ESTIMATING THE SHIP DISMANTLING CAPACITY IN COMPLIANCE WITH THE EUROPEAN UNION'S SHIP RECYCLING REGULATION

Tomi Solakivi*, Tuomas Kiiski, Tuulia Kuusinen, Lauri Ojala
*Operations and Supply Chain Management, Turku School of Economics at the University of Turku, FI-20014, University of Turku, Finland, E-mail: tomi.solakivi@utu.fi, *Corresponding author*

Purpose
End-of-life ships are often dismantled in substandard conditions, causing environmental and health concerns. The European Commission has introduced a new Directive on the matter inspired by IMO's so-called Hong Kong Convention. The Directive calls that by the end of 2018, if not earlier, EU-flagged ships must be dismantled sustainably in shipyards certified by EU. This paper addresses two questions: i) what is the level of capacity needed in order to dismantle the existing EU-flagged fleet; and ii) how available EU-certified recycling capacity is able to match this need.

Methodology
The level of required dismantling capacity is estimated by size and age structure for all merchant ships under the EU-flag as per Jan. 1, 2017. Main research methods include descriptive statistics, regression analysis and ANOVA. The fleet data is obtained from the Clarkson World Fleet Register and dismantling capacity data is compiled based on official statistics.

Results
Based on actual fleet data, more EU-certified dismantling capacity is needed in the future. This suggests that EU shipyard certification process must be extended well beyond the borders of EU. Additionally, EU-regulation will most likely shift the dismantling market balance towards Europe, and thus increase the prices of dismantling.

Originality / Value
Literature that investigates fit between existing and required dismantling capacity of EU-flagged ships is both scarce and outdated. This research, derived from state-of-the-art statistics, answers this evident need. The paper contributes to policymaking by evaluating the implications of EU Ship Recycling Regulation while also providing valuable insights for the future.

Keywords

Ship dismantling, EU Ship Recycling Regulation, dismantling capacity

Introduction

The global merchant fleet comprises tens of thousands of ships, of which a portion comes to the end of their life each year. Ship dismantling refers to activity that breaks end-of-life (EOL) ships into pieces and puts the materials into further use. Shipping market cycles, technical obsolescence and demand for scrap metal are among the factors that drive dismantling activity (Buxton 1991).

Currently, over 90% of the global fleet is dismantled in the shores of South Asia, dominated by the shipyards in Bangladesh, India and Pakistan (CRSL 2017). Dismantling of EOL ships has both positive and negative impacts on the dismantling locations. Besides industry's labour intensity, ship's hull, machinery and other equipment offer valuable reusable materials, such as steel, non-ferrous metals and second-hand items (Sarraf et al. 2010), all of which are vital to local economies, especially in South Asia. At the same time, conditions of dismantling in terms of occupational health and safety as well as environmental aspects are often substandard (Andresen 2001; Abdullah et al. 2013).

For the past decades, policymakers around the world have been developing international regulatory framework to address ship dismantling industry's negative impacts as a response to growing concerns among the general public. The work started in 1989 when United Nations' Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (henceforth referred as Basel Convention) was signed, and was followed by Ban Amendment in 1995 (Moen 2008). Hong Kong Convention on Ship Recycling (HKC) was introduced by IMO in 2009. Notwithstanding of the efforts, the results are not convincing due to interpretation differences, ineffective enforcement or pending ratification (Moncayo 2016).

The European Union (EU) has taken active stance on ship dismantling by introducing the EU Ship Recycling Regulation (EUSRR) in 2013, which largely is inspired by the HKC. Consistent with the HKC terminology, and to illustrate sustainable and sound nature of the activity, EUSRR refers to ship recycling. The EUSRR contains a list of certificated shipyards (European List) that are allowed to recycle EU-flagged fleet (henceforth referred as EU fleet) (European Commission 2016). The first version of the European List accounts for around 1.1 Million lightweight tonnes (MLDT) so far, but the provision will enter in force by the end of 2018 or earlier if active certified dismantling capacity exceeds threshold value of 2.5 MLDT.

