilmesi veya yeterlilik sınavlarında alınan puanların baz alınması yaklaşımıdır. Doğruyu bulmak adına gösterilen çabalar malesef işi daha içinden çıkılamaz bir boyuta, yanlışlara sürüklemekte ve sonuçları insan hatası kodlaması ile kaza raporlarına yansımaktadır.

Avrupa Deniz Emniyeti Ajansı (EMSA) 2018 raporunda [1], gerçekleşen ve araştırılan 1645 kazanın 57.8%'inin insan hatası nedeniyle ve toplamda 70.1%'inin de gemi operasyonları kaynaklı olduğu belirtilmektedir. Aynı raporda gemi operasyonları kazalarında kök nedenlerin bilgi eksikliği ve görevlerin koordinasyonunda eksiklik,

yetersiz iş emniyeti yöntemleri sıralanmaktadır. Bilindiği gibi günümüzde, standart hale gelen denizcilik eğitimi, bireyin yeterliliği elde etmesini sağlamakta ancak yetkinlik kazandırmamaktadır. Yetkinlik "belirli bir konuda rol model olacak şekilde belirlenmiş beceri, bilgi veya yetenek" olarak tanımlanabilir" [2].

Bireyin iyi eğitim alması, deniz tecrübesine ve ehliyete sahip olması işin gerektirdiği tüm yetkinliklere sahip olduğunu göstermekte midir? Yetkin olsa dahi seviyesi ve/veya eksik olduğu yönler var mıdır? Beklenmeyen olaylar karşısında nasıl tepki vermektedir? Şirket prosedürlerine ve/veya emniyet prosedürleri hakkında ne kadar bilgiye sahiptir? Bildiklerini Köprüüstü takımına ne kadar aktarabilmekte ve/veya takımını yönetebilmektedir? Tüm bu sorular gemi işletmecileri açısından belki de en çok merak edilen hususlardandır.

2. Değerlendirme Sürecinin Geliştirilmesi

Kaza istatistikleri doğru zamanda doğru / temel / standart tutum / davranışların ortaya konmadığını göstermektedir [2]. Bu tutum ve davranışların nasıl geliştirilebileceği başka bir çalışmanın konusunu oluşturmakla birlikte bazen zaman, ticari baskı, stress nedenleriyle doğru tutum / davranışlar uygulanamamakta veya gösterilememektedir. Bu durum temelde Kaptan'ın olaylar karşısındaki tepkilerini belirleyen özelliklerine ve çevresini doğru algılamasına dayanmaktadır. Bu özellikler birey için tutum, davranış, bilgi, yetenek ve beceri gibi kavramlarla açıklanabilmektedir. Çevreyi doğru algılama ise literatürde durumsal farkındalık (DF) kavramı ile açıklanmaktadır.

DF, karar verme aktivitelerini yürütmek için gerekli bir zihin durumudur. Bu durum, çevresel elemanları algılamak, bu elemanların ne anlama geldiğini kavramak ve bu elemanların statülerini yakın geleceğe yansıtma işidir [3]. Durumsal Farkındalık, görevle ilgili olarak takımda neler olduğu hakkında kritik bilgileri tanımlama, işleme ve anlama yeteneğidir. Daha basit ifadesiyle, çevrenizde neler olup bittiğini bilmektir [4]. Temel olarak; etrafında olup bitenlerin algılanması, algıya dayalı olarak zihinsel model oluşturma aşaması yani anlamanın gerçekleşmesi, gerçekleşen zihinsel modelin

güncellenmesi ile gelecekteki duruma etkisinin tespiti olarak da tanımlanabilmektedir [5].

İçinde bulunduğu çevrenin tüm bileşenleri algılamış (bilgi toplamış), anlamış (zihinsel modeli oluşturmuş) ve kendisine (gemisine) olası etkilerini doğru değerlendirmiş Kaptan'ın bu noktada hata yapması beklenmez ancak analizler bunun da yeterli olmadığını göstermektedir. Durumsal farkındalığı etkileyebilecek doğrudan ve dolaylı etkenler de söz konusudur. Bu etkenler Tablo 1'de görüleceği gibi bireysel veya çevresel kaynaklı da olabilmektedir.

Table 1: Durumsal Farkındalığı Etkileyen Faktörler

	İçsel (Bireysel)	Dışsal (Çevresel)
Doğrudan	Algı	Stres ve İşyükü
	Kavrama	Arayüz Tasarımı
	İzdüşüm	Otomasyon
	Algılanan Hedefler	Sistem Kapasitesi
Dolaylı	Doğuştan Yetenekler	İlkeler
	Deneyim	Kurallar
	Asıl Hedefler	Prosedürler

Source: Arslantürk, S., (2015), Bilgi Üniversitesi, https://prezi.com/ eagu2uqf4z0r /durumsalfarkndalk/, (30.03.2016).

Temel olarak durumsal farkındalık bileşenleri Coğrafi (Örn. Bulunulan yer), Konumsal Geçici (Örn. Bulunulan konuma bağlı özellikler), Sistem (Örn. İçinde bulunulan koşullar ve K/Ü donanımları yetkinliği), Çevresel (Örn. Rüzgâr, Dalga, Akıntı, Trafik, VTS, vb) ve

Taktiksel (Öncelik belirleme ve karar verme) olarak tanımlanmaktadır [6]. Karar verme; karar vericinin içinde bulundugu dıs çevreden, örgüt içi çevresine, iç dünyasına kadar birçok faktöre bağlıdır. Ayrıca, karar vericinin kararı verdiği ana kadar geçen süre ve bu süre içerisinde tüm çevre faktörlerinin varlıgı ve değişimi başlı başına bir süreci ifade etmektedir [7].

Yukarıdaki bilgilerden yola çıkarak Kaptan değerlendirmesinde iki temel unsurun öne çıktığı görülecektir. Bunlardan birincisi tutum, davranış, beceri, iletişim gibi özellikleri barındıran ve Teknik Olmayan Beceriler (Non-Technical Skills) olarak tanımlanacak becerileri oluşturmaktadır. İkincisi ise sahip olduğu mesleki bilgi ve tecrübesini, yetkinliklerini karşılaştığı olaylarda gösterebilmesini sağlayan ve Teknik Beceriler (Technical Skills) olarak tanımlanacak becerileri oluşturmaktadır. Her iki unsurun da değerlendirme sürecinde ele alınması ve gözlemlenebilmesi ise aslında insan kaynakları yönetimi açısından yeni olmayan bilgisayar destekli dinamik bir değerlendirme sistemi ile mümkündür. Denizcilik eğitimi için farklı bir önemi bulunan köprüüstü simülasyon yazılımları değerlendirme sürecine bu noktada dahil olmaktadır. Simülasyon yazılımları ise doğru kurgulanmış senaryolar ile birlikte yukarıdaki becerilerin ölçülebilmesine izin verecek değerlendirme ölçütleri beraber kullanıldığında sonuç vermeye başlamaktadır.

a. Değerlendirme Ölçütlerinin Belirlenmesi

Gerçekleşen kazaların incelemelerinde farklı yöntemler kullanılarak gerçek nedenler / kök sebepler tanımlanabilmektedir. Bu tanımlama aynı olayın tekrar etmemesi, olası tekrarı halinde yapılacakların belirlenmesi, öncesi ve sonrasında etkin yönetimin uygulanabilmesi, eğitim süreçlerinde kullanılması açılarından da önem taşımaktadır. Dahası, bunlar belirlendikten sonra tekrar etmemesi için "iyi rol model" tutum/davranışları belirlenebilmektedir.

Kaptan değerlendirme sisteminin doğru sonuç verebilmesi iki önemli unsura dayanmaktadır. Birincisi, tanımlanacak ölçütlerin belirlenmesi ikincisi ise belirlenen ölçütlerin ölçümünün nasıl uygulanacağı ile ilgili senaryoların geliştirilmesi sürecidir. Ölçüt belirleme sürecinde kazaların detaylı olarak analizi öncelikli kaynak olmuştur.

Yaşanmış kazalar, yakın kaza (near miss) durumları, acil durumlar ve sonrasında yaşananlar, iletişim sorunları, konumsal özellikler, trafik koşulları, mesleki bilgi ve tecrübe eksikliklerinden doğan sorunlar, takım yönetimi kaynaklı sorunlar belirlenerek listelenmiş, rol model olabilecek davranışlar her bir olay için ayrı ayrı tanımlanmıştır.

Tanımlanan tutum/davranışlar daha sonra deniz kökenli araştırmacılar ve Kaptan değerlendirmesi talebinde bulunan firma yöneticileri tarafından yeni bir sınıflandırmaya tabi tutularak gruplar oluşturulmuştur. Elde edilen gruplar yine konunun uzmanları tarafından yukarıda da açıklanmış olan teknik ve teknik olmayan beceriler olarak ayrıştırılmıştır. Sürecin sonucunda ölçütler tespit edilmiştir. Ölçütlerin ortaya çıkmasının ardından özellikle teknik olmayan beceriler olarak belirlenenlerin köprüüstü takım yönetimi ve köprüüstü kaynaklarının etkin yönetimi olarak tanımlanan BRM eğitimlerinin içeriği ve değerlendirme ölçütleriyle büyük oranda örtüştüğü görülmüştür. Bilineceği üzere BRM eğitimlerinin ortaya çıkışı havacılık sektöründe olmuş ve CRM olarak uygulanmakta iken denizciliğe adapte edilmiştir. Bu doğrultuda elde edilen teknik ve teknik olmayan beceriler değerlendirmesinin geliştirilmesi için THY Havacılık Akademisi uzman eğitmen pilotları ile birlikte karşılaştırma (Benchmarking) çalışmaları yapılmıştır. Benchmarking çalışmaları sonucunda değerlendirme formu son haline getirilerek uygulamaya hazır hale gelinmiştir. Ayrıca karşılaştırma çalışmalarında değerlendirmenin uygulama aşamasına ilişkin olarak da son derece faydalı bilgi alışverişi gerçekleşmiştir.

Değerlendirme ölçütlerinin belirlenmesinin ardından ikinci aşama değerleme standartlarının belirlenmesidir. Burada kastedilen hangi seviyede başarının beklendiğinin belirlenmesi ve bunun nasıl yapılması gerektiğinin belirlenmesine yöneliktir. Değerleme standartlarının başarılı olması Kaptan'ın kendisinden neler beklendiğinin bilinmesi (spesifiklik), gerçekleşen eylemlerin ölçümünün belirlenmesi (ölçülebilirlik) ve standartların ulaşılabilir olmasına (gerçeklik) bağlıdır [8]. Bu doğrultuda bilgi formları, değerlendirme ölçeği ve ulaşılabilir (gerçek) hedefler belirlenmiştir. Özellikle değerlendirme ölçeği oluşturulurken kabul edilemez ve rol model (1 ve 5 arası) aralığında bir ölçek kullanılması tercih edilmiştir.

Kaptan değerlendirme sürecinin sonraki aşaması ise gözlemcilerin eğitimidir. Burada da hangi olaya karşı hangi tutum/davranışlar beklendiği, uygulama süreci, kullanılan kavramlar, değerleme formlarının kullanımı, adaylar ile iletişimler gibi konular ele alınmıştır. Ayrıca değerleme hatalarının neler olduğu ve bu hususlarda yapılması gerekenler değerleme yapacak olanlara ayrıca açıklanmış ve hataların engellenebilmesi açısından yapılması gerekenler sıralanmıştır. Bir diğer önemli aşama da akademisyen değerlendiricilerin standartlara uyumunun sağlanabilmesi için Swedish Club – AllAcademy'den yetkili MRM eğitmeni unvanı elde etmesidir. Değerlemenin daha objektif olabilmesi açısından talep eden firmanın da bir değerlendirici belirlemesi ve uygulamalarda görev alması uygun bulunmuştur. Benzer bir süreç firma değerlendiricisi içinde uygulanmıştır. Bu sayede firmanın Kaptan'dan beklentileri ile diğer ölçütlerin değerlendirilmesi sırasında oluşabilecek boşluklar doldurulmuştur.

b. Senaryo Hazırlama Süreci

Yukarıda belirtildiği üzere Kaptan değerlendirme sürecinin başarılı olabilmesinin ikinci önemli aşaması uygulamada kullanılacak senaryoların belirlenmesidir. Bu doğrultuda belirlenmiş olan ölçütlerin ölçümünün yapılabileceği koşulları taşıyan senaryoların oluşturulmasına başlanmıştır. Özellikle yoğun deniz trafiğinin bulunduğu ve/veya nispeten yüksek risk taşıyan bölgeler kullanılarak senaryo kurguları geliştirilmiştir. Senaryolarda filoda yaşanan sorunlarla birlikte, eksiklikler, acil durumlar ve sonrasında yaşananlar, deniz trafiğine bağlı çevresel faktörler, olası yanlış yönlendirmeler (çeldiriciler), deniz ticaretinde gerçekleşen istenmeyen durumlar, takım yönetimi uygulamaları, liderlik, iletişim sorunları ve teknik bilgiyi gerektiren (COLREG, IALA, electronic navigational aids etc.) cihaz kullanımlarına ilişkin durumlar dikkate alınmıştır.

Hazırlanan senaryoların gerçekliğe uygunluğunun sağlanabilmesi amacıyla seçilen bölgelerde çalışmış Kaptanlar ile görüşülmüş, Kılavuz Kaptanların bilgisine başvurulmuş, ilgili bölge/bölgelere ziyaret gerçekleştirilmiş ve gemide seyir yapılmış, tüm seyir neşriyatı ve haritaları incelenmiştir. İhtiyaç duyulabilecek tüm K/Ü kaynakları (kitaplar, haritalar, rehberler, prosedürler, kontrol listeleri, vb.) hazır hale getirilmiştir.

Simülasyon senaryolarında kullanılacak gemi seçimi ise uygulamayı talep eden firmanın sahibi olduğu gemilere benzer özelliklerde olacak şekilde seçilerek kullanılmaktadır. Geminin özelliklerine bağlı olarak simülasyon senaryolarında son değişiklikler yapılarak testlere hazır hale gelinmiştir.

Değerlendirme hazırlık sürecinin son aşaması ise sürecin takibi ve senaryolar sonrası geri bildirimlerde kullanılmak üzere köprüüstü simülatörü ses ve görüntü kayıt sistemleri ile donatılmasıdır. Geri bildirim sürecinde elde edilen kayıtlar özellikle adayın kendisini/gemisini kendi gözüyle görmesi ve objektif değerlendirme açısından önem taşımaktadır.

c. Geribildirim Süreci

Simülasyon senaryoları uygulamasının ardından değerlendirme ölçütlerine bağlı gözlemcilerin bulgularının sözel olarak adaya aktarılması sürecidir. Özellikle uygulamada hedeflenen ve beklenen tutum/davranış ve beceriler aktarıldıktan sonra senaryonun tekrarı birlikte izlenmektedir. Bu aşamada adaydan beklentiler açıklanırken kendisinin de neyi neden yaptığı / yapmadığı öğrenilmektedir. Bazı uygulamalar kaza/olay ile sonuçlansa dahi olayın kendisi kadar sürecin kendisi de tartışılmakta ve tekrarı halinde ne olması / olmaması gerektiği sorgulanmaktadır. Geribildirim sırasında gerek gözlemciler gerekse de kişinin kendisini değerlendirmesi ile elde edilen bulgular paylaşılmakta ve bu sayede sıradan bir eğitim / değerlendirmenin sağlayabileceğinden daha büyük faydalar elde edilmektedir.

3. Bulgular ve Tartışma

Sistem üzerindeki düzeltmelerin ardından ilk değerlendirmeler 2016 yılında başlamıştır. 2019 yılı itibariye farklı firmalarda görev yapmakta olan 160'ın üzerinde Kaptan/Kaptan adayı değerlendirilmiştir. Gerçekleştirilen değerlendirme çalışmalarının uygulanmasının ardından elde edilen sonuçlardan bazıları aşağıda açıklanmaya çalışılmıştır.

İlk elde edilen bulgu gemi kaptanlarının, çalıştıkları şirketlerin kendi yetkinliklerine ne kadar önem verdiğini görmeleridir. Firmanın beklentilerinden önce Kaptan'a verilen

önemin ortaya konması kurumsal kültür ve kurumsal aidiyet açısından büyük önem taşımaktadır. Bireyin ait olduğu kuruma sahip çıkması, varlıklarını kendi varlıkları olarak görmeye başlaması belki de en çarpıcı sonuçlardan biridir.

Bir diğer sonuç ise beklenmeyen olaylar karşısında verilen tepkilerin mesleki gelişim sürecindeki eksikliği ortaya koymasıdır. Yıllar içerisinde kendilerini geliştirmek zorunda olmadıklarını düşünen kaptanlar, çağın ve teknolojik gelişmelerin karşısında yetkinliklerini güncellemeleri gerektiğini görmüşlerdir. Böylece bireyin sürekli öğrenmeye, araştırmaya açık olması süreci çalışmaya başlamıştır.

Değerlendirme süreci, sürece katılan firma filosu genelinde sinerji yaratmış, pek çok talimat ve uygulama güncelleştirilmiştir. Doğru bilinen yanlışlar, hatalı karara yol açan yönlendirmeler ortadan kaldırılmış, emniyet yönetimi prosedürlerinde önemli güncellemeler yapılmıştır. Özellikle firma açısından kritik öneme sahip bölgeler, gemiler ve olaylar hakkında firma genelinde bilgilendirme süreci başarıyla sonuçlanmıştır. Farklı bölgelerde çalışan ve farklı özelliklere sahip gemilerde görev alacak Kaptanların farkındalık seviyesinde artış gözlemlenmiştir.

Önemli bulgulardan bir diğeri ise değerlendirme sonrası atandığı gemide göreve başlayan Kaptan'ın, değerlendirme sırasında kendisine uygulanan senaryolardan birisi ile gerçek hayatta karşılaştığını rapor etmesidir. Kritik bir bölgede makine arızasıyla karşılaşan Kaptan değerlendirme sürecinde edindiği tecrübeleri kullandığını belirtmiş ve ne yapması gerektiği konusunda kendisini hazır hissettiğini belirterek olayı sorunsuz/başarıyla sonuçlandırabilmiştir.

