AN EMPIRICAL ASSESSMENT OF THE CHEMICAL TANKER INVESTMENTS

Dimitar Dimitrakiev, Ergun Gunes

Abstract: The purpose of this study is to make a clear definition of the chemical tankers and also to show legal impact of the regulations on the chemical tanker industry. Also, to analyses the pre-investment strategies of a chemical tanker from the scholars as well as practitioners point view and to find out the criterion for positive internal rate of return of the new built ship. The continuing technical development that characterizes the chemical tankers and the high value of the capital investments are combined to keep the operators involved in this highly specialized commercial activity. Although the market has been particularly difficult for the ship owners during last decade, they continued investing and building new tankers. One can't help but ask; what could be the main reason behind such a decision during a difficult market situation? Whilst one considers the factors behind an owner's decision to enter or exit the shipping market and their agenda for procurement, such as when to purchase, bare boat or time charter, they need to first look at the history of ship-owners as a whole.

Keywords: Chemical Tanker, Ship Investment, Net Present Value, Discount Factor, Internal Rate of Return

1 INTRODUCTION

Going back a generation, the shipping world was driven by only a few major family- owned companies. Whilst there is a place for this type of ownership to some degree, in this new world of consolidation, with competitive new building costs, ship acquisition and ship owning is now far more driven by cost of finance. Whilst finance was difficult to obtain immediately after the financial crash, it is evident by the number of new building orders since, that this was short-lived and finance is readily available, albeit with far tighter controls. With restrictions on finance and the global downturn coinciding with record-high oil & bunker prices, new breeds of ship owners began to emerge and change the shipping market place. It is the legacies of the financial crisis that have escalated consolidation and have caused the more traditional owning companies to begin re-trenching. These traditional owning companies have historically been driven by technical or managerial prowess and job creation with the ability to succeed in varying arenas, whether tankers, wet or dry cargo, containers off-shore or storage. Other, less risky owning companies have those that were less dependent on accessing finance or able to operate with smaller margins, due to economies of scale such as oil companies, commodity trading houses and even banking companies themselves.

Generally, categories of chemical tanker owners can be listed as:

- Publicly listed;
- Pool operators;
- Independent – family/traditional;
- Oil Company / Energy Company;
- Commodity Trader / linked fleet;
- Governmental / State-owned;
- Banking sector Hedge Fund linked.

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1.1 Definition of Chemical Tanker

As per the International Bulk Chemical code [1], a chemical tanker is a ship constructed and built with the main purpose of carry chemical cargoes named in chapter 17. They can be basic chemical tanker and sophisticated super-segregated chemical tankers that able to carry various types of cargoes at the same time, without having any common pipeline for loading, discharging as well as carrying it. As per MARPOL 73/78, Appendix II, Chapter 17, there are 750 different types of chemical cargoes listed, with different levels hazardous from the safety of life at sea up to the high risk of environmental pollution.

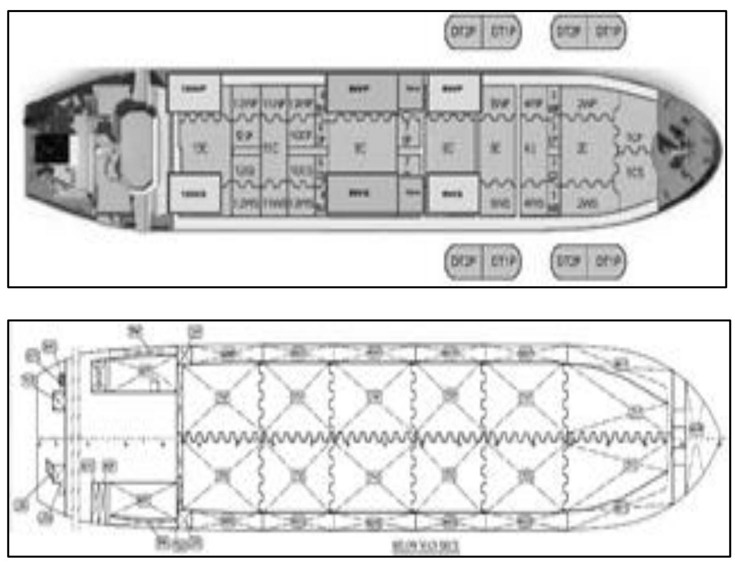

Figure 1. *The layout of the sophisticated super segregated and basic chemical tanker*