However, the adoption of EUSRR is not without controversy. One of the key concerns is the sufficiency of dismantling capacity of the European List (Alcaide et al. 2017). The availability of suitable capacity is one side of the matter but more importantly it comes down to the quantification of the need for the service. Estimating dismantling demand is a difficult task (Chang et al. 2010), while being subject to prevailing market conditions. For example, the preparatory study that formed the grounds of the EUSRR was based on statistics that differ the ones dominant since the global financial crisis (European Commission 2012).

The purpose of this paper is to evaluate what is the level of capacity needed to dismantle the existing EU fleet; and to estimate how the dismantling capacity in accordance with the European List is able to match this need, while taking into account the prevailing market conditions. More specifically, the future demand of ship dismantling is estimated by first calculating the average dismantling age of ships and then the annual fleet size.

The paper is structured as follows: First, key literature on ship dismantling, the regulatory framework and previous estimates on ship dismantling capacity are presented, followed by the empirical results from the statistical analysis. Finally, the results are discussed together with conclusion and suggestions for further research.

Literature review

Ship dismantling

After being acknowledged to be uneconomical to trade at sea, a ship is usually temporarily laid up, sold either in second-hand market or to a shipyard for dismantling (Buxton 1991). The rationale behind shipyards interest in dismantling EOL ships relates to the materials they are carrying. Lloyd's Register (2011) estimates that the recyclable materials account for 95% to even 98% of a ship's weight. According to Yujuico (2014) and Jain et al. (2017), about 80% of a ship's LDT is mostly recyclable steel scrap.

Currently, over 90% of global merchant fleet dismantling takes place in Asian countries and only less than 5% in OECD countries (CRSL 2017). Yujuico (2014) has estimated that approximately one third of global merchant fleet recycled in Asia is registered under EU flag. European Commission (2012) estimates that the dismantling volume of EU fleet ships accounted for over 0.8 MLDT in 2009. Reason why global dismantling market is so concentrated relates to the basic market fundaments. Asian shipyards are usually able to outbid their rivals due to number of reasons: high domestic demand for scrap steel; abundant supply of cheap labour; lax regulations in reference to environmental and safety aspects that entail low cost (Matz-Lûck 2010).
The choice of dismantling method – between landing, alongside, dry-docking, or beaching – determines much of the cost, safety and environmental effects (Choi et al. 2016). The use of methods is geographically focused. The most common method of dismantling in Indian subcontinent is beaching, where a ship is driven on a shore at high tide and dismantled once the tide has receded (Matz-Lück 2010). After sinking or abandoning it is considered as the most polluting method as harmful substances are soaked directly into environment (Yujuico 2014).

International regulation on ship dismantling
Over the past decades, international regulations have been established to control ship dismantling industry in an attempt to guarantee adequate level of environmental, safety and and health conditions. The Basel Convention became effective in 1992 to control the movement of hazardous waste. Its main purpose was to control the transportation of EOL ships, which potentially contained hazardous materials, to be dismantled in developing countries if they were detected (Matz-Lück 2010). In 1995, a more stringent approach was to follow through the adoption of the Ban amendment, whereby prohibiting transboundary movements of hazardous waste of which EOL ships are included (Moen 2008).

The HKC was established already in 2009, but in mid-2017 it is still waiting for ratification. It aims to protect workers as well as prevent pollution caused by shipyards, among other things, through stipulation that new ships must carry inventory of hazardous materials (Yujuico 2014). HKC does not explicitly take position against beaching as a dismantling method, which has been widely criticized (Mats-Lück 2010; Chang et al. 2010). Since it is not sustainable for the environment and the costs of dismantling ships in European countries are considerably higher according to Chang et al. (2010) and Matz-Lûck (2010), the EU has been adopting the most advanced regulation yet for ship dismantling (Yujuico 2014).

