

## Incorporating Ship Green Recycling Regulations into the Design Early Stages

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### ABSTRACT

The ship recycling industry is a vigorous market which offers a huge profit to a range of stakeholders including ship owners, ship brokers and cash buyers from selling ships as scrap. The main aim of this research is to investigate the ship recycling challenges in light of Hong Kong International Convention (HKC) for the Safe and Environmentally Sound Recycling of Ships, 2009 and European Union Ship Recycling Regulations (EU SRR), 2013. The implementation cost of international conventions requirements is high, and therefore this may lead to shipowners fleeing to scrap their ships outside the framework of the law, where the cost is lower. A literature survey is carried out by using bibliometric analysis for thirty ship recycling legal published papers and for each the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, IMO resolutions and the European union ship recycling regulations in order to analyze the gap in the published papers and the convention articles and indicate the better insights in the convention, resolutions and regulations. Before beginning to build any new ships, it is possible to verify that both the design and the scrapping standards are met by researching the possibility of generating some suggested articles that incorporate the requirements of the scrapping phase inside the early design stages. Finally, in view of the laws it is noticed that there is a gap in an important part of the ship's lifespan which is the recycling process and it is not taken into account at the early design stage.

**Keywords:** Green Ship Recycling Industry, Hong Kong International Convention, European Union Ship Recycling Regulations, Early Design Stages.

### INTRODUCTION

Currently, Pakistan, India, Bangladesh, and China are the main locations for ship recycling. With very few exceptions, almost all vessels are dismantled at shore facilities. Current methods of ship disassembly fall short in numerous ways when compared to standards or general norms expected within industrialized nations. Inadequacies with the adopted procedures may include, but are not necessarily limited to, lax

safety measures, a lack of awareness and training, and a lack of facilities. Aside from the ship-dismantling facility, the deployment of improvement measures may also have an impact on pre-dismantling procedures and the final destination of waste or material streams resulting from the extraction process. Current ship-dismantling practices are insufficient, which causes issues that have an impact on both the environment and worker health and safety at work. Environmental effects can be divided into the following categories:

- By occupying and expanding the areas needed for breaking, the dismantling industry has an impact on the local environment, society, and economy.
- Discharges and emissions to sea, ground and air cause both acute and long-term pollution.

Hazardous waste disposal prices grew in industrialized nations in the 1980s as a result of stricter environmental restrictions. This eventually led to "toxic traders" shipping hazardous garbage to underdeveloped nations with laxer environmental laws. The 1989 Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention under the management of UNEP) was entered into force as a result of international outrage over the discovery of these operations [1].

At the international and EU levels, the regulation pertaining to ship recycling has moved from the field of transboundary waste movement to a specialized regime, namely the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (2009) (Hong Kong Convention) [2]. The environment, labor rights, and occupational health are all negatively impacted when end-of-life ships are dismantled under inadequate conditions. The European Ship Recycling Regulation (SRR), which contains a list of approved shipyards (the European List, EL) that are permitted to recycle EU-flagged ships, was developed by the European Union to guide the industry's move towards adopting more sustainable methods [3].

The recycling business is dominated by South Asian nations; issues include occupational health, contamination, and non-sustainable practices. Shipyards outside of Asia that use sustainable methods may be granted authorization by the European Union to enter this market as a result of current restrictions in the recycling industry [4]. Over time, the ship recycling sector has expanded and proven to be a significant source of income for several developing nations. As the business grew in these nations, serious environmental and occupational issues were linked to it. The International Maritime Organization passed the Hong Kong Convention for the Safe and Environmentally Sound Recycling of Ships in 2009 in response to mounting occupational and environmental concerns [5].

Ship recycling is considered to be the best way to reuse parts and save money and time during the initial ship building process. The status of "ship breaking" from the ship scrap business has changed globally due to the current state of reuse and the demands of beneficial developments from the maritime industrial sector when combined with modern technology [6]. Although ship recycling is a commercial activity that generates used steel and provides employment for workers, it has been criticized for its negative impacts on the environment as well as the safety and health of its workforce. The Hong Kong Convention 2009 is a significant step in the right direction. International bodies such as the IMO and ILO have discussed the necessity to create suitable regulations to oversee and regulate ship recycling operations [7].

One sustainable option for ships that reach end-of-life (EOL) is ship recycling (SR). EOL ships are typically dispatched to SR yards in underdeveloped nations. However, the world community is very concerned about the environmental, health, and safety problems in these yards [8]. Ship recycling is a long-term, environmentally friendly method of disposing of outdated ships that have reached the end of their useful lives [9].