Also in this chapter are specified their shipment and transport rules as well as the type of chemical tankers than can carry those cargoes. As per their constructions, chemical tankers can be IMO 1, IMO 2 or IMO 3 of which specifies the level of hazardous and aggressiveness of the cargoes that can be carried with. A 'Type IMO 1' is a chemical cargo carrier constructed to carry products listed in IBC Code. Listed products in this category may have a strong environmental and safety impact and therefore it requires high precaution to avoid any potential pollution. Alkyl (C12+) dimethylamine, Chlorinated paraffin (C10-C13) and Chlorosulphonic acids are some examples for such aggressive cargoes, required to be carried with this type of chemical tankers and located into the cargo tanks with not bigger intake capacity than 1250 m3. IMO 2' is a chemical cargo carrier constructed to carry products listed in IBC Code. Products requiring carriage under IMO 2 have a severe environmental impact but less than IMO 1 products. Safe handling of these cargoes still requires appropriate safety precautions within the construction of the tank/ship to stop the environment coming into contact with these products. Alkylated (C4-C9) hindered phenols, Alkyl (C3-C4) benzenes and Ethylene dichloride are some examples for this type of cargoes. IMO 3' is a chemical cargo carrier constructed to carry products listed in IBC Code. These cargoes listed for IMO 3 carriage have a sufficiently severe environmental impact but is considered the least dangerous with regards to the code. Safe transportation is still of course required, so therefore appropriate ship/tank construction is necessary to decrease the impact of spillage into the environment if in a damaged condition. Acetic acid, Nitrilotriacetic acid, trisodium salt solution, and Choline chloride solutions are examples for similar cargoes.

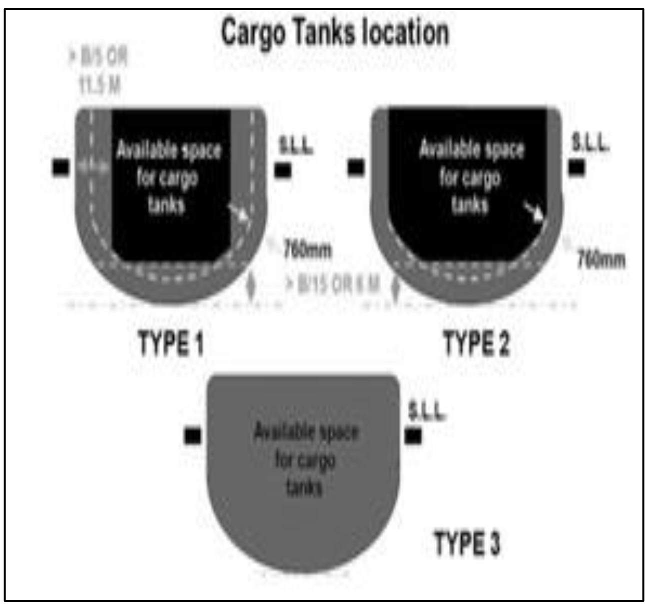

Figure 2. *Cargo Tanks Location of Chemical Tanker*

Chemical tankers which transport products with amply severe environmental and safety hazards which require a moderate degree of containment in a damaged condition can be referred to as Type 3 Chemical Tankers. (Fig. 2) In chemical tanker market does not exist any universal accepted categorization as same as in Product tanker market, but depends on their cargoes, sizes, types as well as tanks layouts they can be as follows (Fig. 3):