Numerous researchers have studied the possible effects of these regulations. Chang et al. (2010) have argued that new regulations will lead to growing need of reporting and wider documentation. Alcaidea et al. (2016) argue that new regulations has already had consequences for the ship dismantling industry because the market has been restructured and there has occurred more of third States flag use and setting up new yards in developing countries. More stringent environmental regulations are bound to increase costs for the South Asian shipyards. Yujuico (2014) suggests that the ‘demandeur pays’ would be a suitable approach in funding the transition towards more sustainable practices.

According to EU Green Paper on Better Ship Dismantling (2007) all ships’s flying the flag of a European Union’s Member State are to be recycled in facilities listed in the European List (European Commission 2016) which was established in December 2016 (European Commission 2007). Knapp et al. (2008) point out that the purpose of the Green Paper has mostly been addressing the issue of health and environmental concerns rather than propose a reinforcement of EU’s ship dismantling volumes. The facilities listed in the European List need to meet strict requirements in order to be certified and have the right to recycle ships from EU flagged owner countries (Mikelis 2013). Paris and Mukherji (2013) have argued that the EU regulation will influence EU's member states to ratify the Hong Kong Convention as well. Moreover, Knapp et al. (2008) argue that it is more likely for a European country to ratify the HKC having already a wide range of EOL ship's and ship dismantling regulations compared to countries outside the EU.

Ship dismantling capacity

There is a reasonably extensive record of studies concerning global ship dismantling capacity. According to Chang et al. (2010) estimating dismantling capacity is a difficult task given the differences in the fleet databases and often insufficient data reporting methods. More importantly, it appears that figures are subject to market conditions at a given time.

International Maritime Organization (2010) estimated that annual global ship dismantling demand would account for 15 MLDT, while Abdullah et al. (2012) provides a considerably higher figure of 60-70 MLDT. Similar variation is notable when annual demand is measured in number of ships: 500-700 ships (Andresen 2001); 900-1,000 ships (Mikelis 2007); up to 4,000 ships (Vedeler 2006). Considering the "safe and green" –capacity relevant for the upcoming EU regulation, Abdullah et al. (2013) have estimated the global green capacity to be approximately 0.78 MLDT annually.

The European Parliament has stated in 2013 the current ship dismantling capacity in OECD countries to be insufficient for EU fleet. However, it is also said that the ship dismantling capacity in locations that operate in an environmentally sound manner but are not located in OECD countries, is already enough to treat all recyclable ships from owners from the EU and will continue expanding. The European Commission's paper estimates that the need for ship dismantling capacity would account for about 1.64 MLDT in 2012-2030 to be able to recycle all EU flagged ships. These estimates, presented in the European Commission Green Paper on ship dismantling (2012) are based on data collected in 2009. Considering the drastic changes in the world economy and the shipping market since then, regarding ship dismantling it is imperative to conduct a research based on updated data.

Results

One of the first assumptions affecting the demand for dismantling is the average lifetime of the ships. The European Commission (2012) estimates the average lifecycle to be 31.7 years, based on the average age of ships dismantled in 2008 and 2009. However, such a short sample period neglects the development of the economy, and in particular the transport volumes, as well as the development of the world fleet, which all contribute first to the freight levels, and the dismantling age of the ships. For this purpose, the average dismantling age was calculated, based on the dismantling statistics of the Clarkson World Fleet Register (2017). Figure 1 presents the LDT weighted dismantling age of merchant fleet in 2005-2016.