Kaptan değerlendirme sürecine katılan firma filosunda görev yapan Kaptanların çoğunluğunun sürece dâhil edilmesi sonrasında edinilmesi veya tekrarlanması gereken yetkinliklere ait eğitim planlamaları da yapılmıştır. Bu eğitimlerden bazıları kişinin kendisini yetiştirmesine yönelik olduğundan bireylere bu konularda destek sağlanırken, diğerleri için web tabanlı eğitim sistemleri kullanılarak yeni eğitimler oluşturulmuştur. Ayrıca yine simulator destekli olarak uygulanabilecek farklı başlıklarda eğitimler de talep edilmiş ve özel olarak gerçekleştirilmiştir. Talep edilen eğitimlerden bir tanesi firmanın

yeni açılan bir hatta çalışacak gemilerinde görev alacak Kaptanlarına yönelik bölgenin özelliklerini açıklayıcı, bölgedeki yaşanan kazalardan elde edilen bilgilerden yola çıkılarak olası sorunların tespiti ve gerçekleşmesi halinde etkin yönetimin nasıl gerçekleştirilebileceğine yönelik olarak hazırlanarak uygulanmıştır. Bu sayede daha gemiye katılmadan ön bilgilendirmeyi simülasyon ortamında tecrübe ederek kazanan Kaptan'ın kendisine olan güveni artmakta, olası kötü tecrübelerin yaşanmasının önüne geçilmektedir.

4. Sonuç

Kaptan değerlendirme süreci yukarıda da açıklandığı üzere esas olarak Kaptan'ın yetkinliklerinin gözden geçirilme sürecidir. Bu süreç sonucunda, bireyin ve değerlendirme sürecini gerçekleştiren gözlemcilerin olası istenmeyen durumlarda Kaptan'dan beklenen tutum/davranış ve becerilerin ne kadarının hangi boyutta gerçekleştiğinin tespitine dayalıdır. Sürecin filoda çalışan tüm Kaptanlara yaygınlaştırılması sonucunda kurumsal kültür, kurumsal aidiyet, sürekli öğrenmeye açık olma, sorgulama gibi kazanımların olduğu da bir gerçektir. Simülasyon senaryolarında istenmeyen olaylara karşı verilen tepkiler, tutum/davranış ve becerilerin ortaya konması ve olması gerekenlerin belirtilmesi ise gelecekte benzer olayların tekrarlanmasını engelleyecek, şayet gerçekleşirse de Kaptan'ın hazırlıklı olmasını sağlayacaktır. Bu sayede filonun emniyet algısı ve emniyet yönetimi uygulamaları da sürekli bir gelişme gösterecektir.

Kaptan değerlendirmeleri yapılırken bilinmesi gereken bazı önemli hususlara da değinmek gerekmektedir. Bu değerlendirme sistemi ve uygulamalar klasik bir sınıf eğitimi değildir. Dolayısıyla bireyin aktif katılımı ve istekli olması son derece önemlidir. Bireyin gemide görev yaptığını düşünerek simülasyona katılması önemlidir. Aksi yaklaşım veya davranışlar değerlendirme sürecini ve bulguları etkileyecektir.

Sürecin sonucunda bir kişilik analizi yoktur ve değerlendirme sistemi de buna yönelik değildir. Ancak, bireyin olaylar karşısındaki tepkilerinin izlenmesi söz konusudur ve takım çalışmasına etki edebilecek olumsuz tutum/davranışların gözlemlenmesi halinde

geri bildirimde mutlaka değinilmektedir. Yine de, kişinin karakterini veya karakter özelliklerini değiştirmez, değiştirmesi beklenmez.

Değerlendirme süreci bireyin kendi içinde bir özdeğerlendirme aşamasını da yaşatır ve kişi isterse kendisi ders çıkarır ve kendini eğitme yoluna başvurabilir ancak sürecin eğitime katkısı bununla sınırlıdır.

Süreçten geçen kişi hata yapmaz demek değildir. Önemli olan hatanın telafisi ve farkına varılması, tekrarının yaşanmaması için gerekenleri görmektir. Bu anlamda son yıllarda havacılık sektöründe tanımlanmaya başlayan hata yönetimi yaklaşımını da desteklemektedir.

Süreç özellikle beklenmeyen durumlara yöneliktir ancak bilindik durumlarda bilindik davranışlar bilinçaltına yerleşmişse düzeltmek mümkün değildir. Farkındalık burada kilit rol oynamaktadır. Farkındalığı yüksek olan Kaptanlarda hatalı tutum/davranışlar zaten birey tarafından fark edilmekte ve düzeltilmesi gerektiği Kaptanların kendisi tarafından ifade edilmektedir.

Kaptan'ın köprüüstü yönetimi açısından önem taşıyan ve iletişim başta olmak üzere davranışlarını etkileyen özelliklerin -ki bu özellikler teknik olmayan beceriler olarak yukarıda belirtilmiştir- seyir emniyetini tehdit etmiyorsa bazen göz ardı edilebilir. Bu özelliklerin filo gemileri yönetimi veya firmanın insan kaynakları politikaları açısından istenen özelliklerde olması için düzeltilmesine yönelik çabalar filo yönetimi sorumluluğunda görülmektedir.

Son yıllarda teknolojik gelişmelerin hız kazanması ile denizcilik sektöründe de hızlı değişmeler yaşanmaktadır. Deniz ulaştırması alanında faaliyet gösteren firmalar açısından en önemli varlık olan gemilerin etkin ve emniyetli yönetimi de bu açıdan son derece önemlidir. Gelecekte de gelişmeye devam edecek teknolojik imkânlar ile bu ve benzeri değerlendirmelerin daha gerçekçi yapılabilmesi için VR teknolojilerinin kullanılabileceği düşünülmektedir. Değerlendirme ölçütlerinin de gemilerde kullanılan elektronik seyir yardımcıları ve seyir kaynaklarının değişmesi ile değişmesini beklemek yanlış olmayacaktır. Benzer şekilde farklı tip gemilerde farklı öncelikler söz konusudur ve

gerekli hallerde bu önceliklere göre değerlendirme ölçütlerine yönelik çalışmalar sürdürülecektir. Ancak yukarıda da açıklandığı üzere elde edilen ölçütler ve değerlendirme yöntemi bugün bilimsel olarak bildiklerimizi desteklemekte ve hatta bir kaç adım ileriye taşımaktadır. Benzer şekilde değişen ticari faaliyetler veya taşıma şekilleri ile senaryolarında gelişmesi ve güncellenmesi zorunludur. Ancak tehlikeler yine emniyet, güvenlik ve çevreye yönelik olarak karşımıza çıkacaktır.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Examination of Ships Arrested by Years in Port State Controls

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ABSTRACT

It has been understood over time that ship inspections should be focused on in order to secure the maritime transport, which constitutes a large part of the current transport activities. The vessels are subject to various inspections both in their own flag state ports and in the scope of the supervision bodies formed by the countries. Memorandum of Understanding (MOU) structures have been established within the scope of Port State inspections. Our country is a member of Mediterranean and Black Sea MOU. In this study, factors affecting the control of ships and the common deficiencies that cause the ships to be arrested were examined. The reasons for the detection of the reasons for the arrest of ships and the identification of the deficiencies on the ships and the importance of these inspections to prevent accidents were investigated. In the study, statistical analyzes were performed by considering the age, type, flag and class of the ships which were inspected and arrested between the years. In the analysis of the data related to the controls, the frequency distributions with R program were examined and visualized by graphs.

Keywords: Maritime, PSC, MOU, Statistics

Liman Devleti Kontrolleri Kapsamında Yıllara Göre Tutuklanan Gemilerin İncelenmesi

ÖZET

Günümüzdeki taşımacılık faaliyetlerinin büyük bir kısmını oluşturan denizyolu taşımacılığını güvenli hale getirmek için gemi denetimlerine ağırlık verilmesi gerektiği zamanla anlaşılmıştır. Gemiler hem kendi bayrak devleti limanlarında hem de ülkelerin oluşturduğu denetleme birlikleri kapsamında çeşitli denetimlere tabi tutulmaktadır. Liman Devleti denetimleri kapsamında Memorandum of Understanding (MOU) yapıları oluşturulmuştur. Ülkemiz Akdeniz ve Karadeniz MOU üyesidir. Bu çalışma kapsamında gemilerin denetiminde etkili olan faktörler ve gemilerin tutuklanmalarına sebep olan ortak eksiklikler incelenmiştir. Gemilerin tutuklanma nedenlerinin istatistiksel olarak ortaya konulması ve kazaya sebebiyet verebilecek eksikliklerin gemilerde tespit edilme durumları ve bu denetimlerin kazaları önlemedeki önemi incelenmiştir. Çalışmada belli yıllar arasında denetlenen ve tutuklanan gemilere ilişkin gemi yaşı, türü, bayrağı, klası dikkate alınarak istatistik incelemeler yapılmıştır. Denetimlere ilişkin verilerin analizinde R programı ile frekans dağılımı ve ikili ilişki analizi (X2) yapılmıştır.

Anahtar Kelimeler: Denizcilik, PSC, MOU, İstatistik

1. Giriş

Dünya ticaret filosunun dünya ticaretinin yüzde 90'ından fazlasını taşıması ve modem toplumun, gemiler tarafından taşınan yüklere artan bir bağımlılığı vardır. Gemilere olan talep, büyük miktardaki malın (ve insanın) dünyanın bir yerinden diğerine, en ucuz ve mümkün olan en güvenilir şekilde taşınması ihtiyacından kaynaklanmaktadır. Bugün, yaklaşık 35.000 gemi deniz yollarında faaliyetlerini sürdürmektedir. Deniz taşımacılığına olan talep, dünyadaki ekonomik faaliyet seviyesinden etkilenmesi ve bunun da gemilerin temini ve dolayısıyla dünya ticaret filosunun büyüklüğü üzerinde önemli bir etkisinin olması beklenmektedir. Bu endüstrideki güvencenin hak ettiği önceliğe sahip olması ve uluslararası nakliyatın kararlaştırılan standartlarla tam uyumunun sağlanması için uygun şekilde izlenmesi ve yürürlüğe konulması, etkili düzenleyici mekanizmalar tarafından yönetilmesi önemlidir [10].

Uluslararası Denizcilik Örgütü (IMO), bu mekanizmaların ana hatlarını oluşturmaktadır. Mürettebatın, yükün ve çevrenin güvenliğini korumak için birçok uluslararası sözleşme geliştirmiştir. Bu sözleşmelerin amacı, denizdeki güvenliği arttırmak ve gemide kabul edilebilir uygunluğu sağlamaktır. Sorumluluk zincirinde gemi sahibi denizdeki gemilerinin güvenliğinden nihai olarak sorumludur. Gemi ve mürettebatın her zaman uluslararası sözleşmelerle uyumlu olmasını sağlamalıdır [12].

IMO tarafından kabul edilen sözleşmelerin yükümlülükleri gereği, uluslararası sefer yapan gemilerdeki asgari standartların kontrol edilmesi gerekmektedir. Bu bağlamda, gemilerin kayıtlı oldukları denizcilik idareleri tarafından yapılan Bayrak Devleti Denetimi (FSC) ve gemilerin uğrak limanlarında yapılacak kontroller için Liman Devleti Denetimi (PSC) sistemleri oluşturulmuştur. Bir gemiye bir devletin bayrağında olma hakkı tanındığında o bayrak devleti, geminin genel kabul görmüş uluslararası güvenlik, mürettebat ve kirlilik önleme standartlarını karşılamasını sağlamak için birincil yetkiye sahiptir. 1982 Birleşmiş Milletler Sözleşmesinin 94 (1) maddesi Deniz Hukuku (UNCLOS)

uyarınca bayrak devleti "yetkilisini ve kontrolünü kendi bayrağını taşıyan gemiler üzerindeki idari, teknik ve sosyal konularda etkin bir şekilde kullanmalıdır" [18].

Ancak, açık sicil ülkelerinin çoğu bu sözleşmeleri ciddiye almamaktadır. Bu durum, gemi operatörlerine / sahiplerine ihtiyaçlardan kaçınma fırsatlarını sağlamakta, bu da denize elverişsiz gemilere ve dolayısıyla deniz taşımacılığındaki güvenliğin bozulmasına neden olabilmektedir. Bu problemi fark eden Uluslararası Denizcilik Örgütü ve kıyı devletleri, gemi standardını kontrol etmek amacıyla FSC'ye ek olarak Liman Devleti Denetimini (PSC) başlatmışlardır. Bununla beraber, gemi denetimleri için kullanılan sınırlı kaynaklar nedeniyle, PSC, bayrak devletlerinin kötü üne sahip olan gemilere, çoğunlukla çok düşük nakliye standartlarına sahip açık sicillere sahip olan gemilere öncelikler vermektedir [11].

Deniz taşımacılığında güvenliğini iyileştirmek için, dünyanın dört bir yanındaki ülkeler Liman Devleti Kontrolünü (PSC) uygulamaya atanmış yetkililer oluşturmuşlardır. Bu özel organizasyonların görevlerini bağımsız ve güvenilir bir şekilde bir güvenlik mekanizması olarak yürütmek ve yeterli güce sahip olmasını sağlamak için uygun önlemler de alınmıştır. Yapılan bu denetimler neticesinde asgari standartları sağlamayan gemilere birtakım yaptırımlar uygulanmaya başlanılmıştır. PSC, bölgesel anlaşmalar ile koordinasyon içerisinde bulunan ülkeler tarafından belirli kriterlere göre yapılmaktadır [13]. Bu çalışmanın sonraki bölümünde liman devleti kontrolü kavramı detaylı olarak incelenmiştir. Bölüm 5'te ise Ocak 2011 yılından Kasım 2018'e kadar Black Sea MOU'ya ait olan ülkeler tarafından yapılan PSC denetimlerinde tutuklanan gemilerde tespit edilen eksiklikleri bu eksikliklerin geminin sicile kayıtlı olduğu bayrak devletiyle, geminin tipiyle, sigortalayan klas kuruluşuyla olan ilişkisinin incelenmesi üzerine kurulmuştur. Son kısımda denetimlerin yapıldığı yerin (teftiş eden otorite), öneminin olup olmadığı araştırılmaktadır.

2. Liman Devleti Kontrolü Kavramı

Liman Devleti Kontrolü (PSC); bir ülkenin kendi limanlarında, uluslararası sefer yapan düşük standarttaki gemileri belirlenmesi ve kendi sularındaki deniz kazalarını engellemeye yönelik çalışmasıdır

Mevcut Liman Devlet Kontrolü (PSC), kökeni 1978'de sekiz kuzey denizi devleti arasında Lahey'de imzalanan bir mutabakatla başlamıştır [7]. 1982 yılında Amoco Cadiz isimli tankerin karaya oturması Fransa kıyılarında büyük bir kirlilik yaratmıştır. Bu olay gemilerin oluşturduğu kirliliğin ciddiyetine ilişkin halktan büyük destek almasının yanı sıra önlenmesine yönelik kuralların gerekliliğini göstermiştir. Halkın desteğiyle önemi vurgulanmış olan bu kirlilik olayı temel esasları denizde can güvenliği, gemilerin yarattığı kirliliğin önlenmesi, gemide yaşam ve çalışma koşullarının iyileştirilmesi olarak belirtilen daha ayrıntılı bir mutabakat ile sonuçlanmıştır. Daha sonraları Paris MOU olarak tanınmaya başlanan Liman Devleti Kontrolü yapısı Şubat 1982'de kurulmuş ve başlangıçta 14 Avrupa ülkesi tarafından imzalanmıştır. Bu antlaşma 1 Temmuz 1982'de yürürlüğe girmiştir [9]. Çeşitli bölgelerde devletler, liman devleti kontrolü ile ilgili mutabakat zaptı (MOU) altında gruplanmıştır. Diğer bölgesel MOU'ların yaratılması, Paris MOU'nun başarılı bir şekilde işletilmesinden kaynaklanmıştır. Karar, 1991 yılında IMO Meclisi tarafından kabul edilen gemi ve boşaltmaların kontrolünde bölgesel iş birliğine ilişkin olarak, Paris MOU'nun standart altı gemilerle mücadeledeki performansını kabul etmiş ve tarafları IMO'yu daha fazla bölgesel düzenleme yapmaya çağırmıştır [4].

3. Liman Devleti Kontrolü Rejimlerine Genel Bakış

Dünya üzerinde liman devleti kontrolü için dokuz bölgesel MOU vardır. Avrupa ve Kuzey Atlantik (Paris MOU) etki alanı ağırlık olarak Avrupa'daki kıyı devletleri, İskandinav ülkeleri ve Kanada'dır. Son yıllarda Avrupa Birliği'nin kapsamının genişlemesiyle üye sayısında artış görülmüştür. Günümüzde 27 üye ülkesi bulunmaktadır. Paris MOU kapsamında denetlenen gemilerin performansları ve tutulma oranlarına göre Bayrak Devletlerini "kara liste", "gri liste" ve "beyaz liste" olarak risk gruplarına ayırmıştır. Ek olarak son üç sene içerisinde üç kez tutulan geminin üçüncü defa tutulmasının ardından en az üç ay süre ile Paris MOU bölgesindeki limanlara girmesine izin verilmemektedir.

Tutulmalar aynı oranda artış göstermeye devam ederse limanlara giriş yasağının süresi arttırılmaktadır [9].

Asya ve Pasifik (Tokyo MOU) Rusya, Japonya, Avustralya başta olmak üzere 18 üye ülkeye sahiptir. Komite bölgede yıllık denetim oranının bölgede faaliyet gösteren gemilerin %80'i denetlemeyi teşvik etmektedir aynı zamanda dünyadaki hedef gemi denetleme oranı en yüksek olan rejimdir. Latin Amerika (Acuerdo de Vina del Mar) Güney ve Orta Amerika bölgesi devletlerinden oluşan 15 üye ülkesi bulunmaktadır. Bölgede hedeflenen yıllık denetleme %20'dir. Karayipler (Caribbean MOU) bölgesi liman devleti denetimi birliği üye devletlerden açısından birçok ada devletinin ve temsili yönetimin bir araya getirdiği oluşumdur. Bu bölgesel denetim rejiminde hedef denetleme oranı bölgedeki gemilerin %15'i olarak belirlenmiştir [15].

Batı ve Orta Afrika (Abuja MOU) Atlantik kıyılarında bulunan 22 Afrika ülkesinin üye olduğu rejimdir. Yıllık denetleme oranı hedefi %15'tir. Hint Okyanusu (Indian Ocean MOU) sınırlarındaki bayrak ve liman devleti yeterliliklerinin gelişimi üzerine 18 üyesi ülke arasında yapılan anlaşmadır. Hedef denetleme oranı %10'dur. Arap Körfezi (Riyadh MOU) Altı Körfez devletinin oluşturduğu %10 denetleme oranına sahip bir başka anlaşmadır. Akdeniz (Mediterranean MOU) Türkiye'nin de üye olduğu 10 ülkeden oluşan birliktir. Hedeflenen denetleme oranı %15'tir [8]. Karadeniz Bölgesi (Black Sea MOU) Anlaşması'nın üye ülkeleri Karadeniz'e kıyısı olan Romanya, Gürcistan, Bulgaristan, Ukrayna, Rusya, Türkiye'dir. Ülkemiz Akdeniz, Ege ve Marmara Denizi'nde bulunan limanlarında Akdeniz MOU, Karadeniz'de bulunan limanlarda ise Karadeniz MOU kapsamında denetimler gerçekleştirmektedir. Nisan 2013 tarihinde yapılan 14. Dönem Karadeniz MOU Komite Toplantısında, Karadeniz MOU' da yeni bir denetim rejiminin uygulamaya konulması konusunda anlaşılmıştır. Bu denetim rejimi ile kara, gri ve beyaz liste uygulaması yürürlüğe girecektir. Ayrıca, bu denetim rejiminde; şirket performansı, yetkilendirilmiş klas kuruluşu performansı, gemi yaşı, önceki denetimler gibi parametreler ile hesaplanarak gemiye özgü bir risk faktörü hesaplanacaktır [13].