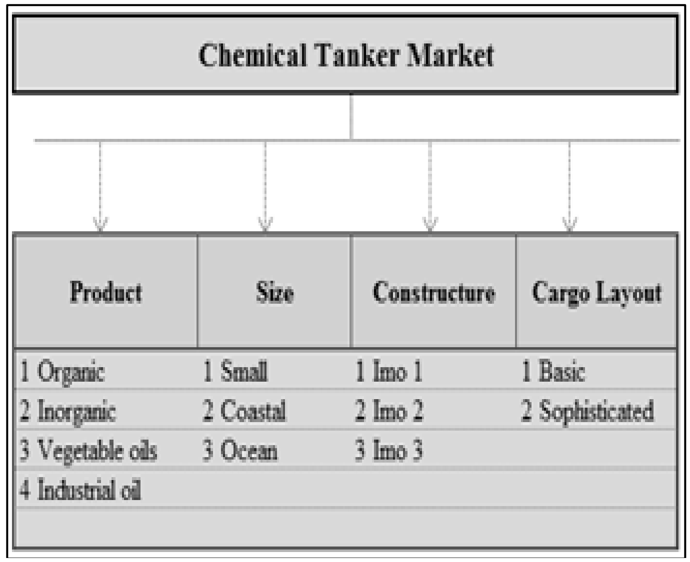

Figure 3. *Chemical tanker market categorization*

1.2 Recent Regulations Related to Chemical Tankers

1.2.1 Ballast Water Treatment System

A ballast water treatment system is designed to avoid spreading any potential contagious organism and bacteria in ships' ballast tanks. Using this system helps to remove any potential aquatic organism before the ship de-ballasts. This system has entered into the force on 8 September 2017. [2], [17] The BWM Convention requires that ballast water management systems used, to comply with the Convention, must be approved by the Administration taking into account the Guidelines for approval of ballast water management systems.

1.2.2 ECA / SECA Implication

The purpose of the changes of MARPOL Annex VI is to reduce emissions of Sulphur oxide and nitrogen oxide from the ships which will help protect the environment from air pollution. In general, SOX and NOX pollution (and other harmful expulsions)are created by the ships exhaust gases which are generated by combustion equipment and devices such as main and auxiliary engines, boilers as well as generators. Exhaust gas emission components that ships are creating can be categorized as below (Fig. 4):

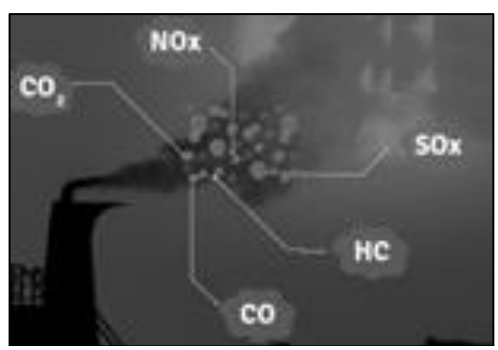

Figure 4. *Exhaust Gas Emission Components from Ships [3]*

- Nitrogen-oxide (Nox)
- Sulfur-oxide (Sox)
- Carbon-dioxide (CO_2)
- Carbon-monoxide (CO)
- Hydro-carbons (HC)

As of 2019 the following emission controlled areas exist (Fig. 5):

1. Baltic Sea including the North Sea region.
2. North American waters including most of the Canadian coastline.
3. Caribbean including Puerto Rico and the US Virgin Islands.

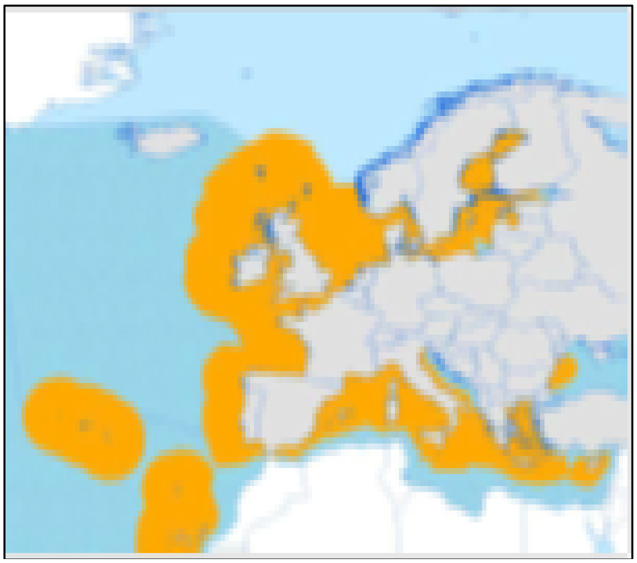

Figure 5*. ECA/SEA covered areas by 2020 [4]*

1.2.3 The Implication of IMO 2020 Regulation

IMO 2020 regulation will impose and create a pressure on the ship-owner to comply with the new restrictions for burning the fuel either by installing the scrubbers or replace high sulfur fuel (HSFO) to low sulfur fuel oil (LSFO), LPG or LNG as was advised by the MEPC 70 in October 2016. However, the new implications mandate 4 main alternatives to cover the new regulations.