A literature survey is carried out by using bibliometric analysis for thirty ship recycling legal published papers which are related to the legal regulations that applied on ship recycling to highlight these papers' gaps. Moreover, a literature review is carried out for each the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, IMO resolutions and the European union ship recycling regulations in order to analyze the gap in its articles and indicate the better insights in the convention, resolutions and regulations. Finally, a literature survey study is conducted for Hong Kong International Convention, IMO resolutions and the European Union ship recycling regulations. As a result, discussion and results can be conducted from bibliometric charts.

## METHODOLOGY

A systematic literature review method study is carried out on a dataset of thirty papers pertaining to legal ship recycling subjects utilizing software: VOS viewer 1.6.19. The procedures used for papers analysis are as follows: first step, creating CSV file contain data for 30 research papers related to legal and regulatory aspects in ship recycling, this data comprises titles of papers, abstracts and author keywords. This is the input file. The second stage involves importing the file twice into the program, depending on the type of analysis, as follows:

For keyword analysis: "create a map based on bibliographic analysis" is chosen and then the input file is imported as a SCOPUS database. After processing, 225 keywords are found and number of keywords are chosen that have high numbers of occurrences (6 occurrences are chosen to show about 30 of this 225), Filtration happens after that to remove some synonyms and output network is generated.

- For title and abstract analysis: "create a map based on Text data" is the chosen option, next importing input file as a SCOPUS data base and set some options to analyze the data for title and abstract of all papers. After processing 728 keywords are identified (10 occurrences for each shown keyword is chosen to show 43 nodes out of 728). Finally, filtration happens to remove synonyms and irrelevant words in order not to appear in the network and affect the analysis.

Additionally, the procedures for conventions analysis are as follows:

1. All articles, regulations, and legal data are extracted from European convention, Hong Kong convention and MEPC Resolutions into CSV file to be ready for analysis.
2. "Create a map based on text data" is chosen to analyze these legal texts and get out with the most occurred keywords and their interrelations.
3. CSV file is imported as SCOPUS database and after processing around 2260 keywords are found, 22 occurrences for every shown keyword are chosen to demonstrate about 40 keywords met this threshold out of 2260, after filtration about 33 nodes are generated on the network [10].

Finally, a full counting which is not binary counting is used for all aforementioned analysis.

## OVERVIEW OF HONG KONG CONVENTION

The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, which was developed with input from IMO Member States and non-governmental organizations and in collaboration with the International Labor Organization and the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, was adopted at a diplomatic conference held in Hong Kong, China, in May 2009. It aims to handle every issue relating to ship recycling, including the possibility of dangerous materials such as asbestos, heavy metals, hydrocarbons, ozone depleting compounds, and others being present aboard ships that are sold for

scrap. It will solve issues with the working and environmental situations in numerous ship recycling facilities around the world [11]. The Hong Kong Convention is used to improve ship safety, human health protection, and environmental protection throughout a ship's operational life and to prevent, reduce, minimize, and, to the extent practicable, eliminate accidents, injuries, and other adverse effects on human health and the environment caused by ship recycling [1]. The new Convention includes regulations on ship design, construction, operation, and preparation that facilitate safe and environmentally sound recycling without affecting ship safety and operational efficiency, as well as on the safe and sustainable operation of ship recycling facilities and the establishment of an effective enforcement mechanism for ship recycling that includes certification and reporting requirements [11].

Hong Kong Convention defines "ship recycling" as "the activity of complete or partial decommissioning of a ship at a ship recycling facility in order to recover components and materials for reprocessing and reuse, while taking care of hazardous and other materials, and includes associated operations such as storage and treatment of components and materials on site, but not their further processing or disposal in separate facilities" [12]. Therefore, the convention's scope is limited to tasks like scraping and storing in the recycling yard and does not include the other stages of the recycling process.

Once the Hong Kong Convention is in effect, each ship that is being transported for recycling will need to have its own unique inventory of hazardous materials (IHM). There are three components to the IHM. According to appendices 1 and 2 of the Ship Recycling Convention, Part I specifies the location and approximate quantity of any hazardous elements in the ship's structure or equipment. Only if they are still on the ship at the time of its recycling would Part II (operationally generated wastes) and Part III (stores) of the IHM be applicable; these lists only need to be created before the recycling [13]. The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009 (Hong Kong Convention), which was recently ratified, was developed by the IMO after the IMO guidelines on ship recycling were accepted. The most recent action taken to create legislation on ship recycling is this convention. It should be noted that the entrance into force requirements have not been satisfied, hence this convention has not yet entered into force [14]. The Ship Recycling Convention includes measures for controlling behavior and enforcing laws from two angles: the first set of regulations pertain to ships throughout their life cycles, and the second set of standards outlines guidelines for running ship recycling facilities. The "Administration," which is the government of the state whose flag the ship is authorized to fly or under whose authority the ship operates, and the state where the recycling facilities are located are identified as the two main actors in ship recycling. The Ship Recycling Convention also imposes duties on port nations, the recycler, the shipowner, and the crew. In order to execute the rules of the Ship Recycling Convention, ships are required to undergo a number of surveys and certifications. The administration is in charge of making sure that these surveys are effective and comprehensive.