Bu MOU'lar dünyanın hemen hemen tüm bölgelerini kapsar. ABD herhangi bir bölgesel MOU'da üye bir otorite olmamakla birlikte, ABD Sahil Güvenlik (USCG) kendi PSC Programına sahiptir. Belki de ABD Sahil Güvenlik'inin liman devleti kontrolüne en önemli katkısı, geminin, bayrak devletinin ve gemiyi sınıflandıran sınıflandırma topluluğuyla ilgili olarak geçmişe ilişkin verilere dayanarak hizmet veren yabancı gemilere öncelik verilmesine izin veren bir biniş karar matrisi geliştirilmesi olmuştur. Standart altı deniz taşımacılığı sorununa bu yaklaşımın, kıt denetim kaynaklarının en iyi şekilde kullanılmasına yönelik bir yöntem olarak etkili olduğu kanıtlanmıştır ve özellikle Avrupa Topluluğu'nda diğer liman devletler tarafından kabul edilmiştir [17].

3.1. PSC 'de Dikkate Alınan Uluslararası Sözleşmeler

Yabancı bir geminin ulusal bir limana girmesi durumunda, geminin ve ekipmanının uluslararası düzenlemelerin gerekliliklerine uygun olduğunu ve geminin bu kurallara uygun olarak işletilip işletilmediğini doğrulamak için dünya çapında benzersiz standartlar ve prosedürler uygulanmaktadır.

Bütün memorandumların ortak olarak benimsedikleri deniz güvenliği için uluslararası düzenleyici çerçevedeki en önemli sözleşmelerin altısı, PSC rejiminin kurumsallaştığı temeller olarak hizmet etmektedir. Bunlar, Gemilerden Kaynaklanan Kirliliğin Önlenmesi Uluslararası Sözleşmesi (MARPOL), Denizde Yaşam Güvenliği Uluslararası Sözleşmesi (SOLAS), Yük Yolları Uluslararası Sözleşmesi (LOADLINES), Uluslararası Denizciler Eğitim, Belgelendirme ve Vardiya Standartları Sözleşmesi (STCW), Denizde Çarpışmaların Önlenmesine Yönelik Uluslararası Düzenlemeler Sözleşmesi (COLREG) ve Gemilerin Tonaj Ölçümü Uluslararası Mutabakatı (TONNAGE)'dır [5].

Tablo 1'den anlaşılacağı üzere dünya deniz ticaret filosunu elinde bulunduran denizci ülkeler temel denizcilik sözleşmelerini benimseyerek tanımışlardır.

Tablo 1: Sözleşmelerin Gemi Filolarına Sahip Ülkelere Göre Durumu

Sözleşmeler	Yürürlük Tarihi	Taraf Ülkeler	%Dünya Deniz Ticaret Hacmi
IMO	17/03/1958	166	98.81
SOLAS 78	01/05/1981	109	93.35
LOADLINES 66	21/07/1968	156	98.76
TONNAGE 69	18/07/1982	145	98.56
COLREG 1972	15/07/1977	148	97.92
MARPOL 73/78	31/12/1988	127	95.92
STCW 1978	28/04/1984	150	98.78

Black Sea MOU denetimlerinde kullanılan hukuki dayanaklar tablodaki sözleşmelerin dışında Ticari Gemicilik (Minimum Standartlar) Sözleşmesi (ILO 1976), Gemi Yakıtlarından Kaynaklanan Petrol Kirliliği Zararının Hukuki Sorumluluğu Uluslarası Sözleşmesi (BUNKERS 2001) ve Gemilerdeki Zararlı Organik Tutunma Önleyici Sistemlerin Kontrolüne İlişkin Uluslararası Sözleşmesi (AFS 2001) denetimlerde dikkate alınan diğer sözleşmelerdir [15].

3.2. PSC 'de Denetlenecek Gemi Seçimi

Liman devletleri kontrollerini gerçekleştirirken maliyet ve zaman değişkenleri açısından belirli sınırlamalar yapılmak zorundadır. Denetlenecek gemilerin seçimi, gereksiz çoklu denetimlerden kaçınmak için bir dereceye kadar koordinasyonun sağlanması gerekmektedir.

PSC muayenesi başına maliyeti eksiklikler tespit edildiğinde 759 USD, herhangi bir eksiklik bulunmadığında 509 USD olduğunu tahmin edilmektedir. Bu bağlamda, diğerlerinin yanı sıra, MOU'nun üyeleri arasında bilgi merkezileştirme ve eylemleri koordine etmeyi amaçlayan, dünyanın hemen hemen tüm denizlerini kapsayan 9 adet MOU 'nun oluşturulmasının bir nedenininse maliyet olduğunu ifade edebiliriz [5].

PSC denetimi için seçilecek gemiler güvenlik, sağlık veya çevreye yönelik tehlikeleri temsil eden ve bu nedenle gözaltına alınabilecek gemiler olarak tanımlanan standart altı

gemileri hedef almaktadır. Örneğin, Ocak 2011'den bu yana, Paris PSC Mutabakat Zaptını imzalayan 27 deniz idaresi, düşük, orta veya yüksek riskli gemileri sınıflandırmak için çeşitli kriterler belirlemiştir. Bayrak performansı (siyah / gri / beyaz listelerdeki görünüm), tanınan organizasyon (RO) performansı, 3 üyenin RO üyesi tarafından tanınması veya tanınmaması, ISM (Uluslararası Güvenlik Yönetimi) şirketlerinin performansı, son 36 ay içinde denetim veya denetim dışı, tespit edilen eksikliklerin sayısı (beşten yüksek veya daha düşük) ve geçmiş göz altılarının sayısına istinaden denetimlerini gerçekleştirmiştir. Bu kriterlerin her birine atanan belirli ağırlıklar, esas olarak profesyonel uzmanlığa dayalıdır [7].

Karedeniz MOU üyesi ülkeler ise denetlenecek gemileri BSIS adı verilen bir bilgi sistemiyle üye ülkelere gelen gemilerin daha önce denetim geçirilip geçirmediği, giderilmesi gereken eksikliklerin mevcut olup olmadığı bilgilerini bu sistemden elde edebilmektedirler. Bilgi sistemi bölgede denetim yapılacak gemilerin seçiminde de aktif rol oynamaktadır. Bu sistem sayesinde gereksiz zaman kayıplarına ve Memoranduma göre gemilerin kontrolü seçiminde öncelikli olarak aşağıdaki belirlenenler göz önünde bulundurulmaktadır.

- Black Sea Mou ülkeleri limanlarına ilk kez gelen veya 12 ay veya daha uzun süreden sonra gelen gemiler,
- Memoranduma taraf bir ülkenin limanlarında tespit edilen eksikliklerin tamamlanması için belirli bir süre verilerek limandan kalkışına müsaade edilen gemilerin başka bir taraf ülke limanında verilen sürenin bitmiş olduğunun görülmesi halinde,
- Pilotlar ve liman idarelerince, seyri olumsuz etkileyebilecek durumlarının olduğu bildirilen gemiler,
- Taşıdığı tehlikeli ve kirletici yükleri ile gemi bilgilerini ilgili liman ve kıyı devletlerine bildirmesi gerekip bildirmeyen, tehlikeli ve kirletici yük taşıyan gemiler.
- Son 6 ay içerisinde işlemleri klas kuruluşunca askıya alınmış gemiler,

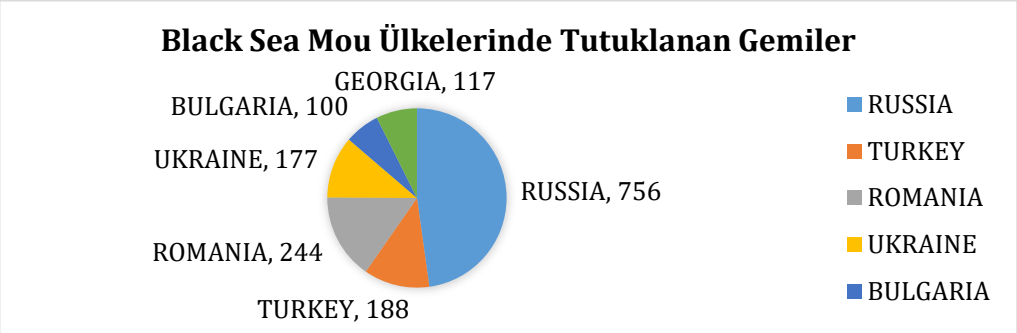
- Başka bir otorite tarafından rapor edilen veya ihbar edilmiş gemiler,
- IMO'nun yürürlükte olan seyir güvenliği ile ilgili hükümlerini ihlal eden ve can, mal ve çevre güvenliğini tehdit eden gemiler [1].

4. Materyal-Metot

Bu çalışmada Karadeniz MOU üyesi ülkelerinin limanlarında tutuklanan gemilerin tutuklanmalarını etkileyen değişkenlere ilişkin retrospektif bir inceleme yapılması amaçlanmıştır. Çalışma kapsamında, Black Sea MOU tarafından arşivlenmiş 2011-2018 yılları arasında Karadeniz MOU ülke limanlarında tutuklanan 1588 tutuklanma incelenmiştir. Çalışma kapsamında toplam 6 ülkedeki 42 limanda yapılan PSC kontrollerinde tutuklanan gemilerin tipleri, yaşları, bayrak devletleri değişkenleri, tutuklu kaldıkları gün sayıları da dikkate alınarak tutuklanma durumları, ortaya çıkan eksiklikler incelenmiştir. Her bir faktörün frekans dağılımları grafikler yardımıyla gösterilmiştir. Gemilerin tutuklanmalarına sebebiyet veren eksiklik kodları histogram grafiğinde gösterilmiştir. Tutulmalara ilişkin verilerin analizinde gemilerin eksik olduğu noktalar tespit edilmeye çalışılmıştır. Limanda denetlenen ve alıkoyulan gemilerin limanda tutulma maliyetlerinin fazlalığı donatan ve armatörler için oldukça önemli konulardır. Yapılabilecek tek şey ise eksiklik tespit edilmemesi yada tespit edilen eksikliğin biran önce giderilmesidir. Bu çalışma liman başkanlıklarının tespit ettiği eksikliklerin daha çok hangi konularda olduğunu göstererek gemi işletenlerinin dikkat etmesi gereken konuları ele amaya çalışmıştır.

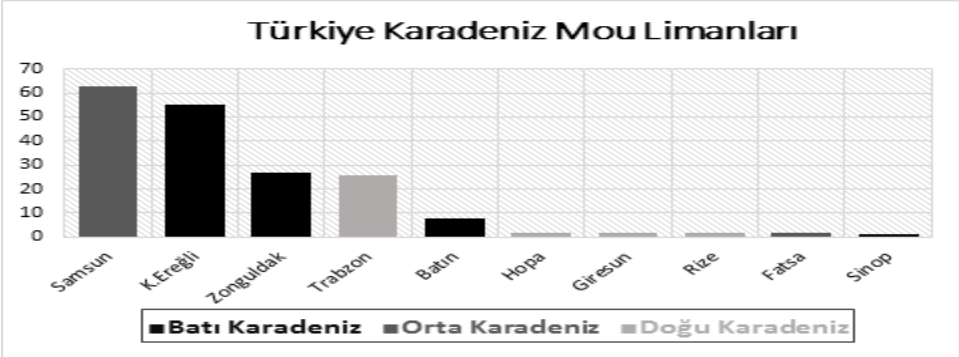
5. Bulgular

Bu bölümde veri analizi sonuçlarına yer verilmiştir.



Şekil 1: Tutuklanma Sayılarının Ülkelere Göre Dağılımı

Araştırma sonuçlarına göre; tutuklanmaların 756 tanesi Rusya'da,244 tanesi Romanya' da, 188 tanesi Türkiye'de, 177 tanesi Ukrayna'da, 117 tanesi Gürcistan'da, 100 tanesinin Bulgaristan limanlarında tutuklandığı görülmektedir. Bu tutuklanmalar Rusya'nın 7 limanında Romanya'nın 5, Türkiye'nin 10, Ukrayna'nın 19, Gürcistan'ın 2 ve Bulgaristan'ın 3 limanında gerçekleştirilmiştir. Liman sayısı en fazla olan Ukrayna ve Türkiye'nin gemi denetimlerinde çokta yeterli olmadığı görülmektedir. Türkiye'de gerçekleşen tutuklanmaların hangi limanlarda olduğu görmek için Grafik 2 bakınız.



Şekil 2: Türkiye'de Gerçekleşen Tutuklanmaların Görüldüğü Limanlar

Black Sea Mou denetimleri kapsamında Türkiye'deki liman başkanlıklarının yaptığı denetimlerde tutuklanan gemilerin %48'i Batı Karadeniz limanlarında %34'ü Orta Karadeniz limanlarında, %17'si ise Doğu Karadeniz limanlarında tutuklanmıştır. Doğu Karadeniz bölgesinde çokça liman başkanlığı olmasına karşın tutuklanan gemi sayısının azlığı denetimlerin yeterli yapılıp yapılmadığı sorusunu akla getirmektedir.

Grafik 3: Black Sea Mou Denetimleri Kapsamında Tutuklanan Gemilerin Yaş Dağılımı

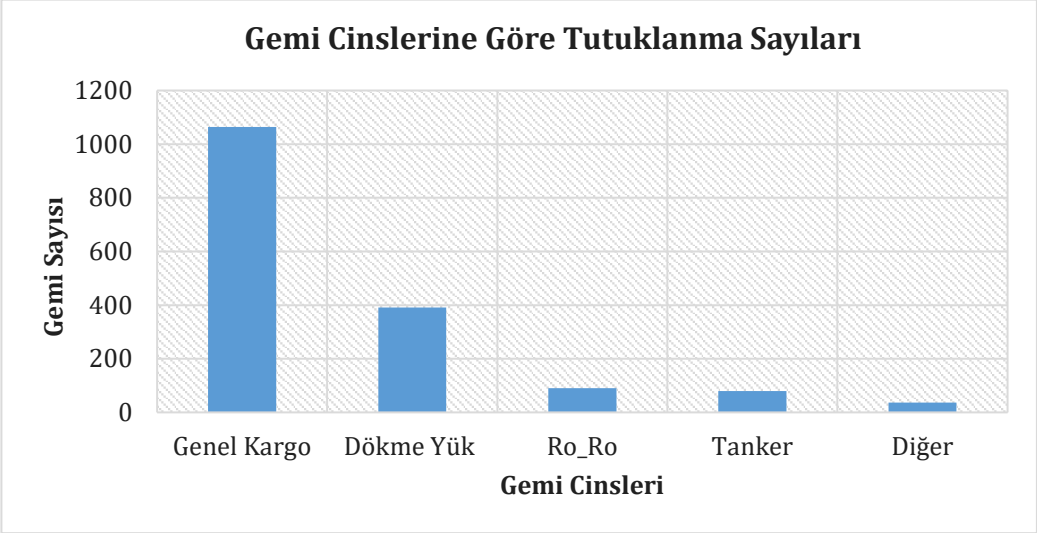
Tutuklanan 1589 gemiden %40'ı 31-40 yıllık gemilerdir. Bu gemilerin yeni sistem ve uygulamalara adaptasyonu zor olduğundan alternatif kullanılan çözümlerin yetersiz geldiği durumlarda ciddi eksiklikler meydana gelmektedir. 40 yıl önceki deniz güvenliğiyle günümüzdeki denizde can, mal güvenliği ve deniz kirlilik konularına verilen önem arasında ciddi farklar mevcuttur. Bu durumda inşa yılının üzerinden 30-40yıl geçmiş gemilerde olan bu yüksek tutuklanma oranlarının önemli bir kanıtıdır. Diğer taraftan tutuklanan gemilerin sadece %10'u 1-10 yaş aralığında inşa edilmiştir. İnşa yılı 11-20 ve 21-30 arası olan gemiler ise sırasıyla %23 ve %22'dir. Kalan %10'luk kısmı 40 yaş ve üzeri gemiler oluşturmaktadır. 40 yaş ve üzeri eski gemiler IMO gereklerini sağlayamadığı ve deniz güvenliği konularında yetersiz kaldığı için denizlerde faaliyet gösterememektedir birçoğu hurdaya ayrılmış durumdadır.

Black Sea Mou kapsamında tutuklanan gemilerin cinsleri IHS Markit esas alınarak Tablo 1'de sınırlandırılmıştır. Sınırlandırılmış gemi türlerinin frekans dağılım grafiği için Grafik 3'e bakınız.