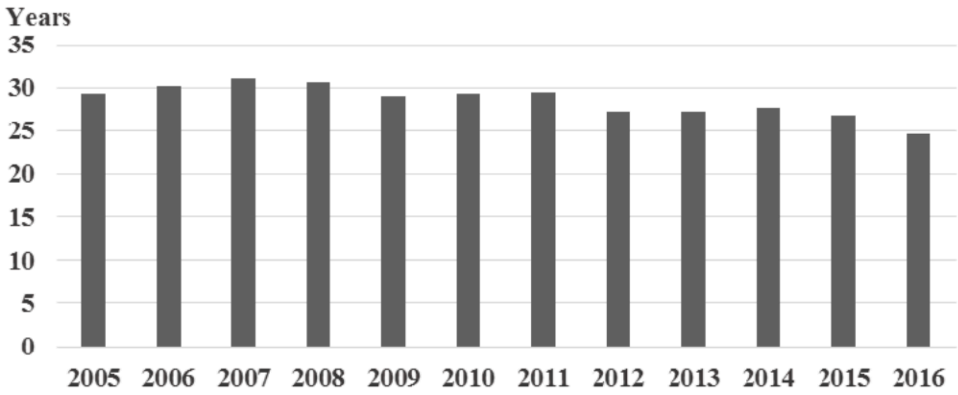

Figure 1. Average dismantling age of merchant fleet 2005-2016

The first observation from the figure is that the average dismantling age of the ships was on its highest in 2007 and 2008, exceeding 30 years. As a results of the financial crisis and the overcapacity in the supply of the ships, the average age of dismantling has since then declined into 24.7 years in 2016. This would indicate that the previous estimates of the European Commission severely overestimate the average lifetime of the ships in the current situation. Further, recent development has shown that potentially the average lifetime of a ship will most likely shorten even more, due to inappropriateness for the current situation (for example the expansion of the Panama canal) and to upcoming stricter environmental regulation.

The upcoming EUSRR (European Parliament 2013) requires that all the ships under the EU flag have to be dismantled in EU-certified dismantling facilities. The future demand for this dismantling capacity was estimated by calculating the LDT of all the commercial ships under EU flag in the Clarkson World Fleet Register Database, and by calculating the yearly sums based on the building year of the ship. As the most common measure for the ship size was DWT, and only a smaller portion of LDT:s were reported, the first step was to estimate the LDT to DWT ratio by ship type. At the same time, these ratios were tested with ANOVA to confirm, whether there were significant differences between the LDT to DWT ratios of different ship types. The estimated LDT to DWT ratios by ship type are presented in Table 1.

					95% Confidence Interval for Mean			
Ship type	**N**	**Mean**	**Std. Dev.**	**Std. Error**	**Lower**	**Upper**	**Min.**	**Max.**
Tanker	5861	0.244	0.097	0.001	0.241	0.246	0.060	1.650
Bulker	1897	0.195	0.062	0.001	0.192	0.198	0.080	0.710
Container	635	0.365	0.065	0.003	0.360	0.370	0.210	0.730
Dredger	239	1.786	2.984	0.193	1.406	2.167	0.000	35.580
Ferry	122	2.260	3.494	0.316	1.634	2.886	0.190	18.670
Gas	450	0.468	0.133	0.006	0.456	0.481	0.250	1.370
General cargo	341	0.335	0.102	0.006	0.325	0.346	0.200	1.410
Multi-purpose	894	0.395	0.084	0.003	0.390	0.401	0.220	0.930
Offshore	106	0.814	1.870	0.182	0.454	1.174	0.020	16.980
Oth non cargo	5	3.493	5.045	2.256	-2.771	9.758	0.180	11.670
PCC	84	0.965	0.184	0.020	0.925	1.005	0.540	1.460
Reefer	53	0.631	0.150	0.021	0.589	0.672	0.410	1.200
Ropax	14	0.829	0.285	0.076	0.664	0.994	0.270	1.290
RoRo	105	0.760	0.327	0.032	0.697	0.823	0.350	3.350
Tug	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cruise	7	4.669	2.053	0.776	2.770	6.568	2.480	7.590
Average	**10813**	**0.347**	**0.714**	**0.007**	**0.334**	**0.361**	**0.000**	**35.580**

Table 1. Estimated LDT to DWT –ratio by ship type

The average LDT to DWT ratio of commercial ships was found to be 0.347. However, as can be seen from Table 1, there are large differences between the ship types, the lowest (0.195 LDT per DWT) for the bulk-ships, and the highest (4.669) for the cruise ships. Based on ANOVA, the differences between the ship categories were mainly significant, confirming that the demand in LDT should be estimated by ship type.