1. Switching to very low-sulfur heavy fuel oil with 0.5 percent or less sulfur.
2. Changing to distillate fuel or marine gasoil with the same cap for sulfur.
3. Using other types of fuels that are likewise low in sulfur, such as liquid natural gas or methanol.

The last alternative is that the ship may continue to run on high-sulfur fuel oil, but then she must be equipped with exhaust stack scrubbers that capture emissions. After 1 January 2020, the ship-owners will have assessed the short to long term economic implications of scrubber use and choosethe optimal commercial decision for the individual owners' operational needs, even if the use of scrubbers is not chosen. [5], [16] They can switch from using traditional bunker fuels (High-Sulphur Fuel Oils, HSFO), to using Marine Gas Oils (MGO). These new MGOs can cost up to 50% more than the HSFO oils already being used.

1.3 Methodology

The NPV net present value method is a leading indicator of project effectiveness because it is most closely related to the goal of raising investor welfare through the investment. NPV represents the present value of future cash returns discounted at the relevant market rate less than the current cost of the investment. With regards to ship management, the application of ship investment strategies is confined to the basic investment valuation models, such as Net Present Value. [6] NPV is considered to be one of the most effective and indicative methods since it will make allowances for the change in monetary valuations over time through Discount Cash Flow [7]. When evaluating a project before making a final investment decision, the rating criterion and ranking for that method is the maximum positive net present value. On this basis, the following rule for decision making is made:

NPV > 0 – The investment is acceptable;
NPV < 0 – The investment should be rejected;
NPV = 0 – The investment is on the bard so additional analysis is required.

The main criterion for the NPV is defined as follows [8]:

$$PV = \frac{R1}{\left(1+\frac{p}{100}\right)^{1}} + \frac{R2}{\left(1+\frac{p}{100}\right)^{2}} + \frac{R3}{\left(1+\frac{p}{100}\right)^{3}} PV = = \sum_{t=0}^{N} \frac{Rt}{\left(1+\frac{p}{100}\right)^{t}}$$

In order to find net present value, the following formula applies:

$$NPV = \frac{R1}{\left(1+\frac{p}{100}\right)^{1}} + \frac{R2}{\left(1+\frac{p}{100}\right)^{2}} + \frac{R3}{\left(1+\frac{p}{100}\right)^{3}} - - I_0 NPV = \sum_{t=0}^{N} \frac{Rt}{(1+p/100)^{\wedge}t} - Io$$ [9]

Where:
R1 = Cash Flows for first year
R2 = Cash Flow for second year
R3 = Cash Flow for third year
P/100 = Discount factor
PV = Present Value
NPV = Net Present Value
I_0 = Initial Investment
N = Total Economical life of the ship

"R" includes all incomes and expenses that are covered by the shipowner during the whole construction, operation and scrapping cycle of the ship (Construction + Economic life + Resale (Scrap).These include capital expenses (initial payment "Deposit" for the ship's contract, loans, taxes, interest) and operating expenses (crewing, maintenance, insurances and admin fees) paid by the owner as well as scraping value and incomes from the freight and TC hires. This study shows that the calculation is not guaranteed mainly due to the significant uncertainties associated with NPV formula elements but is also standard for the calculation of returns.