Tablo 2: Gemi Cinslerinin Sınırlandırılması

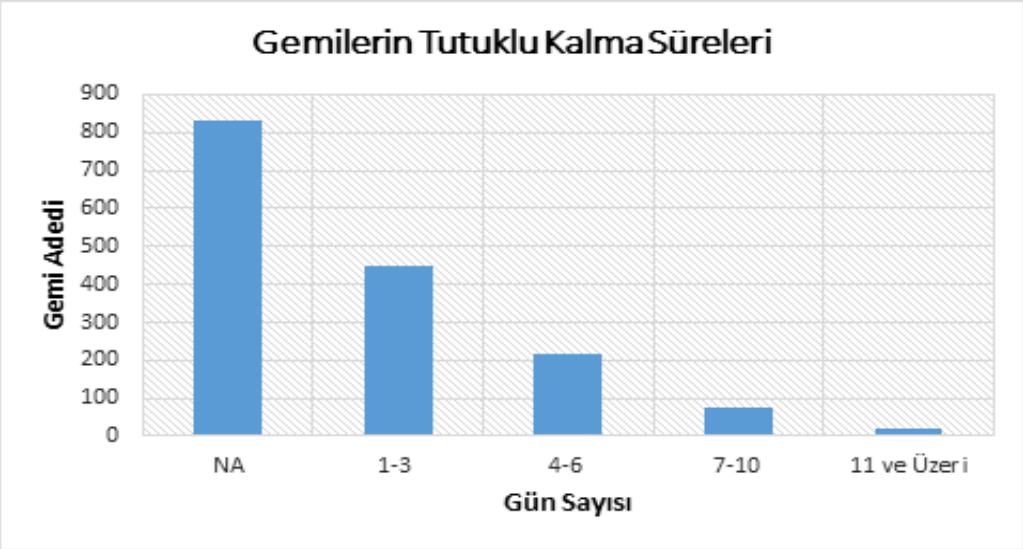
Gemi Cinsleri	Kapsamı İçerisindeki Gemi Türleri
Genel Kargo Gemisi	Konteyner / Soğutma Sistemli Kargo
Dökme Yük Gemisi	Karma Gemi (OBO)
Tanker	Kimyasal/Gaz/Petrol
Ro_Ro Gemisi	Ro_ro Yolcu
Diğer	Ticari yat /Özel amaç

Kaynak: cdn.ihs.com, 2018



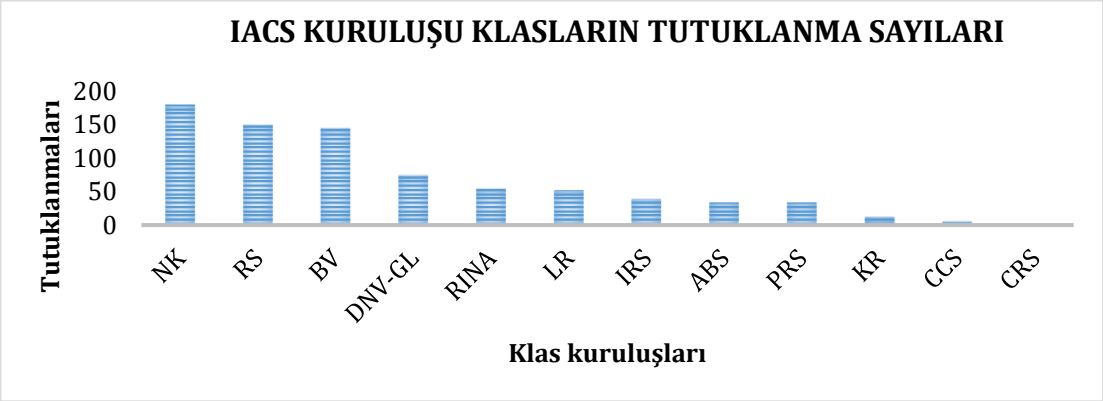
Şekil 4: Black Sea Mou Kapsamında Denetlenen Gemilerin Cinsleri

Tutuklanan gemilerin %67 sini General Cargo gemileri, %24'ünü Bulk Carrier, %5, %4,9 ve %2 'sini sırasıyla Ro_ro, Tanker ve Diğer gemiler oluşturmaktadır.



Şekil 5: Black Sea Mou Denetimleri Kapsamında Tutuklanan Gemilerin Limanda Bekletilme Süreleri

Black Sea Mou denetimlerinde tutuklanan gemilerin %55 'inin ne kadar süreyle tutuklu kaldığı yani limanda bekletildiği bilinmektedir. %28 'i 1 ila 3 gün arasında bekletilmiş, 4-6, 7-10 ve 11 üzeri gün bekletilenlerin oranı sırasıyla %13, %4 ve %1,3'tür. Limanda beklediği her saat gemi için büyük önem teşkil etmektedir. Liman masrafları, yükün zamanında teslim edilip veya alınmaması donatan ve armatör açısından ciddi kayıp demektir. Bu yüzden hiçbir gemi sahibi yükleme boşaltma işlemi dışında gemisinin limanda kalmasını istemez bu yüzden bu denetimler sonucu tespit edilen eksikliklerin bir an önce giderilmesi ve geminin limandan ayrılıp faaliyete devam etmesi önemli bir konudur.



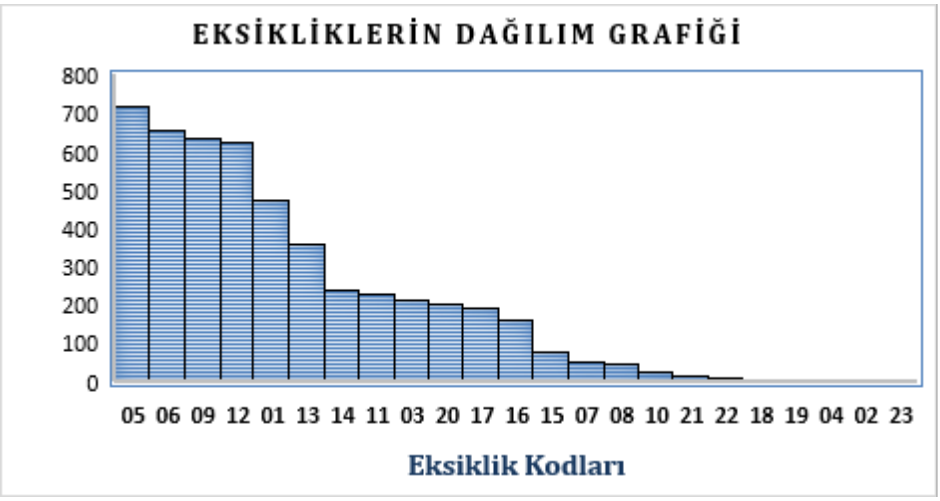
Şekil 6: Black Sea MOU Kapsamında Tutuklanan IACS Üyesi Klaslı Gemilerin Durumu

Black Sea Mou kapsamında yapılan denetimlerde tutuklanan gemilerin klasları incelendiğinde 790 tanesi Uluslararası geçerliliği ve güvenirliği olan IACS üyesi klas kuruluşlarınca denetlenmiş gemiler olduğu ortaya çıkmıştır. Grafik 7 de tutuklanan gemilerin hangi IACS üyesi klasa ait olduğu görülmektedir. En çok Japonya klas kuruluşu NK 'e ait 180 gemi tutuklanırken Hırvatistan klaslı (CRS) sadece 1 gemi tutuklanma yaşamıştır.

Tablo 3: Eksiklik Kodlarının Tanımı ve Görülme Sıklığı

Kodlar	Kodların Tanımı	Görülme Sıklığı
01	Gemi Sertifika / Dökümantasyon	474
02	Mürettebat ve Yaşam Mahali (ILO 147)	3
03	Yürütme gücü ve Yardımcı makineler	215
04	Çalışma alanları	5
05	Can Kurtaran Ekipmanları	719
06	Yangın Güvenliği	657
07	Alarm sinyal sistemleri	51
08	Stabilite, yapı ve ilgili ekipmanlar	48

09	Seyir güvenliği ekipmanı	637
10	Yükleme Sınırı	24
11	Su ve hava durumu	230
12	Acil durum sistemleri	626
13	Güvenli yönetim (ISM)	357
14	Radyo İletişimi	240
15	Kirliliğin Önlenmesi	75
16	Çalışma koşulları	159
17	Çalışma ve yaşam durumu	192
18	Gemide Can Emniyeti (Solas)	7
19	Tehlikeli Yükler	6
20	Yapısal koşullar	201
21	Kargo Operasyonları	17
22	Demirleme düzenleri (ILO 147)	11
23	Dökme yük gemileri	3



Şekil 7: Eksiklik Kodlarının Dağılımı

Black Sea Mou denetimleri kapsamında tutuklanan 1589 geminin tutuklanmasına sebep olan eksiklik kodları incelenmiştir. Bu incelemeler sonucu 4957 adet eksiklik tespit edilmiştir. Tespit edilen bu 23 farklı eksikliğin kodları, tanımları ve uygulanma sıklıkları Tablo 2'de gösterilmiştir. Tutuklanmalardaki eksiklik kodlarının gemilerdeki durumu göz önüne alınıp incelendiğinde tespit edilen eksikliklerin %14'ü kod 05 yani cankurtaran ekipmanlarındaki eksiklikler ya da arızalardan oluşmaktadır. İkinci olarak kodların %13'lük kısmını kod 06 yani yangın güvenliği konularındaki oluşan eksiklikler oluşturmaktadır. Diğer önemli eksikliklerden bahsetmek gerekirse %12'lik oranlarıyla 09 ve 12 numaralı kodlar ciddi oranlarda tespit edilmişlerdir bu kodlar sırasıyla seyir güvenliği ve acil durum sistemlerindeki eksiklikler için kullanılmaktadır. Eksikliklerin neredeyse %50'lik kısmını oluşturan bu 4 önemli eksiklik kodunun ortak noktalarına bakıldığında hepsinin can güvenliği konularında olduğu görülmektedir. İncelemeler sonucunda can güvenliği konularında birçok geminin eksik veya yetersiz olduğunu söylemek mümkündür.

6. Tartışma

Mert'in 2014 yılında Deniz Kazaları İle Karadeniz Memorandumu Kapsamındaki Gemi Tutulmaları Arasındaki İlişki isimli tezinin sonucuna göre tutuklanan gemilerde tespit edilen eksikliklerin %16 gibi önemli bir kısmını yangın güvenliği ile ilgili konular oluşturmuştur. Benzer şekilde Akpınar 2008 yılındaki Kuru Yük Denizyolu Taşımacılığında İşletme Ve Gemi Temelinde Emniyetli Gemi Yönetimi Uygulamaları isimli tez çalışmasında 2007 yılında yapılan denetimlerdeki eksiklik oranlarına bakıldığında yangın önleme %16,25 ile yine en önemli yerdedir. Çalışmamızda ise en önemli eksiklik %14'lük oranla can kurtaran ekipmanlarındaki sorunlar oluşturmuştur.

Mert'e göre 2008-2013 yılları arasında Karadeniz de yapılan PSC denetimleri sonucunda yaşanmış 1357 adet tutulmanın 1140 tanesi 24 yaş ve üzeri gemilerden oluşmaktadır. Çalışmamızda ise bu rakam 1589 tutuklanmanın 1153 tanesi 24 yaş ve üzeri olmasına ek olarak bunlarında %54 lük kısmını 31-40 yaş arası gemiler oluşturmaktadır.

Tozar ve Güzel 2012 yılında Türk Boğazları İçin Gemi Risk Modeli Önerisi, isimli çalışmalarının sonucuna göre İstanbul ve Çanakkale Boğazları için ilk aşamada uygulanabilecek öncelikli gemi yaşına dayalı gemi risk gruplama modeli oluşturulmuştur. Buna göre; 25 yaş üstü gemiler çok yüksek, 15-25 yaş arası gemiler yüksek, 10-15 yaş arası gemiler orta, 5-10 yaş arası gemiler orta-düşük olarak değerlendirilmiştir. 2007 Türk Boğazları geçiş istatistikleri bu modele uygulanmıştır. Yapılan analiz sonucunda İstanbul Boğazı ve Çanakkale Boğaz'larından geçen gemilerin sırasıyla %56 ve %59'u "yüksek" ve "çok yüksek" risk grubundadırlar. Bu bağlamda bakıldığında bizim incelediğimiz Karadeniz MOU denetimleri kapsamında tutuklanan 1589 geminin %82 'si "yüksek" ve "çok yüksek" risk grubundadırlar.

7. Sonuç ve Öneriler

Çalışma sonucunda Black Sea Mou üyesi 6 ülkenin 2011-2018 yılları arasında denetlediği ve limanda alıkoyduğu 1589 geminin inşaa yılları, cinsleri, klas kuruluşları, tutuklanma sebeplerini gösteren eksiklik kodları detaylı olarak incelenmiştir. Yapılan bu incelemeler sonucu tutuklanan gemilerin %67 si genel kargo yükü taşıyan gemilerdir. Tutuklanan gemilerin %82 gibi önemli bir kısmı çok riskli gemi sınıflamasına giren 25 yaş ve üzeri gemilerdir. Denetimlerin sıklaştırılmasıyla bu sınıftaki gemiler önümüzdeki birkaç yıl içinde tamamen seferleri bırakıp hurdaya ayrılmak durumunda kalacaktır. Tutuklama verilerine göre ortalama 4-6 gün arasında limanda bekletilen gemi oranı %13'tür. Gemi işleteni için geminin limanda tutuklu kalması işlerin aksaması ve maliyetlerin artması demektir. Bu yüzden her işleten gemi filosunu kısa zamanda yenileyerek uzun vadede kazanç sağlamayı hedeflemelidir. Geminin faaliyet durumunu denetleyen özel klas kuruluşlarının durumuna değinmek gerekirse IACS üyesi klas kuruluşları tarafından klaslanan gemiler nerdeyse toplamın %50'lik kısmını oluşturmaktadır. Buradan da anlaşılacağı gibi klas kuruluşun yeterince faal olmadığı söylenebilir. Tutuklanan gemilerde tespit edilen toplam 4957 eksikliğe gelecek olursak eksikliklerin önemli kısmını cankurtaran ekipmanları ve yangın güvenliği konuları oluşturmaktadır. Bu durumu gemiler açısından değerlendirecek olursak bu denli önemli bir konuda bu kadar eksikliğin olması ciddi bir sorun teşkil ederken liman devletlerinin detaylı denetimleri

sayesinde bu eksikliklerin fark edilip gemileri düzeltmeye zorlaması bir avantajdır. Bu tip denetimlerin sıklaştırılmasının zamanla gemilerin daha dikkatli olmalarını sağlayacağı ve en azından göz göre göre gelen kazaların önlenmesi mümkün olabilecektir.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Training and Assessing Software in MET

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ABSTRACT

Current demands to the contents and syllabus in training seagoing cadets and maritime industry-related students imply the use of computer-based training to an increasing degree. The paper presents digital training and assessing program named "Structure Formation in Iron-carbon Alloys" to have future professionals well familiarized with these. The iron-cementite diagram allows determining the formation of structures of carbon steels and cast irons with different carbon content and at different temperatures. On its basis heat treatment modes, steel hot forming temperature range are chosen. The paper aims at giving an account of the program, showing the advantages of introducing it as an example of best practices.

Keywords: computer-based training, training and assessing, MET, structural material, iron-cementite diagram.

1. Introduction

Shipping industry has been developing into a very sophisticated business in a variety of senses for the previous decades. Cutting-edge technologies have been used in building ships, making their equipment and machinery. These considerations entail an urgent necessity for training well-qualified maritime industry-related personnel (both shore-side and ship-side) capable of maintaining and operating the structures, machinery and equipment on the basis of profound knowledge obtained at MET institutions.

Admiral Nevelskoi Maritime State University, based in Vladivostok, Russia, has long been involved in the process of training well-qualified sea-going personnel, and has been committed to providing quality education and training as prescribed by STCW 1978, as amended, and supported by a long-standing tradition of excellence.

Building a modern ship, as well as machinery and equipment, implies utilization of various and, not rarely advanced, materials. Yet it should be stressed that it is alloys of iron and carbon that account for over 90 per cent of all structural materials used aboard vessels. Therefore cadets and students should be taught peculiarities of the said materials. The minimum knowledge, understanding and proficiency required from future seafarers are defined by STCW Code, as amended. Great attention is paid to the subject matter in Part A, Chapter III - Engine department. For instance, Table A-III/1 "Specification of minimum standard of competence for officers in charge of an engineering watch in a manned engine-room or designated duty engineers in a periodically unmanned engine-room" contains function "Maintenance and repair at the operational level" with a competence defined as "Appropriate use of hand tools, machine tools and measuring instruments for fabrication and repair on board". This competence implies knowledge, understanding and proficiency in "Characteristics and limitations of materials used in construction and repair of ships and equipment" and also "Characteristics and limitations of processes used for fabrication". Having been educated and trained a cadet should be able to prove that his / her "Selection of materials is appropriate. Fabrication is to designated tolerances. Use of equipment and hand tools, machine tools and measuring

instruments is appropriate and safe". Another competence is defined as "Maintenance and repair of shipboard machinery and equipment". This competence implies knowledge, understanding and proficiency in "The use of appropriate specialized tools and measuring instruments". Having been educated and trained a cadet should be able to demonstrate that "Safety procedures followed are appropriate. Selection of tools and spare gear is appropriate. Selection of materials and parts is appropriate". Minimum standard of competence for chief engineer officers and second engineer officers on ships powered by main propulsion machinery of 3,000 kW propulsion power or more (A-III/2) also explicitly requires theoretical knowledge in technology of materials, resulting in ability to carry out the planning and preparation of operations so that it suits the design parameters.

Therefore, there are international standards and it is MET providers' task is to choose best ways to make their trainees meet the standards.

This paper is aimed at considering the experience gained in computer-based training, namely the use of training and assessing software designed to improve knowledge, understanding and proficiency of future seafarers, analyzing the improvements, if any, giving conclusions and advice. Therefore, a particular case of computer-based training is scrutinized.

2. Background

Computer-based training is defined as computer-mediated training delivered with the help of intranet or Internet via web-browsers. With the advancement of technology, these trainings have become an intrinsic part of our lives and in the current age, CBT refers to every kind of electronically supported methods of learning. In a broader aspect, computer-based training refers to all kinds of self-paced training activities which are conducted with the help of computers. These trainings are extremely flexible and can be taken at workplace, home or while traveling. CBT provides an advanced kind of training that even the classroom trainings cannot. Due to this reason, it has turned out to be extremely popular and widely availed. To be effective CBT should be based on a prior

conducting a needs and task analysis program which in turn will determine the skills, competences and knowledge required for achieving a good performance at work. Proper and effective computer based training also requires graphic designers to develop screen designs that are intuitive, screen interactions that are user-friendly and multimedia content that is motivating, inspiring and highly effective.

Considering the advantages of computer-based training one can point out:

1) CBTs can be used for training a large number of individuals in a proper and standardized manner. With CBT, a large group of individuals can be trained in a proper and flexible manner saving both the mentor and trainees' time;

2) CBTs are self-paced. The learners can check and regulate their speed of training and can even repeat a lesson if the need arises;

3) CBTs allow measuring learners' progress in learning and acquired skills with the help of reliable, authentic, valid and standardized tests;

4) CBTs also provide feedback to the trained students, thus motivating and inspiring them in the long run.

Current demands to the contents and syllabus in training seagoing cadets and maritime industry-related students imply the use of computer-based training to an ever increasing degree. The authors have compiled and are introducing into the process of training cadets and students, as well as in assessing their knowledge and practical skills a training and assessing program named "*Structure Formation in Iron-carbon Alloys*".

Iron based alloys seem to be most commonly used in industries and play a basic structural material for shipbuilding, machine-building and tool-manufacturing. These materials are used when making fixed and moving parts of ship's main and auxiliary engines, propeller shafts, thrust block shafts, and intermediate shafts, crankshafts, rudder heads and other auxiliary machinery parts. Efficiency in operating engine, auxiliary machinery, and tools is dependent on how well future professionals to work both on board ship and in building

/ repair shop have been familiarized with the formation of the iron-carbon alloy structures.

A good grasp of these materials is had through the iron-cementite state diagram visualizing the formation of their structures, and the selection of the appropriate heat treatment. The diagram serves the basis for selecting heat treatment modes, the temperature range of steel hot forming method, etc.

The content of the program includes: "*Diagram Study*, *Training Tests* and *Assessing Test*". Its study helps understand the physical processes that occur in iron-carbon alloys and result in the formation of corresponding structures under slow cooling.