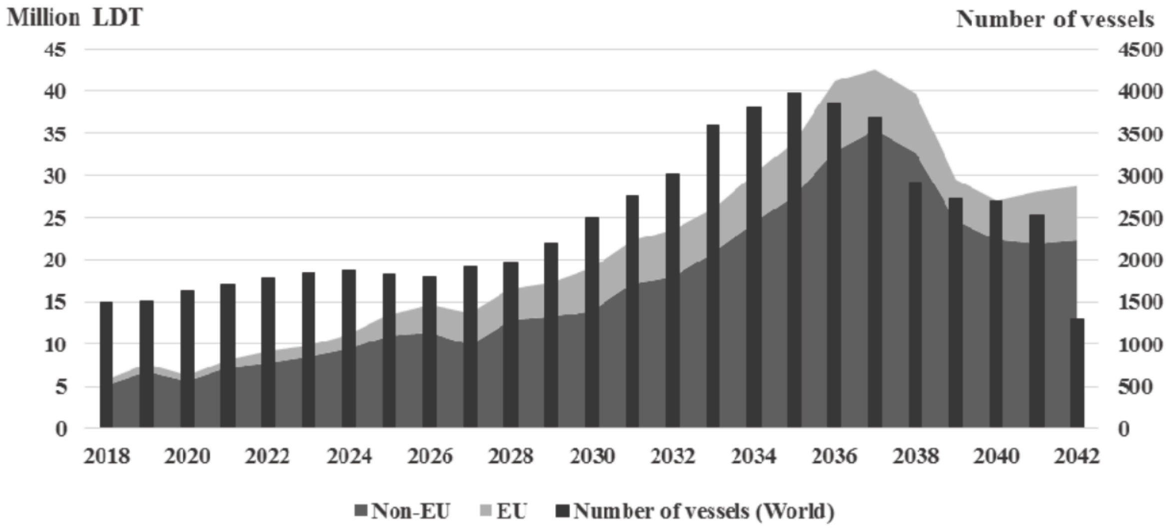

Figure 2. Estimated demand for ship dismantling 2018-2042

Figure 2. presents the estimated demand for ship dismantling in 2018-2042. For this, the size of the world merchant fleet (by ship type and building year) was calculated by using the LDT to DWT ratios in Table 1. As the existing fleet also contains ships over 25 years old, they were smoothened evenly over the time period.

Based on the assumption of 25 years average lifetime, global demand for ship dismantling is expected to increase from around 5.1 MLDT in 2018 to 42.6 MLDT in 2037, after which the demand for dismantling will decline to around 28 MLDT in 2041. For the EU fleet the demand will increase from 0.6 MLDT in 2018 to 8.4 MLDT in 2036. In case demand is measured in number of ships, respective numbers for the global fleet in 2018–2034 increases from 1,495 to 3,981 until dropping to 1,288 by 2042. A similar trend – albeit in a smaller scale – is notable for the EU fleet as the number of grows from 130 to 652 in 2018–2035 till declining to around 320 by 2042.