2 PRE-INVESTMENT MODEL [10]

The price of a ship is based on the demand and supply of market transactions, which in most cases are provided by well-known broking companies. With a comparative goal, a time charter contract has been proposed, where the figures are taken into account according to broking companies reports. At the given calculation of the chemical tankers, it is assumed that the capital investments are funded with a 70% loan and 30% own equity. The effective interest rate on debt is currently considered to be 5.6264%. It is assumed that the chemicals are newly built and will be in operation in about 10 years before being sold in the second-hand market. There are also $ 95,000 administrative costs and $ 375,000 reserve finance is considered. (Fig. 6) For the purpose of this study, it is assumed that the ship is time chartered for a period of time. This approach is often used to avoid the negative result of using the conditions of a spot market and uncertainties of the market. Also, another purpose of such an approach can also be explained by the fact that, determining and assessing the relevant time charter equivalent, which is calculated in order to disclose and recheck the actual market level of the carriage being discussed. Given the fact that the ship will be registered under FOC (Flag of Convenience), and distribution of loan repayments according to the tax provisions "interest = cost / the principal –from the profit after taxation [11]" will not be mandatory. Resources in the depreciation fund will also not be necessary due to the lack of tax payments. Thus the capital costs during the loan repayment period are possible to be set up by the ship-owner to the full amount of the annual loan repayments. Furthermore the ship-owner will be free to set up the appropriate share of the operating profit as a depreciation fund.

Pre-Investment Model for Chemical Tanker		
New building price	*US$ 22,500,000*	*US$ 22,500,000*
Initial Investment	*30%*	*US$ 6,750,000*
Bank Loan	*70%*	*US$ 15,750,000*
Annual Loan Interest Rate	*5.63%*	*US$ 886,158*
Admin Expenses for the loan	*- US$ 95,000*	*-US$ 95,000*
Savings	*US$ 375,000*	*US$ 375,000*
Active life	*15*	
Discount factor /year	*1.00%*	
Annual Inflation	*3.00%*	

Income and Expenses		
Description	First 3 years	From 4th year onw
Daily TC Rate	US$ 9,750 / d	US$ 10,500 / d
Daily OPEX	-US$ 5,250 / d	-US$ 5,250 / d
Total days in a year	365	365

Annual Amortisation	
New building price	*US$ 22,500,000*
Ship Light Weight (мон)	*4,000 t*
Scrap Price per ton ($)	*US$/t 420*
Scrap Value of the tanker	*US$ 1,680,000*
Second-hand market value	*US$ 15,000,000*
Operational Period	*15 t.*
Annual Depreciation MIN	*US$ 500,000*
Annual Depreciation MAX	*US$ 1,388,000*

DAILY CASH FLOW			
TC Rate/Day [1]	*Opex - Day [2]*	*Capital Exp / Day [3]*	*Total Cash Flow [1]+[2]+[3]*
US$ 9,750	*- US$ 5,250*	*- US$ 2,462*	*US$ 2,038*

Figure 6*. Pre-Investment Model for New Building Chemical Tanker*

The main purpose of figure 7 is to calculate the effectiveness of the investment made according to market conditions. In today's market, 10,000 DWT Chemical tankers have a TC value of about $ 9,750 per day, and the ship is assumed to have a minimum 3 years' Time charter period contract, thus eliminating the uncertainties and negative effects of the spot market.

Year	*Incomes[1] US$ /y*	*Opex [2] US$ /y*	*Capital Exp [3] US$ /y*	*Cash Flow [4]*	*Discount Factor [5] = 1 / (1 + D)^N*	*NPV = [4] * [5] US$ /y*
0		*-6,845,000*		*-6,845,000*	*1.0000*	*-6,845,000*
1	*3,558,750*	*-1,916,250*	*-898,466*	*766,355*	*0.9901*	*758,768*
2	*3,558,750*	*-1,916,250*	*-898,466*	*789,346*	*0.9803*	*773,793*
3	*3,558,750*	*-1,916,250*	*-898,466*	*813,026*	*0.9706*	*789,115*
4	*3,832,500*	*-1,916,250*	*-898,466*	*1,145,525*	*0.9610*	*1,100,827*
5	*3,832,500*	*-1,916,250*	*-898,466*	*1,179,891*	*0.9515*	*1,122,626*
6	*3,832,500*	*-1,916,250*	*-898,466*	*1,215,288*	*0.9420*	*1,144,856*
7	*3,832,500*	*-1,916,250*	*-898,466*	*1,251,746*	*0.9327*	*1,167,526*
8	*3,832,500*	*-1,916,250*	*-898,466*	*1,289,299*	*0.9235*	*1,190,646*
9	*3,832,500*	*-1,916,250*	*-898,466*	*1,327,978*	*0.9143*	*1,214,223*
10	*3,832,500*	*-1,916,250*	*-898,466*	*1,367,817*	*0.9053*	*1,238,267*
11	*3,832,500*	*-1,916,250*	*-898,466*	*1,408,851*	*0.8963*	*1,262,787*
12	*3,832,500*	*-1,916,250*	*-898,466*	*1,451,117*	*0.8874*	*1,287,793*
13	*3,832,500*	*-1,916,250*	*-898,466*	*1,494,650*	*0.8787*	*1,313,293*
14	*3,832,500*	*-1,916,250*	*-898,466*	*1,539,490*	*0.8700*	*1,339,299*
15	*3,832,500*	*-1,916,250*	*-898,466*	*1,585,675*	*0.8613*	*1,365,820*
In Total	*56,666,250*	*-35,588,750*	*-13,476,986*	*11,781,054*		*10,224,638*