Training tests provide the user with an opportunity of studying the lines, points and structural components of the corresponding areas of the diagram. Assessing tests provide the user with an opportunity of estimating his / her knowledge of the iron-cementite diagram as a whole and get prepared for passing a test in the subject. The iron-cementite structural diagram in the paper we present is given in its simplified version: the notion of peritectic transformation has been omitted. Studying the *Iron – Cementite* diagram is aimed at learning the transformations taking place in carbon steels and cast irons under slow cooling and the formation of their structures at equilibrium.

Modern information technologies allow for visualizing the processes occurring in iron-carbon alloys to be followed by applying the knowledge to practical work. There is a Russian and an English version of the program. The sourcecode for the English version matches the initial Russian version to the fullest extent. The only difference is the language used.

3. Method and Findings

The study mode of the diagram is represented by a frame of the main lines of the diagram (Figure1.), a frame of the characteristic points of the diagram (Figure2.) and a frame of the structural areas of the diagram (Figure3.). In the practical study of lines and points of a diagram, in the menu on the right, the trainee shall click the selected button. In the diagram, the selected line or point will appear in a flashing color with a pointing arrow,

and a description of the line or point will appear in the text box below the diagram. In the process of studying the structural areas of the diagram, after clicking the menu button on the right, the selected area of the diagram with a pointing arrow is displayed on the right of the diagram, and a description of the area is displayed in the text box at the bottom of the diagram.

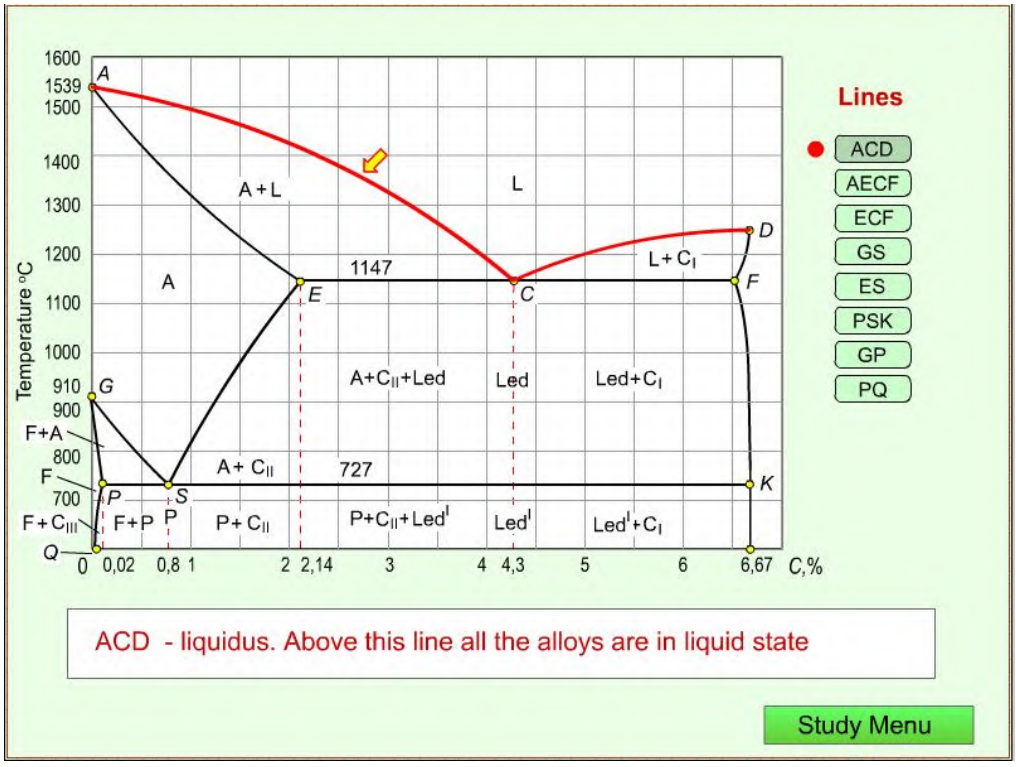

Figure1: Work frame for study of the main lines of the diagram.

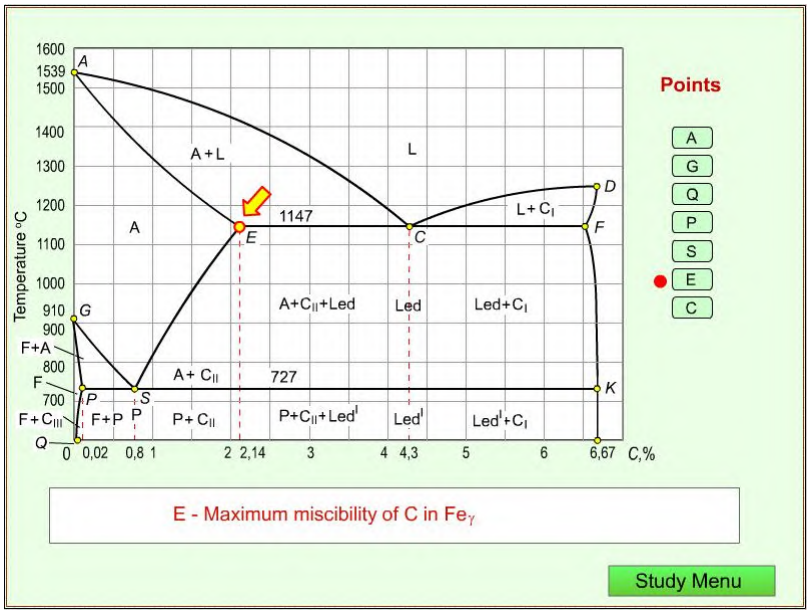

Figure2: Work frame for study of points of the diagram.

Figure3: Work frame for studying structural areas of the diagram.

In the self-assessing knowledge mode, a question is displayed in the text box below the diagram. In this mode, the lines and points function as buttons. When clicking a line or point, a message appears on the result with a prompt of the correct answer (Figure4.).

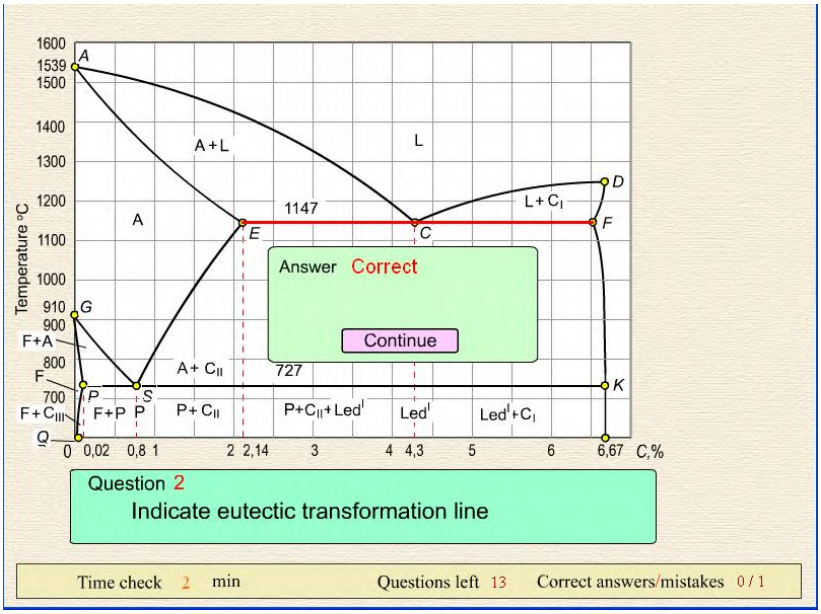

Figure4: Work frame for knowledge self-assessment mode.

In the final testing mode, the program works in the same way as the self-test mode, but without displaying a message about the wrong answer. Figure 5 shows the frame of the final testing mode based on knowledge of the diagram areas. There are totally 17 questions according to the number of areas. Of these questions, variants of test tasks are formed with 15 questions each. The test option is automatically selected. Testing time is limited to 15 minutes. Upon completion, a message about the results with the evaluation is displayed.

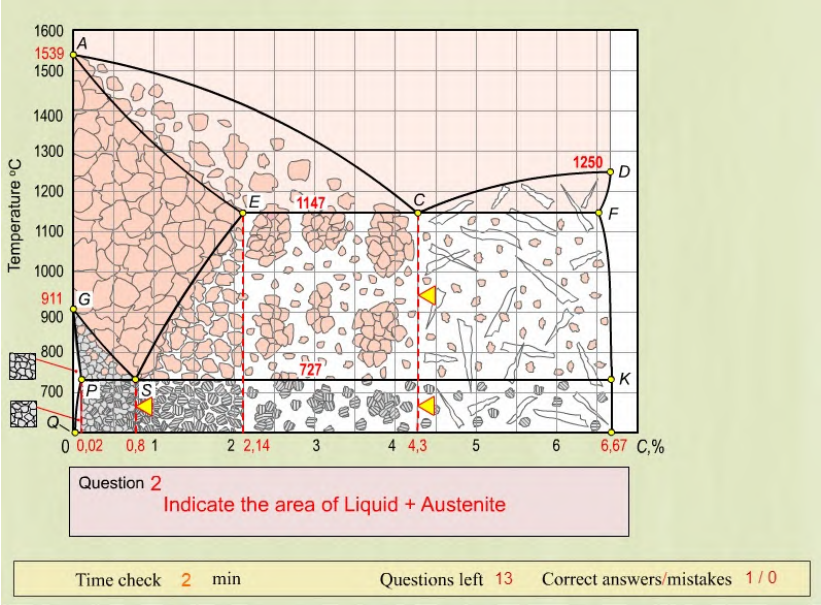

Figure5: Work frame for final test mode.

The above described program, as experience has proved, makes it possible with lesser time consumed to have a grasp of iron-carbon alloys and become fully aware of their applications under appropriate operational limitations.

4. Conclusion

In conclusion, we have shown with the example of the *Structure Formation in Iron-Carbon Alloys* Training and Assessing Program that computer-based training is a powerful tool for improving training and assessment within MET. It can be regarded best practice, as learning goals are achieved through the employment of appropriate instructional methods allowing for MET perfection: the material to be mastered is visualized, time needed for familiarization, practicing and testing is reduced, the grasp of the material is strengthened, and, consequently, the maritime industry receives well-qualified personnel.

The program is accessed via the Internet at http://msun.ru/dir/kaf_tm/educate/diagramma _19/ language/rus_engl.html.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Industry 4.0, Industrial Internet of Things and Shipping 4.0 epoch: tasks, challenges and problems

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ABSTRACT

Last decade true jump in approaches to developing and control of complex technical systems occurs. In maritime field technologies, based on Industry 4.0, IoT, IIoT, Shipping 4.0 concepts are implementing very actively. Thanks to vast progress in wireless and satellite data transfer technologies, mass appearance of embedded computer systems it's became possible to maintain links to the classical approaches, continuing maintenance of existing systems with upgrading them bit by bit, and at the same time to create most complex technical systems like fully unmanned ships, and also allow to perform absolutely new tasks like truly intelligent remote control.

Thus big innovative leading companies have created Maritime Autonomous Surface Ships direction, Unmanned Cargo Ship Development Alliance, Advanced Autonomous Waterborne Applications Initiative, Digital, Internet, Materials & Engineering Co-Creation technical ecosystem, One Sea Ecosystem Alliance, Distributed Intelligent Vessel Components software. As a result of these efforts on maritime field new digital transformation plans are appeared, which envisage creation of unmanned, autonomous and remote controlled ships by 2025 - 2035. But complexity and vulnerability for external intrusion of such ships are also growing enormously. So, in 2017 and 2018 some shipping companies and ports were attacked by hackers, suspended business activity and lost huge amounts. Therefore the task of maritime branch cyber security providing became also very actual.

Ways of modern concepts and technologies implementing in maritime branch are analyzed. Concrete directions of deep studying are shown. Possibilities and technologies, successfully realized in education process, are described.

Keywords: Industry 4.0, IIoT, Shipping 4.0, digital transformation, e-learning

1. Introduction

To achieve these goals big world companies made some steps. Thus Unmanned Cargo Ship Development Alliance is created; research projects Advanced Autonomous Waterborne Applications (AAWA) Initiative autonomous ship and Maritime Autonomous Surface Ships (MASS) are realized; Distributed Intelligent Vessel Components (DIVEC) software, supporting new protocol for device connecting and data transferring between them, is developed; Digital, Internet, Materials & Engineering Co-Creation (DIMECC) technical ecosystem and One Sea Ecosystem Alliance are created [1-6]. Members of these projects, alliances and initiatives are big innovative companies, leaders of maritime branch. As result of these efforts in maritime branch appeared and lie on the realization stage the plans of digital transformation, which assume creation of unmanned, autonomous and remotely controlled (in varying degrees) ships during 2025 – 2035 years, and in some cases even significantly earlier.

In AAWA project, created by initiative of Finland, following companies are participating: Rolls Royce Marine, DNV GL, Inmarsat, Deltamarin, NAPA Group, Brighthouse Intelligence, Finferries, ESL Shipping, and also some leading universities: Aalto University, Tampere University of Technology, Åbo Akademi University and VTT Technical Research Centre of Finland. Entire budget of the project is about 6.5 millions of Euro.

In 2018 Rolls Royce and Finferries companies have successfully realized SVAN (Safer Vessel with Autonomous Navigation) collaborative project. This was first worldwide demonstration of remotely controlled autonomous ferry with focusing on improvement of safety and ship control, which allowed to show to ship owners and seafarers of the whole world in quite close years in connection with fast coming of Ship Intelligence era.

June 15, 2018 Aker Arctic Technology company has successfully tested the model of autonomous ship in its "ice" laboratory in Helsinki. In demonstration test the model of the ship has detected the obstacles, using onboard sensors, maneuvered near them without operator intrusion and has been moored itself to corresponding pier.

2. Method

The test was performed in the water without any ice. Usually "ice" laboratory Aker Arctic is used for icebreaking ships testing, but also it offers wonderful numerous possibilities for developing and testing of technologies, sensors, algorithms and propulsion control systems, which are developed for autonomous ships, working in harsh environmental conditions. Wireless model of the ship, used in this test, was equipped with battery, which supplied following modules, listed below.

1. Module of propulsion plant.
2. Module of data transfer to "shore buildings" of so called "shore".
3. Module of autonomous navigation system, which guided the ship model around obstacles, detected by onboard sensors.

Different components are connected using recently developed by Aker Arctic company DIVEC software. Network infrastructure is provided by modern protocol, which is organizing devices' connection and data exchange among them. Relatively simple, but highly efficient network architecture was originally developed for high ice loading monitoring system for data transferring between different systems. DIVEC software proposes and supplies extensible and adaptable infrastructure, which allows to interact with systems and components of large number of manufacturers. Technology, used for testing of model of autonomous ship in laboratory, may be adapted for using with part and full scale prototypes.

The Unmanned Cargo Ship Development Alliance, leaded by Chinese HNA Technology Group, was formed by 9 participants, among them ABS Classification society, China Classification Society, China Ship Research & Development Institute (China Ship Scientific Research Centre), Shanghai Marine Diesel Engine Research Institute, Hudong-Zhonghua Shipbuilding, Marine Design and Research Institute of China (MARIC), Rolls-Royce and Wärtsilä. Alliance Plans to create and to float unmanned cargo vessel by October 2021. This ship will integrate the possibilities of independent decision making, autonomous navigation, surrounding circumstances analyzing and remote control.

Maritime Autonomous Surface Ships general direction by definition of Institute of Marine Engineering, Science and Technology (IMarEST) may be subdivided to 2 branches:

Unmanned surface vehicles (USV) may be controlled remotely, but specialist, which controls them, must not be on board a ship or near it;

Autonomous surface vehicles (ASV) are self sufficient systems, which don't require any intrusion of operator after launching.

The UK Maritime Autonomous Systems Regulatory Working Group (MASRWG), which is working on regulatory issues, is created in Great Britain, and in period January 17-18, 2019 corresponding conference UK Maritime Autonomous Systems Regulatory was held.

Completely different questions, connected with development and maintenance of autonomous ships and facilities of their control, are regularly discussing on variety of world level international conferences, connected with maritime transport.

But technical complexity of such ships and their vulnerability from external intrusions became extremely huge as well. So, in 2017 и and 2018 some shipping companies and ports were attacked by hackers and were forced to stop significant part of theirs business activity for some time, having enormous financial losses. That's why the task of cyber security providing in maritime field also became extraordinarily actual.

Understanding this perfectly, maritime companies and organizations bring to the forefront not only themes of application of modern information technologies in the fleet, but also methods and facilities of cyber security level enhancement. Thus, January 23, 2019 in Lisbon was held 1st Transport Cyber Security Conference, organized by The European Union Agency for Network and Information Security (ENISA). Conference was held at support of Directorate General for Mobility and Transport of European Commission, DG MOVE, European Union Aviation Safety Agency (EASA), European Maritime Safety Agency (EMSA) and EU Agency for Railways (ERA).

There were 170 conference participants from entire Europe, which presented all transport branches. They have discussed program of European Union on cyber security,

its importance for transport sector, and also discussed the ways for further collaboration. The ways of further implementation of Directive on Security of Network and Information Systems (NIS Directive), taken to execution from August 2016, which had to be adapted during 2018 to laws of each country, were discussed as well. In particular was raised the question about necessity of developing of knowledge and practical skills in cyber security field, and increasing of overall culture in cyber security field. Also the necessity of cooperation deepening among DG MOVE, DG CONNECT (Directorate General for Communications Networks, Content and Technology), ENISA, EASA, EMSA and ERA to enhance significantly the situation with cyber security in transport branch was shown.

During the conference it was also decided the following:

1. To follow the NIS Directive in accordance with needs and specificities of each kind of transport closer.
2. To stimulate information and experience exchange, including cyber security aspects as standard item at discussions during meetings of Aviation Security (AVSEC) и Maritime Security (MARSEC) committees, and also Stakeholder Advisory Groups on Maritime Security (SAGMAS), Aviation Security (SAGAS) and Land Transport Security Expert Group (LANDSEC), which are occupied with security questions.
3. To enhance qualification on cyber security of all employees in transport sector. DG MOVE has to support development of toolkit, containing actual and necessary knowledge about successful solutions on cyber security for transport staff.
4. To continue the dialogue on cyber security with third countries and to collaborate with International Civil Aviation Organization (ICAO) and International Maritime Organization (IMO).

Taking unto account significantly increased technical complexity and automation level of maritime systems, IMarEST has created the Special Interest Group (SIG) to solve the following tasks:

- identification and evaluation of existing and newly arising cyber risks;

- developing of preventive recommendations for improving of understanding and proposing of practical facilities for problems solution;
- sharing of information for maritime engineers, scientists and another specialists, which work with mentioned systems.