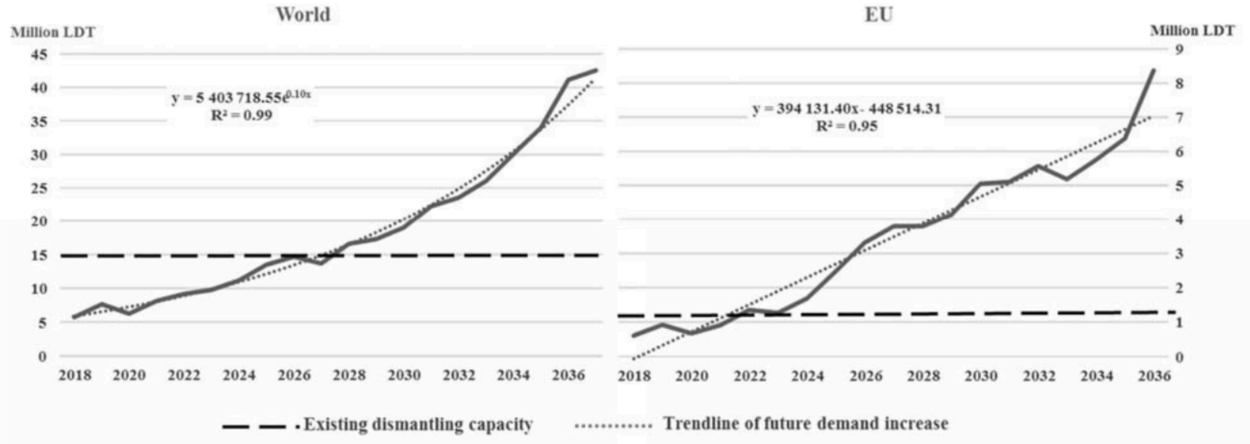

Figure 3. Estimated increase in demand for ship dismantling capacity in 2018-2037

The yearly increases or ship dismantling capacity between 2018 and the year of estimated peak demand (EU 2036, world 2037) was estimated with regression analysis. For the world, the demand for ship dismantling capacity was estimated to increase exponentially, around 10% per year between 2018 and 2037 ($y=5403718^{0.10x}$, R^2=99%). For the EU fleet, and at the same time for the EU-certified dismantling capacity, the increase is estimated to be linear, increasing around 0.4 MLDT per year between 2018 and 2036.

The level and increase of demand can be compared with the estimates on existing dismantling capacity. Even as the current global capacity can be considered insufficient for the future demand (Stuer-Lauridsen et al. 2003), especially the dismantling locations with low infrastructure and equipment requirements (Bangladesh, India etc.) and abundance of labour supply can be assumed to be able to meet the increasing demand. The situation with the EU-certified "green" dismantling capacity, however, is more challenging. The theoretical maximum of the currently EU-certified capacity is assumed to be around 1.1 MLDT (European Commission 2016), whereas the world demolition volume has been on average around 15 MLDT during the last five years. Compared to the estimated future demand, this theoretical maximum will be exceeded already in 2022. At the same time, this theoretical maximum has not been tested yet. The realized capacity of the EU-certified dismantling locations has been around 0.3 MLDT. This as such would mean that after 2022, the EU-certified capacity should increase roughly on a pace of the current realized capacity.

Discussion and conclusions

The motivation of this paper originates from the upcoming EUSRR, in which the key contribution in relation to previous regulation is that in the future ships flying the flag of any of the EU member states are to be recycled in ship dismantling facilities certified by the EU. Prior to the regulation, the European Commission estimated that the current and available certified capacity meeting the requirements would be sufficient to handle the demand. However, these estimates are based on analysis conducted already years ago, based on data mainly from a completely different macroeconomic situation. This paper analysed whether the market fundaments have changed, and whether the previous estimates of the European Commission are still valid.

In 2012, the European Commission (2012) estimated the average lifecycle to be 31.7 years, based on the average age of ships dismantled in 2008 and 2009. The findings of this paper are conflicting. Ship dismantling data from Clarkson World Fleet Register (2017) show that after 2007 the average age of recycled ships has declined into 24.7 years. This in practice indicates that the demand for ship dismantling capacity of EU fleet and other ships will increase significantly faster than anticipated. Similarly, during the pre-crisis years the increased transport volumes and the soaring freight rates triggered investments that increased the size of the fleet significantly. In combination with the declined dismantling age of the ships, this further increases the imbalance between the previously estimated and realized ship dismantling demand in the future.