Figure 7. *NPV and IRR Calculation*

In the first scenario, the invested chemical tanker is assumed to have been in service for a 7-year period, after which the ship-owner decides to sell it for $ 15,000,000. The calculation will show following:

Resale value after 7 Years	Loan Value after 7 Years
$\sum_{0}^{7} \frac{\$\ \mathbf{15\ 000\ 000}}{(\mathbf{1+1.00})\text{^}\mathbf{7}} = \$\ \mathbf{13\ 990\ 771}$	$\sum_{0}^{7} \frac{\$\ 15\ 750\ 000}{(1+1.00)^{7}} = \$\ 14\ 690\ 309$

Assumption 1 - 7 years operating period before the ship is resale in second-hand market

Resale Price - Loan		
$ 13 990 771 + (-$ 14 690 309)	=	-$ 699 539

Total netincome after 7	=	$ 6 157 972
Initial Invested Capital (equity)	=	$ 6 845 000
NPV after 7 years	=	- $ 687 028

Resale value after 8 Years	Loan Value after 8 Years
$\sum_{0}^{8} \frac{\$\ \mathbf{15\ 000\ 000}}{(\mathbf{1+1.00})\text{^}\mathbf{8}} = \$\ \mathbf{13\ 852\ 248}$	$\sum_{0}^{8} \frac{\$\ 15\ 750\ 000}{(1+1.00)^{8}} = \$\ 14\ 544\ 861$

Assumption 2 - 8 years operating period before the ship is resale in second-hand market

Resale Price - Loan		
$ 13 852 248 + (-$ 14 544 864)	=	-$ 692 612

Total Net Income after 8 years	=	$ 7 355 544
Initial invested capital (equity)	=	$ 6 845 000
NPV after 8 years	=	$ 510 544

As a result, the study shows that the methods for analyzing the initial investment for any business are as same as in the "Investment in shipping" analysis. As already noted, whether the investment is good and whether to continue or reject, the results of the analyses, from which the following approach gives a clear idea to the ship owners and investors:

1. Investigating and establishing the value of the ships is usually done by shipbrokers reports.
2. Calculating cash flows of the investment for the operational/economic life of the ship as well as its second hand /scrapping value.
3. Calculation of the NPV of the investment.
4. Taking a strategic decision.

3 RESULTS

This study shows that the continuing technical development that characterizes the chemical tankers and the high value of the capital investments are combined to keep the operators involved in this highly specialized commercial activity. Although the market has been particularly difficult for the ship-owners during the last decade, they continued investing and building new tankers. In general, the shipping world was driven by only a few major family-owned companies. Whilst there is a place for this type of ownership to some degree, in this new world of consolidation, with competitive new building costs, ship acquisition and ship owning is now far more driven by cost of finance. Whilst finance was difficult to obtain immediately after the financial crash, it is evident by the number of new building orders since, that this was short-lived and finance is readily available, albeit with far tighter controls. With restrictions on finance and the global downturn coinciding with record-high oil & bunker prices, new breeds of ship owners began to emerge and change the shipping market place. Generally, the shipping business is a highly regulated market but in the chemical tanker market, due to the nature of the cargoes, this sector is even stricter than other divisions. Implications of BWM system, ECA/SECA pressure and finally IMO 2020 Low Sulphur bunker regulation make feel the owners that they are more focused on complying the legal requirements rather than commercial activities. Despite all that restrictions and difficult implication, the investors are still there to invest in new buildings. Stricter restrictions supposed to clear the market from old ships that it is not economically wise to retrofit the ships but to scrap it and stabilize the supply and demand curve! As a result, in this study is shown the calculation for 10000 dwt chemical tanker IMO II marine line coated assumed to trade at black sea and Mediterranean sea and as per given details, optimal duration for internal rate of return is calculated accordingly.