The recognized ship recycling facilities are also liable for specific activities. First of all, they can only accept ships that adhere to the Ship Recycling Convention's rules. Additionally, they are only permitted to receive ships that can be recycled. Finally, they must provide any shipowner who has considered about having his ship recycled at this facility with the documentation relating to that authorization [13]. The fact that the Ship Recycling Convention avoids the most contentious aspect of ship breaking, namely the removal of hazardous materials first before the ship is sent for recycling, is another important flaw in the convention. While the Ship Recycling Convention adopts measures to reduce environmental risks associated with ship recycling, it ignores the necessity to end the practice of breaking ships on beachheads, i.e., "the process of beaching" [12].

It is unquestionably true that the Hong Kong Convention places greater demands on recycling facilities while placing less restrictions on ship owners. While the ship owner is responsible for paying for compiling the mandatory Inventory of Hazardous Materials and completing the necessary surveys, the recycler is responsible for training all of his employees and management, ensuring the environmentally sound

management of hazardous waste during removal, storage, transport, and disposal, maintaining safety systems, maintaining records, and providing personal protective equipment to all employees. According to the Hong Kong Convention, the ship owner of a vessel carrying the flag of a Party State is required to recycle the vessel in a licensed yard situated within a Party State. The ship owner must accept his fair market share of the costs of compliance borne by the yard in the Party State if he chooses not to switch the ship's flag to a non-Party flag in order to avoid the requirement to recycle in a Party to the Convention [15]. The Convention's major responsibilities include reporting requirements, requirements for ship recycling facilities, and requirements for ships. Ship requirements can often be separated into three categories:

1. Regulations, such as Regulations 4 and 5, that address the issue of hazardous materials;
2. Regulation 9 on the development of a ship recycling plan.
3. The comprehensive Regulation 10 on the formation of various surveys

Facilities for ship recycling requirements regulations 17 and 18 covering the general requirements and the ship recycling facility plan are at the core of the regulating chapter on ship recycling facilities. Regulations 15 to 23 influence ship-recycling facilities by defining certain standards that must be adhered with. The final set of obligations, which includes notification and reporting requirements, is covered by regulations 24 and 25 [16].

## THE EU SHIP RECYCLING REGULATION (NO 1257/2013)

The EU Ship Recycling Regulation primarily consists of 32 articles, divided into 6 titles and 2 annexes that list hazardous materials and their associated control measures.

Both large commercial seagoing vessels carrying the flag of an EU member state and those flying the flag of a third country that make port calls at EU ports or anchorages are subject to the ship recycling regulation. Ships flying the flag of a member state covered by the proposed legislation would not be subject to the Waste Shipment Regulation (EC 1013/2006), in order to provide legal clarity and prevent administrative difficulties. The use of some hazardous substances on ships, including as asbestos, ozone depleting chemicals, PCBs, PFOS, and anti-fouling compounds, would be forbidden or restricted under the new regulations. Each new ship carrying the flag of an EU member state (or a ship flying the flag of a third country calling at the EU ports or anchorages) will need to have a list of dangerous materials on board.

The major goal of this regulation is to prevent, reduce, minimize, and, to the extent practical, eliminate accidents, injuries, and other negative consequences on human health and the environment brought on by ship recycling, as is evident in Article 1. Throughout a ship's life cycle, this Regulation aims to improve safety, human health protection, and Union marine environment protection. It does this by ensuring that hazardous waste from ship recycling is managed in an environmentally sound manner. The Regulation specifically aims to greatly lessen the negative effects associated with the recycling of EU-flagged ships, particularly in South Asia, without adding needless financial obligations [1].

The EU Ship Recycling Regulation distinguishes between the date of its entry into force and the date of implementation, in contrast to the Hong Kong Convention. The regulation becomes effective on December 30, 2013, two days after it was published in the EU Office Journal [17].

## TYPICAL REGULATIONS AND THEIR RELATIONSHIPS

Regulations are not mutually exclusive. In the process of creating more effective recycling legislation, it is usual to transpose from one regulation or its main mechanisms to the legally enforceable responsibilities

of another. By providing some important definitions and fundamental ideas, established conventions and standards can serve as the foundation for new regulations. For instance, the Basel Convention and the IMO's rules provide the Hong Kong Convention direction, making it easier to comprehend and put into practice.