In this paper, the future demand for ship dismantling capacity was estimated by analysing the size and age structure of the existing fleet. Assumptions were made that the ships would be recycled when they reach the age of 25 years. The fleet size in LDT was estimated by using the LDT-DWT –ratios calculated from the fleet data of Clarkson World Fleet Register. The results showed that the global demand for ship dismantling is expected to reach its peak, 42.6 MLDT in 2037. For the EU fleet the peak of demand, 8.4 MLDT, will be in 2036. This would mean that the global demand for dismantling between 2018 and 2036 will increase exponentially, at an average rate of 10% per year. For the European Union, the increase will be around 0.4 MLDT per year between 2018 and 2036. So far the realized capacity of the EU-certified dismantling locations has been around 0.3 MLDT. This as such would mean that after 2022, the EU-certified capacity should increase roughly on a pace of the current realized capacity.

To generalize the results, it would seem that the future demand for ship dismantling for both the global and the EU fleet have been underestimated. This finding supports the doubts of Alcaide et al. (2017) over inadequacy of the dismantling capacity of the European List. The pace of fleet growth has been phenomenal over the past decade, which explains the low estimates by Andresen (2001) and Mikelis (2007), and puts the Vedeler’s (2006) figure in a new perspective. For the global fleet, the supply is more likely to be able to meet the demand, as capacity constraints in beaching are less likely to occur. For the EU fleet, increasing capacity at the required pace might be more challenging, as the accepted methods of dismantling are both more capital intensive, and require more skilled labour.

As usual, the changes in market balance will most likely have its effects. The challenges in meeting the demand will most likely drive up the cost of dismantling, meaning additional costs for the ship-owners. At the same time, shipyards that will be able to meet the standard, will most likely benefit. From the policy perspective, it would seem obvious that the challenge will be in keeping the certification process in the right pace to prevent serious market effects from occurring. The worst case scenario would be that the certification process of the European Union will be watered down and the standards will be lowered to solve the issue.

This analysis is by no means without limitations. The results are based on the currently available data, market conditions and international regulatory framework. In case major changes would occur, the results should be updated. As one of the examples of possible changes is the environmental regulation of ships, in which many major changes are to be implemented in the near future. Some of these regulations (SOx, NOx etc.) will lead to a major retrofitting of the existing fleet or in some cases in early dismantling of the ships. In the former case, the demand for retrofitting would reserve some of the dismantling capacity, further aggravating the problem. In the latter case, the effect would be in escalating the problem even before than anticipated. As a natural stream for further research, both should be taken into account.

References

- Abdullah, H.M., Mahhoob, M.G., Banu, M.R., and Seker, D.Z. (2013) Monitoring the drastic growth of ship breaking yards in Sitakunda: a threat to the coastal environment of Bangladesh. *Environmental Monitoring Assessment*. 185 pp. 3839-3851.