4 REFERENCES

[1] International Maritime Organisation, IBC Code (International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk). Linked Date: 21 May 2019.http://www.imo.org/en/OurWork/Environment/PollutionPrevention/Chemical Pollution/Pages/IBCCode.aspx

[2] International Maritime Organization.http://www.imo.org/en/MediaCentre/HotTopics/Documents/FAQ%20-%20Implementing%20the%20Ballast %20 Water%20Management%20Conventi on.pdf.

[3] Agarwal, M (2018), Understanding Various Components of Exhaust Gas Emissions from Ship. Linked date: 15 March 2019.https://www.marineinsight.com/guidelines/understanding-various-components-of-exhaust-gas-emissions-from-ships/.

[4] DNV-GL, (2014). Energy Efficiency and the Environment Seminar, DTO, Turkey.

[5] Liang. L. H (2017). What you need to know: The 2020 IMO Fuel sulphur regulation. Asia Editor, Seatrade Maritime News. Linked: 22 May 2019.http://www.seatrade-maritime.com/images/PDFs/SOMWME-whitepaper_Sulphur-p2.pdf.

[6] Girgin. S. C,.Karlis A,.Nguyen H. O, (2018) A Critical Review of the Literature on Firm- Level Theories on Ship Investment, International Journal of Financial Studies.

[7] Ivanov, I. D (2017), Investment Return in Commercial Centers in Bulgaria, Ph.D Thesis, Economy University, Varna.

[8] Girgin. S. C,.Karlis A,.Nguyen H. O, (2018) A Critical Review of the Literature on Firm - Level Theories on Ship Investment, Australian Maritime College.

[9] Harilaos N. Psaraftis, Dimitrios V. Lyridis and Christos A. Kontovas. (2012). The Economics of Ships. Blackwell Publishing Ltd. Published 2012 by Blackwell Publishing Ltd. Page 2.

[10] Gunes, E (2019), Investigation of Chemical Cargoes and Chemical Tankers in Black and Mediterranean Seas, Ph.D Thesis, N. Y. Vaptsarov Naval Academy, Varna.

[11] Petkov N. (2005), Lectures Notes. Technical University of Varna.

[12] Pires, F. C. M,. Assis, L. F,. Fiho, M. R (2012) A real options approach to ship investment appraisal. African Journal of Business Management ISSN 1993-8233, 2012.

[13] Haider, J. J. Ou, Z. Pettit, S. Analysing risk in ship finance. Cardiff Business School. Linked: 8 April 2019.https://orca.cf.ac.uk/74481/1/analysisng%20ship%20finance%20%281%29.pdf

[14] Stavseth, E. (2013). Introduction to ship investment analysis and ship financing. Linked: 12.12.2018 . http://shipstrategy.com/files/Introduction-to-Ship-Investments-by-Erik-Stavseth-March-2013.pdf

[15] Alexandridis, G. Kavussanos, M. G. Kim, C. Y. Tsouknidis, D. Visvikis, I. D. (2018). A Survey of shipping finance research: Setting the future research agenda. Working Paper.http://www.cutcfs.com/wp-content/uploads/2018/06/ TSOUKNIDIS-DIMITRIS-WORKING-PAPER-Survey-of-shipping-finance-research-DT-sent-to-me-on-24-may-2018.pdf

[16] Dachev, Y., Panov, A., Traditional Navigation in e-Navigation Context. 18th Annual General Assembly AGA 2017. IAMU, Varna, 11-13 October 2017, pp. 106-115, ISBN 978-954-8991-97-1.

[17] Dachev, Y., Lazarov, I., Impact of the Marine Environment on the Health and Efficiency of Seafarers, Journal “Business and Economics”. WSEAS, Vol. 16, 2019, pp. 282-287, ISSN 1109-9526, E-ISSN 2224-2899.