Following goals will be included to corresponding formed list of Maritime Cyber Risk Management SIG, but not limited:

- forming of awareness on above mentioned problems;
- identification of ways on trustworthy information getting on cyber threats;
- analysis and implementation of best practices with basing on IMO guides, Baltic and International Maritime Council (BIMCO) recommendations, international standards on information security of ISO/IEC 27000 group in general and ISO/IEC 27001 in particular, created in cooperation by International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC);
- providing input to normative work on maritime cyber risks management in IMO, in European Union and another international organizations;
- enhancement of organizing and training on mentioned questions on board of ships and on shore;
- discussing of approaches and means of maritime cyber risks control as precondition for getting permission to putting autonomous ships into operation.

In Amsterdam in June 2019 Autonomous ship symposium is scheduled. Thus, field of information technologies and cyber security running forward... News are arriving like from cornucopia!

In Lewis Carroll's book "Through the looking-glass, and what Alice found there" there is very interesting phrase, which is characterizing modern world and rate of its development from philosophical point of view: "... it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!"

In 21st century this is destiny of enterprises, organizations and stand-alone specialists, which don't want to be behind the "waves of change" of technical progress and to remain at the bottom of professional ladder.

Thus, it's proposed to improve and deepen learning of information technologies in Maritime Education and Training (MET) institutions in following directions.

1. IoT, IIoT, industrial data transfer technologies, networks and protocols.
2. Wireless data transfer technologies.
3. Hardware of wide class computer control systems, including industrial computers, programmable logic controllers (PLC), integrated or embedded computer systems.
4. Satellite data transfer systems and technologies.
5. Cyber security aspects and technologies.
6. Big data, artificial intellect, virtual and augmented reality technologies.
7. Complex objects remote control technologies and protocols.
8. Cloud systems and technologies.
9. English language learning enhancement in general and information technology terms particularly in MET institutions by using, among other things, English language learning books and with English language using classes leading on corresponding subject.

To achieve these goals it's necessary to use specialized equipment and hardware (not only standard computers), special software like Wireshark traffic analyzer [7] and distance learning (e-learning) technologies.

It's necessary to hurry! If not to pay attention to mentioned points urgently, it will be extremely difficult to liquidate accumulated gap.

3. Findings

Theory of Automatic Control and Computing Machinery department of National University "Odessa Maritime Academy" participates in EduNet (Education Network) program from 2011 and participated in TATU (Trainings in Automation Technologies for

Ukraine) project in 2013-2017 [8]. Programmable Logic Controllers, network switches, wireless access points and some another equipment allow to learn studying disciplines, connected with mentioned above pp.1-3 [8 – 11]. E-learning system based on MOODLE platform is used for students' remote access to corresponding teaching materials [11].

4. Conclusion

Ways of modern concepts and technologies implementing in maritime branch are analyzed. Concrete directions of deep studying are shown. Possibilities and technologies, successfully realized in education process, are described.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Towards Introducing Knowledge Management Concept to Maritime Education & Training

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ABSTRACT

Knowledge Management (KM) had been one of the hottest topics in the last decade, especially in knowledge-intensive and highly competitive organizations. Admitting that knowledge is a key asset in any organization, any management should start planning how to manage the knowledge available in the organization represented in employees, and how to establish a method to utilize and maintain such knowledge in order to become skilled at creating, acquiring and transferring knowledge to support sustainable development of the organization. The Maritime Education and Training (MET) is vocational education in general; requires highly qualified and field-experienced individuals to serve as maritime teachers. This arises the research problem; that mostly used KM tools may be good enough to efficiently manage explicit knowledge but do not manage implicit knowledge to the same extent, especially when dealing with an implicit-rich educational facility like marine simulators for example. Therefore, a system capable of concurrently managing both explicit and implicit knowledge is critically in need, in order to resolve the current problem.

Findings

- General Lack of defining KM.
- Lack of identifying the importance of KM, and as a result, failed to anticipate its effect.
- Strong wellness of policymakers and employees to contribute to the process of adding KM systems to the MET Domain. After being convinced with its essentiality.

- The practicality of the roadmap of implementation introduced by the research.

Keywords: Maritime Education and Training, Knowledge Management, Educational policies, Communities of Practice, Maritime Knowledge

1. Introduction

Knowledge is the backbone of any civilization. It affects, directly and indirectly, the building, development and the sustainability of the community in general. Nowadays, obtaining knowledge is an easy task, considering globalization and the availability/accessibility of information. The challenge is to sustain such knowledge in order to use it through various applications, in other words; manage your knowledge.

Knowledge Management (KM) concept had been a hot topic in the last few decades, it was found essential, especially in knowledge-intensive organizations. No doubt, knowledge is the main asset in any organization, which force any management to start planning how to sustain such asset represented in the knowledge of their employees, and how to find a way to utilize and maintain such knowledge. KM concept is important to enhance the understanding of how an organization becomes skilled at creating, acquiring and transferring knowledge to support sustainable development.

1.1 Aim

To Highlight the importance of Applying KM Concept into MET and Suggesting a roadmap enabling the swift entry of KM into policies and Quality Standard Systems of MET.

1.2 Method

Analytical/Critical review of the current level of KM application in MET domain. Data collected Using Qualitative methods.

2. Background Studies & Literature Review

2.1 Knowledge Management

Literature provides hundreds of definitions of KM, many of them are related to the context of information being used or processed within a system. On the other hand, some definitions suit all types of information. One of the widely used definitions is offered by Davenport [10] who stated that Knowledge management "is the process of capturing, distributing, and effectively using knowledge", as simple as that.

A different definition touches the context of information used in a company is the one introduced by Karlsen & Gottxchalk [21] "Knowledge management is a method to simplify and improve the process of creating, sharing, distributing, capturing, and understanding knowledge in a company".

The Gartner Group created yet another definition but carries a detailed description suitable to an information-intensive enterprise, expressed by Duhon [12] "Knowledge management is a discipline that promotes an integrated approach to identifying, capturing, evaluating, retrieving, and sharing all of an enterprise's information assets. These assets may include databases, documents, policies, procedures, and previously un-captured expertise and experience in individual workers."

At the same time, another set of definitions focuses on the human factor and introducing the concept of *Community of Practices (*COPs), like the one adopted by Swan, et al. [37] "Knowledge management is about harnessing the intellectual and social capital of individuals in order to improve organizational learning capabilities".

In addition, there are definitions that introduce Information Technology (IT) systems as a major player in a successful KM system as the definition laid by Tan, Et al. [38] "Knowledge management deals with the organizational optimization of knowledge through the use of various technologies, tools, and processes to achieve set goals".

The latest set of definitions may be suitable to be applied in an educational facility, although it will not cover the major aspects that characterize the maritime education. Given the nature of the industry, a Maritime Education & Training (MET) related KM definition may still be required to be innovated.

Abundance in the literature concerning KM concepts applied incorporates is clear, produced as early as the 1990s [17,18,40]. With the beginning of this century, the interest in applying KM concepts into education had been focused upon; it started with a trial to implement corporate-KM in education as did Kidwell et.al in 2000 & Bernbom in 2001. Then there was a huge studiousness surge into the matter when the Institute for the Study of Knowledge Management in Education (ISKME) was established in 2002. Since then,

there has been serious literature on applying KM in education, like what [34, 36] wrote in 2002, followed by Petrides & Nodine in 2003 and Metcalfe in 2006. It is fair to say that KM in education literature surged after the establishment of ISKME.

Although education may be the same when it comes to philosophies and theories, the application may differ when it faces a special nature of education, like maritime education. Maritime education is a vocational education, derived largely from vocational-knowledge and experience, which is reflected greatly in the scarcity of experienced maritime teachers.

The literature of applying KM in the maritime domain was greatly addressing the shipping industry either in running shipping companies like in articles and books of Fei in 2011 and 2013 or shipping logistics as written by Lee & Song in 2010 & 2015 and by Radhika in 2014 (14, 15, 24].

On the other hand, a modest approach was made to the application of KM in MET institutes were found in a few paragraphs on an article by Raicu & Niţă in 2008 in addition to a research done by Kitada, et al [22] about the application of KM techniques to improve online MET.

The absence of literature describing a seriously long time testing of the application of KM concepts and techniques in MET institutes will be the derive and contribution of this research, trying to find an appropriate tool to be implemented in a case study on the employees of an existing Maritime Education and Training Facility in the Middle East.

3. Types of Knowledge

Literature divides knowledge into three main types:

3.1 Personal knowledge (conceptual knowledge)

Also, called conceptual knowledge [40]. It is the first phase of knowledge, where an individual collects information in order to be familiar with something., it does not necessarily transfer into behavioral changes. It is the base for the next level of knowledge.

"Personal knowledge relates to firsthand experience, idiosyncratic preferences, and autobiographical facts" [19].

3.2 Procedural Knowledge (structural knowledge)

Next phase of knowledge is the procedural knowledge when we learn the know-how of things. It is the process of gaining information to do something in particular. When an individual gain a skill of actually doing something is said that he had the procedural knowledge of this thing.

3.3 Propositional Knowledge

Propositional knowledge is the primary concern of epistemology (Theory of Knowledge, 2017). It is simply the type of knowledge that affects your judgment positively, that makes an individual wiser and more competent at his profession. One can claim that this type of knowledge is the most challenging type, either in obtaining it or transferring it to others.

4. Types of Knowledge in the Maritime Education & Training domain

Knowledge in METs is always being utilized by Educators (teachers/instructors) and learners (students/trainees). Cross [8] once said, that finding a marine teacher is a very hard job, because of the non-ending claim that it takes a good seafarer to become a good teacher, and it takes a good teacher to become a good seafarer, so on and so forth.

The International Maritime Organization (IMO) regulated the maritime educational process in a convention named "International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers" (STCW). in the convention, there are specific requirements for maritime teachers, every administration (country) should have its own Quality Management System (QMS) defining the qualifications of their maritime teachers. The only thing that the STCW mandated in this matter, was that the maritime teacher should at least carry the same level of the certificate that he teaches [20].

The maritime student on the other hand, as an undergraduate, undertakes the first type of knowledge (personal knowledge) which he/she need to pass the first level of assessment. This level requires teachers to have enough personal knowledge to go around. But because of the special nature of the maritime education, there is a lot of

procedural knowledge involved as well, especially after the transformation of the STCW from being knowledge-based to a competency-based educational system [7]. In the STCW there are a lot of competences where it clearly says that the student should have the ability to perform certain tasks. In order to perform these tasks, he should be educated to do it, and in order to do that, his teacher should have this type of knowledge (procedural knowledge).

Going on, the MET does not stop at the college level, it is a continuous educational process as long as the seafarer is in service, and as long as his/her license is valid. There are certain courses needed to be undertaken to revalidate the sea-going license of the seafarer. These mandatory courses are typically transferring new techniques in several matters, as mentioned in the STCW.

For management level education and training, it is all about decision making. In the tense nature of sea life, decision making requires a lot of training and special capabilities, again the transfer of these abilities must be done through an experienced teacher who accommodates a certain level of propositional knowledge.

Lastly, to conclude, according to STCW, the level of the teacher is dependent on the level of education required for the trainee, undergraduate, operational level, management level, and mandatory revalidation courses. Where a mix of personal knowledge and procedural knowledge are needed in undergraduate level and to obtain the operational level certificate, and a mixture of procedural and propositional knowledge is required in the latent two levels of education, managerial level certificate and the revalidation mandatory courses.

5. Implicit and Explicit Knowledge

As discussed, KM is all about sharing knowledge with others sharing the same interest, based on interactive and transmission processes between producers and consumers of knowledge. This knowledge is either implicit or explicit.

Schacter [35] defines implicit memory by the limited control of conscious or intentional recollection of data. Reber [33] on the other hand, defines implicit learning as "the

acquisition of knowledge that takes place largely independently of conscious attempts to learn and largely in the absence of explicit knowledge about what was acquired".

The difference between implicit and explicit was expressed by Dienes & Perner [11] in an illustrative example "They didn't say so explicitly; it was left implicit". Furthermore, a formal differentiation between implicit and explicit knowledge is introduced by Polanyi [30]:

> *"Explicit knowledge is that which is stated in detail and leaves nothing merely implied. It is termed "codified" or "formal" knowledge because it can be recorded. Implicit knowledge is that which is understood, implied and exists without being stated. It is informal, experiential, and difficult to capture or share. It is knowledge that cannot be expressed"*

Because of that contradiction, Fei [14] claims that different KM methods should be used to deal with different types of knowledge. IT, for example, has limited outcome when implicit knowledge is transferred when a face-to-face approach should be facilitated for better results.

6. Knowledge Management Software

Searching for the history of KM tools, it was found that the need for an IT solution was evident following the booming in the application of KM in the industrial domain. The first few KM programs were introduced in the mid-90s, the first introduction of the same to Academia was in the 2000s. The actual booming into Academia took place when major universities started teaching KM in their majors, and a number of KM PhDs thesis were introduced [9].

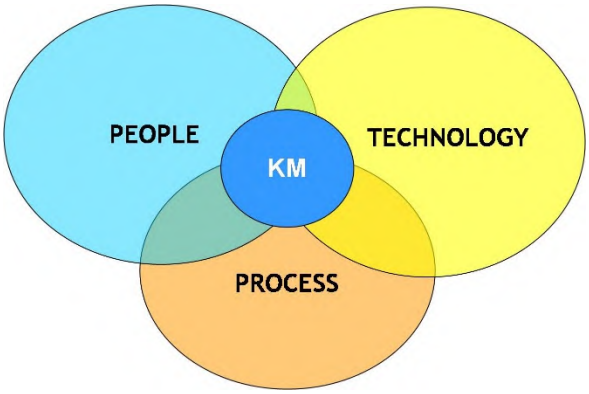

Figure 1: The Three Pillars of KM. Lyke-Ho-Gland [26] Want Better Process Management? Think Knowledge Management

6.1 Features Required for the Intended Software

In order to achieve the purpose of this research, the following features should be available in the KM software chosen to be used in the research process

1. **Method to retain both implicit and explicit knowledge.**

Able to handle all types of data; such as word, audio, and video in such a way that it can be easily stored and reached upon request.

2. **Statistical output**

Where the system can provide statistical data on the usage of the system for every user, time spent, and contribution. Also, the system needs to provide data regarding the availability of certain content and the number of users that holds such content, for example, if the user is looking for how many staff holds the knowledge of "ship stability", the system should provide the percentage and information about these knowledge holders.

3. **Content Management**

The system should have the ability to categorize and catalog data in a certain retheme either designed by the higher management or customized by the user himself. This would lead to a quick search for information and easier access to required data. Also, searching capabilities should be available.

4. **Personal accounts**

Every user should have his own account where he can contribute to the system, and at the same time, access the contribution of other users.

5. **Sends Notification to Users**

When any user updates the system with any kind of knowledge, other users should receive a notification. The notification may be set up according to "persons of choice" or "subject of interest".

6. **Accessible from management**

The hierarchy of staff members should be taken in consideration in the system, meaning that a department head should have access to the activities of his subordinates, either by full access to their personal accounts or by the availability of statistical reports of his/her activities. Using a master key-like password. This would ease the usage of "rewards and punishment" principle.

7. **Mobile Phone application**

Nowadays, ease of access is a must, knowledge must be available at the tip of your fingers using mobile smartphones. The mobile application does not need to have all the features of the system, but at least the major features should be available.

8. **Designed for educational purposes**

The utilizing of a KM system initially designed for educational institutes well far more effective than being originally designed for industrial or customer service usage. albite the data, information, and knowledge as concepts are still the same, but the utilizing capability is different.

9. **Helps and support the establishment of communities of practice (COPs)**

COPs had been identified as the heart and soul of any successful KM system, people of common interest share their experiences, one of the methods is through a KM Software. This should allow both official and un-official networking between colleagues, through chats, file sharing, commenting …. etc.

10. Repository of knowledge availability

Any kind of knowledge uploaded on the system should be stored and reached upon request. The entity may have its own servers in case of the sensitivity of such information, or it could use web-based programs or cloud storage to build their own repository.

11. Work with the organization's existing KM Technology

Most of the educational institutes have some level of KM in place, even if it is not up to the required level. Whatever the level of KM available, the nominated software should be able to absorb, work with, and upgrade it to a satisfactory level of KM implementation and build Capabilities over time.

12. Open source

If the software is of an open source nature, this will allow management to continually improve the software features. The necessity of change may surface over time, driven by the continuous development of the entity itself. In addition to customizing the software to meet the constantly changing needs of users.

13. Server Based

In the case of a Maritime Education Institute, the importance and the price of its knowledge will lead to the importance of having its own servers and storage facilities.

6.2 Market search for intended software

The number of available KM programs on the market is huge, in order to understand the nature of such software, a thorough study was made on a limited number of programs, looking for their suitability to the intentions of this research.

To make the study more applicable and fruitful, a recommendation from "Captera" [5], a virtual company that aims to help entities find the suitable software for the nature of their work, where they recommended top 20 programs for the year 2018. The research will

choose only the top 10 of the list for this review, of which all will be examined to their suitability to the AASTMT in precise.

Table 1: The Chosen KM Programs Compared to The Availability of the Research Intended Features

Feature	Availability											Feature Available
	Confluence	Inmagic presto	Zoho connect	Freshdesk	Bitrix 24	eXo Platform	MangoApps	iMeet Central	PHP KB	Auros	AASTMT Community	
Retain implicit & explicit Kn.	Y	N	Y	N	Y	Y	Y	Y	N	Y	Y	73 %
Statistical output	N	N	Y	N	N	Y	N	N	Y	N	N	27 %
Content management	N	Y	N	N	Y	Y	Y	Y	Y	Y	N	64 %
Personal accounts	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100 %
Notifications to Users	Y	N	N	N	N	N	Y	N	N	N	N	18 %
Accessible from management	N	N	Y	N	N	Y	Y	N	N	N	N	27 %
Mobile application	Y	Y	N	N	Y	Y	Y	N	Y	N	N	55 %
Designed for	N	N	N	N	N	N	N	N	N	N	Y	9 %

educational use												
Communities of practice	Y	Y	Y	N	Y	Y	N	N	Y	Y	Y	73 %
Knowledge Repository	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100 %
Work with Org. existing KM	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	82 %
Open source	N	N	N	N	N	Y	N	N	N	N	Y	18 %
Server based	N	N	N	Y	Y	N	N	N	N	N	Y	27 %
Total Wight of Software	54 %	31 %	54 %	31 %	62 %	77 %	54 %	31 %	54 %	45 %	62 %	

From table 1, the sample programs were inspected for the availability of the features that serve the purpose of this study. Giving that All features were given the same weight for their equal importance and their strong correlation, the following remarks were found:

- The most suitable programs are *EXO Platform – AASTMT Community – Britrix24.*
- The least suitable programs are *Inmagic Presto – FreshDesk – iMeetCentral.*
- The three features that are almost available in all programs are *Personal accounts – knowledge raspatory -Work with organization's Existing KM.*
- The features that are less available in most programs are *Notifications to Users - Designed for educational use - Open source.*
- The only software that is designed for educational purposes is the *AASTMT Community.*

From the above findings, this research will use the *AASTMT community* software for the following reasons:

- The program came second from eleven programs analyzed by the researcher.
- The software is the only program on the list that is designed specifically to serve the purpose of an educational institute.
- The research will be conducted on some of the AASTMT educational departments, and the AASTMT is the maker and the owner of the software, this will overcome a lot of logistical and security problems that may arise.
- Staff members that will participate in this research already have personal accounts on the program.
- The software is of an open source nature and can be developed to add all missing features by the aid of its maker.