- Alcaidea J., Piniella, F., and Rodríguez, D. (2016) The ”Mirror Flags”: Ship registration in globalised ship breaking industry. *Transportation Research Part D*, Vol. 48 pp. 378-392.
- Alcaide, J., Rodríguez-Diaz, E., and Piniella, F. (2017) European policies on ship recycling: A stakeholder survey, *Marine Policy*, Vol. 81, pp. 262-272.
- Andresen, A.B. (2001) *Worker Safety in the Shipbreaking Industries*. The International Labour Office. An issues paper.
- Buxton, I.L. (1991) The market for ship demolition. *Maritime Policy & Management*, Vol. 18 No. 2, pp.105-112.
- Chang, Y.-C., Wang, N., and Durak, O.S. (2010) “Ship Recycling and Marine Pollution.” *Marine Pollution Bulletin*, Vol. 60 No. 9, pp. 1390-1396.
- Choi, J-K., Kelley, D., Murphy, S., and Thangamani, D. (2016) Economic and environmental perspectives of end-of-life ship management. *Resources, Conservation and Recycling*, Vol. 107, 82-91.
- European Commission (2007) *Green Paper on Better Ship Dismantling*, COM (2007) 269.
- European Commission (2010) *The feasibility of a list of ”green and safe” ship dismantling facilities and of a list of ships likely to go for dismantling*, European Commission (DG ENV) 2010.
- European Commission (2012) *Regulation of the European Parliament and of the Council on ship recycling*. Commission Staff Working Document. Brussels 23.3.2012
- European Commission (2016) European List of ship recycling facilities. <http://ec.europa.eu/environment/waste/ships/list.htm>, retrieved 11.8.2017.
- European Parliament (2013) Regulation No 1257/2013 of the European Parliament and of the Council of 20 November 2013 on ship recycling and amending Regulation (EC) No 1013/2006 and Directive 2009/16/EC Text with EEA relevance
- International Maritime Organization (2009) *The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships*. <http://www.imo.org>, retrieved 25.5.2017.
- International Maritime Organization (2009) *Adoption of the Final Act and Any Instruments*, Recommendations and Resolutions Resulting from the Work of the Conference. International Conference on the Safe and Environmentally Sound Recycling of Ships 19.5.2009
- Jain, K.P. – Pruyn J.F.J. – Hipman J.J. (2017) Material flow analysis (MFA) as a tool to improve ship recycling. *Ocean Engineering,* Vol. 130, pp.674-683.
- Kagkarakis, N. Merikas, A – Merika, A. (2016) Modelling and forecasting the demolition market in shipping. *Maritime Policy and Management*, Vol 43 No. 8, pp. 1021-1035.
- Knapp, S., Kumar, S., Remijn, A. (2008) Econometric analysis of the ship demolition market, *Marine Policy*, Vol. 32, pp. 1023-1036.
- Lloyd’s Register (2011) *Ship recycling: Practice and regulation today*.
- Mikelis, N. (2007*) a Statistical Overview of Ship Recycling*, Proceeding of the International Symposium on Maritime Safety, Security and Environmental Protection. Pp. 1-9.
- Mikelis N. (2013) An Analysis of the European Regulation on Ship Recycling. *BIMCO Bulletin* no. 6
- Moen, A. (2008) Breaking Basel: The elements of the Basel Convention and its application to toxic ships. *Marine Policy*, Vol. 32, pp. 1053-1062.
- Moncayo, G.A. (2016) International law on ship recycling and its interface with EU law. *Marine Pollution Bulletin*, Vol. 109, pp. 301-309.

- Matz-Lûck, N. (2010) Safe and Sound Scrapping of 'Rusty Buckets´? The 2009 Hong Kong Ship Recycling Convention. *Review of European Community & International Environmental Law,* Vol. 19 No.1, pp. 95-103.
- Paris, C., Mukherji B. (2013). EU and South Asia Scrap Over Recycling Ships. *Wall Street Journal*, June 16. Retrieved 18.8.2017 from http://online.wsj.com/news/articles/SB10001424127887324423904578522982568438250
- Sarraf, M., Stuer-Lauridsen, F., Dyoulgerov, M., Bloch, R., Wingfield, S., Watkinson, R. (2010) *Ship Breaking and Recycling Industry in Bangladesh and Pakistan*. Report No 58275-SAS, International Bank for Reconstruction and Development/The World Bank.
- Stuer-Lauridsen, F., Kristensen, N., Skaarup, J. (2003) *Shipbreaking in OECD*, Danish Environmental Protection Agency, Working Report No. 18, 2003.
- Vedeler, K.V. (2006) *From Cradle to Grave – Value Chain Responsibility in the Ship Scrapping Industry*, Master'sThesis. Norwegian School of Business.
- Yujuico, E. (2014) Demander pays: The EU funding improvements in South Asian ship recycling practices. *Transportation Research Part A,* Vol. 67, pp. 340-351.