7. Interviews

In order to legitimize the research, gain credibility, validate the research problem and to know how deep the problem has reached into the Maritime educational system. Also, to conciliate the practicality/suitability of the proposed solution and obtain an overview of the expectation of its outputs.

A number of interviews had been carried out over a long period of time, some of the interviews were made in a highly scientific/professional method, and some was less formal, and some were carried in a non-formal manner, depending on the time available and the circumstances of the interview.

The names and the identity of the interviewers will not be reviled because of privacy disclosures, but the researcher is free to declare that the professional positions of the staff members interviewed can clearly reflect on the overall subject, either to identify the problem or to evaluate the solution. (detailed information is available for authentication upon request).

The pool of interviewers is from different sectors of Academia, policy makers, educational deans, heads of departments, research and development, researchers, quality assurance

personnel, undergraduate studies administrators, postgraduate studies executives, student affairs, senior and junior lecturers.

7.1 Interviews discussion points and feedback

- **What is KM and how well it is embedded in our Maritime educational system**

All of the Higher managerial position interviewed had a very clear understanding of KM as a concept, the same understanding of the concept was not available at the majority of the non-managerial and junior staff members. Although after the concept had been introduced to who was not familiar, they all appreciated the vital role that KM play in delivering maritime education.

On the other hand, when asked about wither the KM is implemented in the current educational system or not, they all agreed that they cannot admit that there is any official KM tool being used to apply the concept, except few shy personal initiatives from individuals that will soon demolish eventually, as a result of absence of a fathering policy.

- **How would you suggest an action plan to apply/improve KM in your department/deanery?**

The researcher received a number of suggestions in this debate, varying from using computer software, data collection portal, content management system, to human-centered systems, like the communities of practice, scheduled meetings, non-formal gatherings, shadowing etc.

some may not have used the scientific name of the tool but at least they describe it well enough to reflect that they have a fair understanding of the concept and the deep will to contribute in case of adopting.

- **Do you think that KM as a practice should be a self-driven initiative from employees or an institute policy-driven from higher management?**

This was the single discussion item that all participants agreed upon. The KM in order to flourish it must be a policy-driven concept, following the "rights and liabilities" code. Personal initiatives will not live long in the absence of strong commitment from higher management. Of course, this does not relieve the employees from their responsibility

towards the KM system, but in the presence of rules and regulations, the application could be formally supervised and monitored through legitimate channels.

- **Do you believe that the roadmap proposed by the researcher will help resolve the problem (if any), and how well do you think the proposed solution will perform?**

Optimist interviewers saw that the road map proposed by the researcher as a solution to the lack of proper KM absence well most probably succeed, but will need great support from policymakers and some training on the software. Some had doubts in the ability of software engineers to achieve the level of required results, given the complicated nature of the scientific content of the maritime education

The pessimistic participants, on the other hand, didn't have much to say on the platform but had very strong doubts about the ability of personnel to adapt to the system and take a roll in its application, even in the presence of strong compulsory requirements from the administration. in their point of view, people have always ways to override the system.

Finally, all agreed that if we could overcome the technical challenge and were able to find a way to ensure people docility, the system will achieve its goal and KM will positively affect the quality of Maritime Education and Training

8. Findings

- General Lack of defining KM.
- Lack of identifying the importance of KM, and naturally, failed to anticipate its effect.
- Strong wellness of policymakers and employees to contribute to the process of adding KM systems to the MET Domain. After being convinced with its essentiality.
- The practicality of the roadmap of implementation introduced by the research.

9. Conclusion

In conclusion, knowledge management systems are an essential managerial tool used in any knowledge-intensive organization. Believing that the knowledge of its employees is the most important asset in any successful competitive organization; top management should always utilize its resources in the most beneficial way. In order to do that, this

paper had illustrated different aspects of knowledge management and its subsidiary theories. Also, discussed Nonaka & Takeuchi theory on the flow of organizational knowledge and how this theory would successfully be integrated throughout the educational system backed by strong formal and non-formal Communities of Practice (COPs) and a powerful functional Content Management System (CMS).

Therefore, this research recommends that all Maritime Education and Training Institutes shall construct/develop a Knowledge management model/system and implant it in its quality standard system where all employees would obligatorily contribute in. In this way, knowledge will be retained within the institution, and the overall performance of the Institute would surely magnify.

For further research, the complete design of a knowledge management platform will need to take place and introduced to a sample of participants. On that ground, quantitative methods shall be used to measure the effectiveness of the tool concerning the quality of Maritime Education and Training.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Optimal Use of Port Cranes to Maintain The Environment of Port Cities

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ABSTRACT

Through the different dimensions of the problem that appeared with carbon emission standards according to the authorities ports through the useful life of the cranes and now the homogeneity and commitment to new environmental requirements and where the problem lies in the number of cranes using diesel as fuel to produce operating power can be used by using the so-called flywheel for energy storage as a power regeneration system to help reduce the maximum power requirements on RTG cranes used for loading or unloading ship loads. Where the operator can make minor adjustments by deploying a new smaller generator for RTG operation. This generator will reduce fuel consumption, reduce emissions and reduce operational costs of reducing the amount of fuel that can over the long term offset the proposed additions and modifications. The current paper is detailed. The current paper focuses on reviewing the amount of energy and fuel consumption that can be reduced in Tired Gantry (RTG) rubber cranes in container terminals using simulations. The variable speed generator will be integrated into the RTG and simulation results show that total energy savings will exceed 30% relative to conventional RTG. Which is proposed to include variable frequency drive (VFD) and brake resistors.

Keywords*:* RTG, Terminal, Fuel, Container, VFD.

1. Introduction

A number of variations and modifications can be used in the current proposal based on the following constants. For example, in any set of primary energy, basic backup power systems and energy storage can be used on any RTG crane such as the upper lift or lift system. In the case of an elevator system, power systems can be installed on the surface near the elevator shaft. The current proposal includes different scenarios for the components, methods, processes, systems and / or devices, as described in this paper, which includes different configurations, sub-assemblies and sub-assemblies. Skill and expertise in this area will understand how to make and use the current proposal after fully recognizing and understanding its aspects and is an example of improved performance, ease and / or reduced implementation cost.

2. The Challenge Features, Statement and Overview

RTG is the major contributor to the carbon footprint of seaports and is another major issue added to air pollution issues in seaports, a source of carbon emissions and a source of greenhouse gases. The large-displacement diesel generators include almost all RTG cranes, such as diesel generators that allow RTG the flexibility they need to move between corridors to complete container storages, and power that container terminals move containers at scheduled speed and avoid stacking. However, the diesel generators currently used in the RTG groups are a strong consumer of the energy source, which is the fuel. Here comes the increase in operating costs, especially with the rise in global fuel prices and secondly the source of emissions that cause many cancer diseases, especially for the cities where these ports are located. The total costs of operation of seaports, especially in light of the steady increases in the globalization operations and the direction of economies of scale.

The main task of the container terminal equipment (CTE) on the side of the quay is the trading of containers of various types and density, which is the main task of the port, but the critical aspects of this equipment is the negative impact on the marine environment and air for its dependence on fuel to generate the electrical energy necessary to operate

the equipment of various kinds, Pollution and air pollution caused by serious diseases such as cancers of various kinds and the current project works to the compatibility between the economic aspect of the operation of the equipment and the environmental side so that it does not result in additional costs to reduce profits Which is expected from the operators of the port terminal where the equipment varies in terms of technical specifications of each and through some technical solutions can reduce carbon emissions and also benefit commercially and through the restructuring of the operation of the equipment, which is illustrated by the current research where it is located on the sea side to exercise the task Its basic of loading and unloading the docking ship as soon as possible. Due to the large size of the container handling equipment (CHE) and its exposure to the sea, this requires the application of technical techniques during the transport of containers to and from the water operations and to and from the assembly area of containers by vehicles.

Therefore, the research paper analyzes the options for greening of bridge cranes and rubber cranes (RTG) in seaports in terms of energy consumption rates and emission reduction methods. In order to achieve the overall goal of the integrated preservation of the health of the population in the cities of ports and reduce the source of cancer, where solutions will be provided from the point of storage of waste energy, and reduce the time inactive, and improvements in the movement of movement of the sun, and the use of alternative fuels, . The decision-making criteria are used to provide justification for the condition of the Crane Crane as one of the solutions, which included meeting capital requirements in terms of operating cost overruns according to actual operation. Finally, information was provided on the local and global impact of emissions, the potential challenges to the implementation of the solutions put forward and the opening for further studies.

3. Objectives

We have several objectives:

1-1Survey the current landscape of technology to reach the most appropriate solutions that may reduce the use of power of the crane RTG and emission outputs that correspond to the dimensions of the current challenge

2-1Identify the available technologies available in the commercial market taking into account the dimensions of operating costs.

3-1 Evaluate both the technical performance of the cranes as well as the financial performance and the emissions resulting from the implementation of each option.(included in final report)

4-1Preparation of a survey of the operational feasibility of implementing the expected technology. (In the final report)

5-1 Preparing standards for commercial feasibility and standards of success. (In the final report)

4. Summary of Solution

Based on our findings, we recommend the following:

1-2From a financial considerations perspective, net present value (NPV) positive technological options with likely payback period of under 10 years include a diesel electric hybrid solution with energy storage using ultra capacitors, an engine start-stop system to reduce idle time, and the adoption of CNG as an alternative fuel.(In details will be with final report)

2-2 From an environmental considerations perspective, we analyzed the different retrofit options from the perspective of global carbon dioxide (CO2) emissions as well as local tailpipe emissions of nitrous oxide (NOx), sulfur oxide (SOx), carbon monoxide (CO), hydrocarbon (HC), and particulate matter (PM). The options have varying levels of impact on these different types of emissions, and each port would need to assess which combination is best suited to meet their objectives.

Cranes form a major portion of cargo handling equipment at any container port. Many of these cranes employ heavy-duty diesel engines, and emissions from these engines have a very direct effect on air quality in and around the port.

RTG cranes straddle multiple lanes of stacked containers, and can move 20 or 40 foot long containers weighing up to 65 tons, rubber-tired gantry cranes run on rubber tires that enable them to move from one line of stacked containers to another. The capacity of an RTG is defined by the maximum height and width of the stack, the maximum weight of the container that can be lifted, and the power of the onboard diesel engine if applicable. As an example, the RTG has a maximum lifting height of '1 over 6' and a maximum span of '7 + 1 truck lane'. The suspended portion of the crane, which receives the container, is called the "spreader". The main purpose of an RTG is to load and unload containers from trucks, and for the on-shore movement of containers.

The plurality of RTGs in use today are powered by large diesel engines. The engine runs a generator to produce electricity. All cranes drives are powered by electric motors using the electricity generated onboard. RTGs function by making three basic movements:

1) Hoisting (and lowering) movement– Router to or dedicated to raise (or lower) the spreader .

2) Trolley movement – to move the spreader transversely across and among the stack .

3) Gantry movement – to move the entire crane along the length of the stack

The maximum potential for regenerating power on an RTG crane is while lowering a container; energy can be captured from the movement of the crane, which occurs by virtue of the container's own weight.

Although the student research team was able to explore many solutions by studying the titles of the title of the current challenge, the team tends to the solution can be implemented in a short time through a training course for employees of the North Valley station through the operator, which spent huge investments 11 years ago only Taking into account not to Incurs additional expenses and the available solution depending on to

study the stages of the movement of the crane as noted above and work on the method of storage and energy saving.

5. Key Finding

The area refers to the relationship between time in minute and energy demand (KW), which according to previous studies indicates the following (Loading stage)

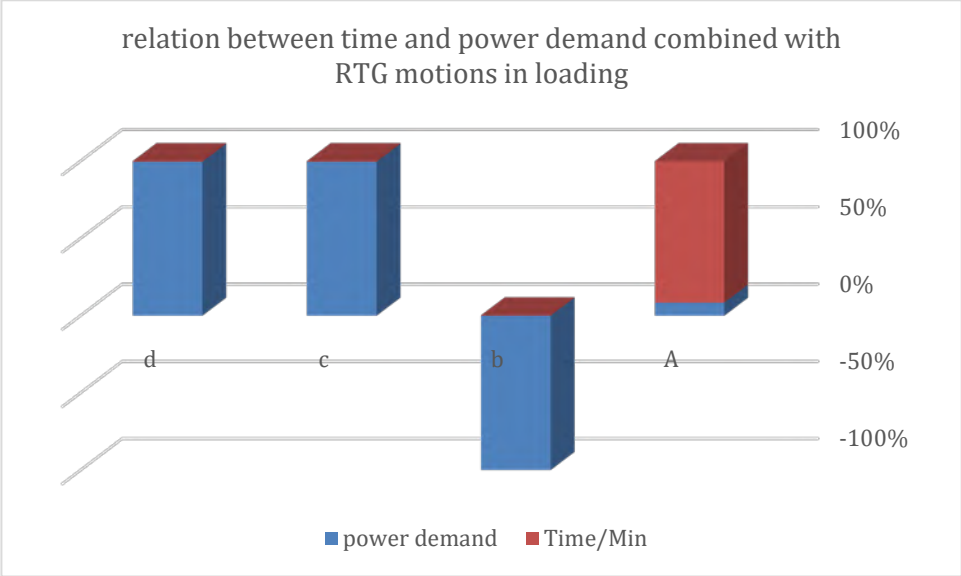

Figure 1: Power Demand

The above chart indicates strength indicators resulting from reduced movement of the Crane in the case of an inactive arm in a mechanical movement of the CREN. It also clearly shows the peak time in the power demand and operation of the arm where the lift movement begins. Studies have shown that power jacks are generated for 18 minutes during each hour of operation. The renewal capability is expected to be similar to RTG cranes. In addition, the maximum power requirement on an RTG diesel engine is only 4% of the total operating time, which means that if peak power demand can be reduced, the size of the diesel engine can be reduced and therefore wasted energy is saved.

Besides the continuous power during each move, the motors need to accelerate and overcome the inertia of the crane's moving parts such as the big cable reels. This creates a peak of extra power demand at the start of each movement. On the other hand, there also is a peak of negative power each time the crane decelerates at the end of each movement, albeit somewhat smaller because of the losses in the electric motors and inverters.

The power demand during each the motion with section "A" to "F" it will depends on the required power force, while the speed of the movement and the efficiency of the motors and inverters. The required force can also be negative or useless when the container is lowered or during braking .It is clear that the hoist movements dominate the power demand of the crane. The influence of the speed of the movements is visible by relatively small difference in the height of the peaks when the crane is empty and when it is full, e.g., between "B"' and "E". The peaks in the demand during acceleration and deceleration are also visible. Through the different dimensions of the problem that appeared in the northern station of the valley in terms of full compliance with carbon emission standards according to the authorities of the valley and since the operator has invested not long ago through the useful life of the cranes and now the homogeneity and commitment to new environmental requirements and where the problem lies in the number of four Twenty cranes using diesel as fuel to produce operating power can be used by using the so-called flywheel for energy storage as a power regeneration system to help reduce the maximum power requirements on RTG cranes used for loading or unloading ship loads. Where the operator can make minor adjustments by deploying a new smaller generator for RTG operation. This generator will reduce fuel consumption, reduce emissions and reduce operational costs of reducing the amount of fuel that can over the long term offset the proposed additions and modifications. The current paper is detailed. The current paper focuses on reviewing the amount of energy and fuel consumption that can be reduced in Tired Gantry (RTG) rubber cranes in container terminals using simulations. The variable speed generator will be integrated into the RTG and simulation results show that total energy savings will exceed 30% relative to conventional RTG. Which is proposed to

include variable frequency drive (VFD) and brake resistors. A number of variations and modifications can be used in the current proposal based on the following constants. For example, in any set of primary energy, basic backup power systems and energy storage can be used on any RTG crane such as the upper lift or lift system. In the case of an elevator system, power systems can be installed on the surface near the elevator shaft. The current proposal includes different scenarios for the components, methods, processes, systems and / or devices, as described in this paper, which includes different configurations, sub-assemblies and sub-assemblies. Skill and expertise in this area will understand how to make and use the current proposal after fully recognizing and understanding its aspects and is an example of improved performance, ease and / or reduced implementation cost.

6. Solution Features

Load lifting device includes:

I-4 At least one motor to drive the mechanical lifting device that has the capacity to raise the maximum rated load

2-4 At least one power storage unit to store electrical power and supply power to at least one motor, with output capacity storage (energy storage unit);

3-4 At least one major power system with the power to generate the power system, electrically connected to at least one power supply and at least one motor to provide electrically to the power unit referred to in the preceding clause

4-4 A unit that electrically connects at least one power supply, at least one main power system and at least one motor;

5-4 Control system to control the operation of at least one main power system and the lifting device. To monitor at least one power supply, Where at least one engine receives operational power selectively from at least one power supply and at least one main power system, at least one engine provides recharging power when the lift device reduces the load, where the ratio of the power system The main at least one of the estimated energy to peak load energy is between 0.2 and 0.7.

6-4 Here is the Load Lifting 1 where the power supply returns the regenerative braking power to at least one power supply to increase the stored power when the load-lifting device reduces the load.

7-4The load-lifting device 1 the electric carrier returns the regenerative braking power to at least one main power system when the load-lifting device reduces the load.

8-4 The load-lifting device 1 the electric carrier returns the regenerative braking power to at least one energy storage unit to increase the stored power and then transfers it to the main power system at least one when the lift device reduces the load.

9-4 The proposed lifting Load 1 has an energy storage capacity of between 100 and 5000 kWh, while the capacity of an energy storage unit is between 50 and 2500 kW.

10-4 Where the Load lifting referred to 1 has the capacity and capability to supply the main power system and at least one card ranging from 50 to 5000 kW.

11-4Lifting device for load 1 where the main power system includes at least one main source of energy selected from the group consisting of engines, diesel engines, gas turbine engines, small turbines, spark ignition engines, fuel cells, solar cells and electrical networks, controlled induction systems, A combination of that.

12) The proposed Load Loader 1 includes an energy storage system based on an energy storage system chosen from a battery pack, a bank of condensers, a compressed air storage system and one or more flywheels and a proposed combination. In this case, the load-lifting device of the application 1 shall be the energy storage unit part of the weighing load in the load-lifting device. Load Loader 1 the lifting device is selected from a group consisting of cranes, gantry cranes with rubber tires, overhead cranes, mobile cranes, and cranes from ship to shore, container cranes. In this case, the lifting devices 1 have not only the lifting capacity, but more than the ability to carry energy dissipation to replace the renewable energy on the electric carrier.

The lifting device 1 also includes an additional power system connected to the electric bus.

Proposed load-lifting device 1 A control system includes a selected controller of a group consisting of analog devices and programmable logic controllers on computers.

Load lifting 1 A load-lift device is a rubber bridge consisting of legs. At least one main power system is installed between each pair of legs mentioned near the end of the bottom of the legs.

Load lift device 1 Also where the load lifting device is a rubber bridge consisting of legs, and the installation of at least one energy storage between a pair of legs mentioned almost to the bottom end of the legs mentioned. In this case, the load-lifting device 1 where the load-lift device is a rubber bridge with legs, at least one of the legs is attached to the first pair of the above mentioned legs to fix the legs on the side The first of the jumper and the first main power system at least between the second pair of legs mentioned almost at the bottom end of the second pair of legs on the other side of the jib crane.

The load-lifting device 1, where at least one energy storage unit and at least one main power system are measured, are provided in an upgradeable model with receivers on a load-lifting device. It receives diesel engine and generator set. The load-lifting device mentioned 1 where at least one motor is selected from the set consisting of variable-speed drive motors, AC motor drives and DC motors. Load Loader 1 where at least one energy storage unit provides power regulation for at least one main power system.

7. Conclusion

Ports in general contain many equipment and kernels according to the type of goods that are traded with different types of ships. This causes the environmental pollution of the cities where these ports are located in terms of the carbon emissions resulting from the operation of this equipment, which often exceeds international rates and rates Which is implemented through international agreements such as MARPOL and port safety, which the current paper aims at in terms of solutions to reduce emission rates, which are inexpensive solutions in the short term and which depend on reducing fuel and emissions in the case of arm movement Which would reduce fuel consumption and decrease carbon emissions as well as reduce operating costs.

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III. Global Conference on Innovation in Marine Technology and the Future of Maritime Transportation
18th-19th of April 2019, Selçuk, İzmir

The Proceedings *of GMC '19*

Updating Issue in Standards of Training, Certification, and Watchkeeping for Seafarers (STCW)

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ABSTRACT

General consesnsus during that time that sea mishaps pointed to crew competency and training at a terrible cost to human lives. STCW –adopted in 1978; entered into force in 1984; too general, at the individual administration interpretation. There are till too many vague areas. These areas are related with the standards of competence; IMO oversight of compliance; port state control inclusion; provisions for new developments. The issue are taken through tasking IMO to allow for mutual oversight and consistency in application of standards, quality standards syetems(QSS), oversight of training, assessment, and certification procedures, placement of responsibility on parties.

Keyword: STCW, IMO, Standards, Training

1. Introduction

The 1978 STCW Convention was the first to establish basic requirements on training, certification and watch/keeping for seafarers on an international level. Previously the standards of training, certification and watch/keeping of officers and ratings were established by individual governments, usually without reference to practices in other countries. As a result, standards and procedures varied widely, even though shipping is the most international of all industries. (Xclusiveseaschool.com, n.d.)

The Convention prescribes minimum standards relating to training, certification and watch-keeping for seafarers, which countries are obliged to meet or exceed. The 1995 amendments (adopted by a relevant Conference) represented a major revision of the Convention, in response to a recognized need to bring the Convention up to date and to respond to critics who pointed out the many vague phrases, such as "to the satisfaction of the Administration", which resulted in different interpretations being made (Bueger, 2015).

The 1995 amendments entered into force on 1 February 1997. One of the major features of the revision was the division of the technical annex into regulations, divided into Chapters as before, and a new STCW Code, to which many technical regulations were transferred. Part A of the Code is mandatory while Part B is recommended. (Maritime.edu, n.d.) Dividing the regulations up in this way makes administration easier and it also makes the task of revising and updating them more simple: for procedural and legal reasons there is no need to call a full conference to make changes to the Code. Another major change was the requirement for Parties to the Convention that are required to provide detailed information to IMO concerning administrative measures taken to ensure compliance with the Convention.

This represented the first time that IMO had been called upon to act in relation to compliance and implementation - generally, implementation is down to the Flag States, while Port-State control also acts to ensure compliance (quality assurance/multiple layers of "defense"). Under Chapter I, regulation I/7 of the revised Convention, Parties are

required to provide detailed information to IMO concerning administrative measures taken to ensure compliance with the Convention, education and training courses, certification procedures and other factors relevant to implementation. (Shipping et al., 2011)

2. Evolution

General consensus during that time that sea mishaps pointed to crew competency and training at a terrible cost to human lives. STCW – adopted in 1978; entered into force in 1984, too general at the individual administration interpretation. Still too many vague areas. Severely limited – vague requirements that were left to the discretion of parties to the Convention. Increasing problems with standards of competence, IMO oversight of compliance, port state control inclusion, provisions for new developments. The need was made more urgent with the grounding of M/V Braer in the Shetland Islands on January 5, 1993; two years earlier in 1990, 158 people had died as a result of a fire on board the S/S Scandinavian Star. (Shipping et al., 2011)

2.1 First Amendment – STCW 1995

a. The noted enhancements – greater participation of port state control

b. Tasking IMO to allow for mutual oversight and consistency in application of standards

c. Quality standards systems (QSS), oversight of training, assessment, and certification procedures

d. Placement of responsibility on parties

e. Rest period requirements for crew

2.2 Second Amendment – STCW 2010

a. The increasing use of multinational crews

b. Responsibility for competency of crew, which once fell only on flag state administrations, is now spread over all parties that issue certificates

c. Issuance of "recognition" certification

d. The rapid development of new technology

Chapters II and III as well as the sections of the Code now require shipping company to participate and comply. Structure in the Code in the Details of the Competence tables were made more robust and structured to meet demand of new technology.

2.3 Amendments in 2010 comprises:

• 17 articles (due to legality) were unchanged to make way for the rapid process of "tacit agreement" of all parties

• Annex of regulations containing legal requirements made into 8 chapters; many of the regulations were amended

• Code is divided in 2 parts: Part A contains mandatory requirements; Part B contains recommendatory guidance

2.4 The Manila Amendments to STCW:

The Manila Amendments to STCW are intended to make the convention coverage more appropriate to the current industry. Indicative examples include:

a. e-navigation,

b. systems engineering,

c. electro-technology

d. leadership and teamwork

e. many others…

But:

There is still a serious need for raising the industry's awareness, improve the so-called "soft skills" (professionalism) of people involved in the maritime domain and certainly integrate in the current training programs a much better assessment of competence! (Mejia Jr, 2005)

2.4.1 Manila "changes" address the following:

- training in modern technologies, such as ECDIS;
- training in marine environmental awareness;
- training in leadership and teamwork;
- training for electro-technical officers and ratings;
- updating of tanker competence training;
- training for security (and dealing with piracy);
- introduction of modern training methodologies;
- training for ships operating in polar waters;
- training for operating dynamic positioning systems;
- certification requirements for able seafarers;
- stronger measures to prevent fraudulent Certificates of Competence (CoC) practices and improve monitoring of compliance;
- revised hours of work and rest (along with MLC 2006);
- prevention of drug and alcohol abuse (along with MLC 2006).

2.4.2 Manila Conference Resolutions

- Verification of certificates and endorsements
- Standards of training & certification and manning levels – manning is responsibility of administrations and ship-owners
- Promotion of technical knowledge, skills and professionalism of seafarers
- IMO was invited to update model courses
- Competence in polar waters
- Attracting recruits and retaining seafarers
- Provision of suitable on-board trainee accommodation
- Promotion of participation by women
- Amend STCW on 5 yearly basis, review every 10 years
- Day of the Seafarer

Mandatory Code Part A- New STCW 2010 mandatory training; ECDIS; Bridge resource management; Engine room resource management; Requirements of leadership ability on

all levels; Communication; Security training all personnel with security tasks. (Mejia Jr, 2005)

(Guidance) Code Part B- New STCW 2010 training guidelines for: Navigation in polar areas; Offshore Supply Vessels (OSV) (Anchor handling); Dynamic Positioning (DP); Damage control

What is a quality seafarer? - One that can be relied upon to ensure the efficient, safe, clean, secure running of the ship in achieving the purpose of the operation of the ship! 'Triple E'- Efficiently; Economically; Environmentally friendly. HOW to achieve this? - Train, Train (again), Retrain & (in the end) Retain… (Maritime Labour Convention et al., 2011)

3. STCW Conv. Chapters & STCW Code

Chapter I: General provisions

Chapter II: Master and deck department

Chapter III: Engine department

Chapter IV: Radio communication and radio personnel

Chapter V: Special training requirements for personnel on certain types of ships

Chapter VI: Emergency, occupational safety, medical care and survival functions

Chapter VII: Alternative certification

Chapter VIII: Watch-keeping

STCW Conv. Chapters & STCW Code- The regulations contained in the Convention are supported by sections in the STCW Code. Generally speaking, the Convention contains basic requirements which are then enlarged upon and explained in the Code. Part A of the Code is mandatory. The minimum standards of competence required for seagoing personnel are given in detail in a series of tables. Part B of the Code contains recommended guidance, which is intended to help Parties implement the Convention. (Shipping et al., 2011). The measures suggested are not mandatory and the examples

given are only intended to illustrate how certain Convention requirements may be complied with. However, the recommendations in general represent an approach that has been harmonized by discussions within IMO and consultation with other international organizations. (Bueger, 2015)

At the core of the amended STCW Convention lies the concept of competence. It is then necessary to recall the definition in section A-I/1 of Code A (p 75), which states, inter alia. The level of proficiency to be achieved for the proper performance of functions on board ship in accordance with internationally agreed criteria as set forth herein and incorporating prescribed standards or levels of knowledge, understanding and demonstrated skill. Competency based qualification is a statement of competence that incorporates assessment of skill, knowledge and understanding, as well as the proof of the ability to apply skills, knowledge and understanding to the proper performance of tasks, duties and responsibilities aboard ship. It involves the process of comparing evidence of competence against a standard. The major difficulty many institutions around the world are facing is in interpreting the standards in the competency tables in STCW Part A. The end result and "success" will be strongly associated with the methods & resources available to measure performance. (Encyclopedia Britannica, n.d.)

Competence based learning- Identify competence based performance standards; Compare these to presently applied practices; In case of differences then necessity to learn/train; Competence based standards as assessment framework; Accreditation of result of training efforts; Evidence of performance monitored and measured.

Brief Discussion of "Simulation Issue"- navigation equipment, GMDSS, radar, radar and navigation, ship handling, fisheries, inland waterways, dynamic positioning, crane handling, vessel traffic management, search and rescue, oil spill management, propulsion plant, steam generation plant, electrical power plant, refrigeration plant, cargo handling, ballast control, dredging ship, offshore processes, drilling technology. (Bueger, 2015)

IMO's Audit Scheme- The audit of all Member States become mandatory since 1st of January 2016, to determine the extent to which they give "full and complete effect" to their

obligations and responsibilities contained in a number of IMO treaty instruments. The mandatory IMO instruments included in the scope of the Scheme cover safety of life at sea (SOLAS 1974 and its 1988 Protocol); prevention of pollution from ships (MARPOL); standards of training, certification and watch-keeping for seafarers (STCW 1978); load lines (LL 66 and its 1988 Protocol); tonnage measurement of ships (Tonnage 1969); and regulations for preventing collisions at sea (COLREG 1972).

4. Peculiarities of the 2010 STCW

• Direct participation of shipping companies – appropriate certification; safe manning refresher training; record keeping; shipboard familiarization; crew coordination; SOLAS communication (maritime English)

• Responsibilities of Flag State – all 17 Articles in the Convention; all the 8 Chapters defining regulations in the Convention; all the 8 Chapters defining the Competence tables; all the sections in the Code Parts A and B

• Flag State is the sole implementing Administration for a particular party signatory of the STCW Convention

• New requirements: use of simulators; conduct of trials; explicit requirements mandated to the shipping companies for compliance

5. Relation of ISM Code and STCW

Both contain precise requirements containing the education and qualification of masters, officers and crew. ISM Code – description of structure of a Safety Management System, demanding its development, implementation and maintenance. STCW – supplies a legal basis for the uniform fulfilment of requirements as found in ISM Elements. Element 6 – Resources & Personnel (only certificated personnel are qualified to operate the ship). Element 7 – Shipboard operations (LSA, FSA – crew must be qualified to operate these equipment).

Element 8 – Emergency Preparedness ships to have contingency plans and must exercise drills.

6. STCW 1978

Sets qualification standards for masters, officers and watch personnel on seagoing merchant ships.

Amendments – STCW 78 to 95- Enhancement of port state control; Communication of information to IMO to allow for mutual oversight and consistency in application of standards; Quality standards systems (QSS), oversight of training, assessment, and certification procedures; Placement of responsibility on parties, including those issuing licenses, and flag states employing foreign nationals, to ensure seafarers meet the requirements; Human elements issues addressed; Increasing use of multinational crews; The responsibility for competency of crews, which once fell only on flag state administrations, is now spread over all parties that issue certificates; Strengthen the port state control provisions of the STCW Convention by expanding the grounds on which a foreign may be detained; Allowing port state control officers to look beyond merchant mariner's certificates and conduct direct assessments of the competence of merchant mariners; To address the problem of fatigue – every person assigned duty as an officer of a watch or as a rating forming part of watch shall receive a minimum of 10 hours of rest in any 24 hour period; these 10 hours of rest may be divided into two parts as long as one segment is at least 6 hours long, with strictly limited exceptions; Training requirements – seafarers to be provided with "familiarization training" and "basic safety training" which includes basic firefighting, elementary first aid, personal survival techniques and personal safety and social responsibility. (Caputo, n.d.)

Examination and demonstration of skills – minimum standards are presented in a table of competences with four columns:

- Competence or ability to be established
- Area of knowledge, understanding and proficiency within each competence
- Methods of demonstrating competence
- Criteria for evaluating competence

Objectives- Standardization; For State Parties to be country neutral

STCW Effectivity- STCW 1978 entered into force in April 1984; STCW 95 entered into force February 1, 1997; full implementation February 1, 2002; STCW 2010 Manila Amendments entered into force January 1, 2012; full implementation January 1, 2017

STCW Implementation: The Philippine Model- Legislation – from a Letter of Instruction (LOI) to Republic Act 10635; Monitoring of education and training of seafarers; ISO Certification – pursuant to the STCW requirement for a quality system; Information and education campaigns

STCW Business Model- Customer feedback; Quality and integrity issues with the product; Efficiency and effectiveness of the operation; Standards conformity; Alignment with others of the same product output; Acceptance with integrity stamp

7. Approach

Outward looking- What was the competition doing? How where they doing it? Best practices

Inward-looking- Review common practices being done. Infuse desired attitudes to achieve the goal

8. Tactical Plan of Approach

Simultaneous and with time line. Identify CPM (critical path). Target setting with time line. Results based evidence (milestones).

9. Coordinated Effort with External Stake Holders

Call in the "cavalry" (assistance); Start the lobby process

10. Identified as Top Urgent

Show stoppers – EMSA audit results; inter-agency relations; customer feedback on changes; political and legal support. Low hanging fruits – technical expertise; people management. SWOT analysis – identification of strengths, weaknesses, opportunities and threats. Allies and threats. Activation of manpower. Legal basis for ratification. Technical experts – build the force multiplier with specific targets in the courses, assessment and evaluation. Logistics support – commence the parallel logistic build up to accommodate

the expected surge. Focus groups. Quality team. Legal team. Monitoring team. Accreditation team. External intervention – legislative issues and conflict; political support; stakeholder's representation. Mock and Simulation Trials – trial balloon strategy; testing for acceptability; gathering feedback. (Caputo, n.d.)

11. Key legislative points in the Convention

- Article I
- Article IV – Communication of Information
- Sufficient number of specific certificates issued in compliance with the Convention
- The Secretary General shall notify all parties the receipt of any communication under this Article
- Article V – All prior treaties, conventions, arrangements relating to the standards of training shall have full and complete effect during the terms thereof

12. Summary & Conclusion

The key to maintaining a safe shipping environment and keeping our oceans clean lies in all seafarers across the world observing high standards of competence and professionalism in the duties they perform on-board. The International Convention on Standards of Training, Certification and Watch-keeping for Seafarers 1978, as amended in 1995 and again in 2010, sets those standards, governs the award of certificates and controls watch-keeping arrangements. Keep in mind that STCW provisions not only apply to seafarers, but also to ship-owners, training establishments and national maritime administrations. Maritime education and training needs should be considered, discussed, studied and analyzed via a multi-facet approach. Above all, they must be continuously improved upon. The status quo should never be considering acceptable and we should not be hesitant to experiment and, yes -even fail now and then- in order to make the necessary progress to improve the current state of the art. Time spent in a simulator worth each and every penny invested. Furthermore, the use of simulators for assessment of competence can help to reduce the use of written exams (which are still very useful for assessing the knowledge underlying the competencies). Looking at the issue of training for instructors in the maritime industry, the STCW requirements placed on them are

relatively vague! So, who it is that makes the best educators. Is it academics? Or maritime practitioners? The STCW does not require any particular experience of maritime trainers and the term "appropriately qualified and experienced" leaves a very large room to maneuver.

IMO's Model Courses- IMO has designed this series of courses to help implement the Convention on Standards of Training, Certification and Watch-keeping for Seafarers, (STCW), 1978, as amended and, further, to facilitate access to the knowledge and skills demanded by the increasingly sophisticated maritime technology. Each course includes a framework (detailing the scope, objective, entry standards, and other information about the course), an outline (timetable), a detailed teaching syllabus (including the learning objectives that should have been achieved when the course has been completed by students), guidance notes for the instructor and a summary of how students should be evaluated. The courses are flexible in application: maritime institutes and their teaching staff can use them in organizing and introducing new courses or in enhancing, updating or supplementing existing training material.

Hardware (equipment) vs Software (people)- Previously, IMO's Conventions/Regulations were focusing heavily only on hardware (introduction of modern equipment and ensuring safety by rather descriptive rules/guidelines). It is indicative the framework created by: SOLAS (the Goal Based Standards provide a paradigm shift); MARPOL 73/78; Load Line; ILO 147-MLC 2006; Classification Society Survey Rules; Recent legislation (the ISM Code & STCW) focuses more on the ability of the shore management and crew on-board (remember: software) to operate the ship and its equipment in a safe manner, with continuous regard for environmental protection.

The key to maintaining a safe shipping environment and keeping our oceans clean lies in all seafarers across the world observing high standards of competence and professionalism in the duties they perform on-board. The International Convention on Standards of Training, Certification and Watch-keeping for Seafarers 1978, as amended in 1995 and again in 2010, sets those standards, governs the award of certificates and

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ISBN: 978-605-01-1268-9