"Technical Guidelines for the Environmentally Sound Management of the Full and Partial Dismantling of Nuclear Facilities" was released by the Basel convention. The convention's forerunner, "Ships" was published in 2003 [18].

## BIBLIOMETRIC ANALYSIS

A dataset of thirty legal research publications in period range from 2012 to 2020 on ship recycling topics was subjected to bibliometric analysis in order to find gaps in the international conventions on ship recycling and to offer more in-depth understanding of the topics under investigation. Through the identification of unexplored research areas and knowledge gaps, this helps scholars working in that discipline to plan their future work. An analysis that synthesizes and summarizes the results of analyzing the body of current literature is called a systematic literature review. It was selected due to the fact that our data set consists of roughly thirty papers that are manually processable. Furthermore, the review's scope is extremely narrow.

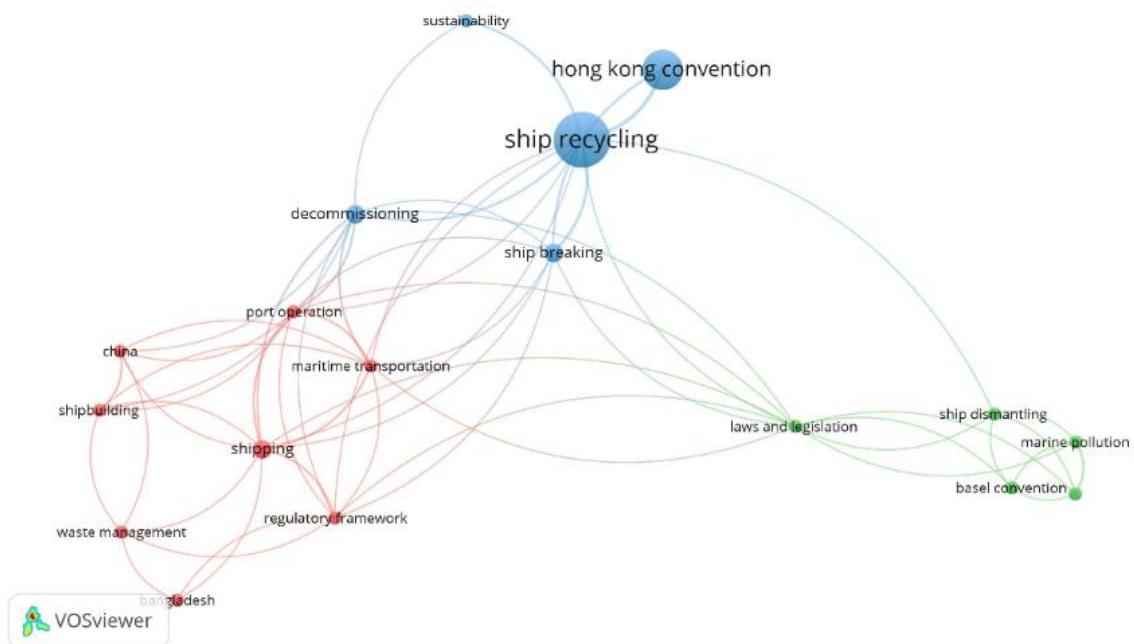


Figure 1: A bibliometric analysis chart for the key words of 30 legal ship recycling research papers.

Figure 1 shows the key words analysis in range of years through which most of the legal ship recycling research papers are published from 2012 to 2020. This chart indicates that in these research papers, the European Union ship recycling regulations and the IMO resolutions were not mentioned, but the focus was largely on the Hong Kong convention. The Basel Convention and marine pollution were also mentioned in the study. Moreover, the chart determine that China and Bangladesh are countries which are under spot in ship recycling within scope of regulatory frame work. Finally, these countries are related to the waste management which indicates that they don't apply the safe manner of waste disposal through maritime transportation.

Furthermore, figure 2 indicates the title and abstract analysis in the same range of years for these research papers in legal ship recycling. In this chart, the countries Indonesia, India, south Asia and Brazil appeared in addition to Bangladesh and China this indicates that there are problems faced these countries related to ship recycling process, safety of workers, health and environment. Also, it was noticed that there is a relationship the transboundary movement, international trade and Basel convention which regulate this movement by applying its articles through implementation of inventory of hazardous materials. In addition, a few laws mentioned the state of Indonesia and addressed matters of health, safety, and the environment and its relation with the regulation which can be applied. Moreover, there is a relation between "Bangladesh, cost, facility" this reflects that the implementation of laws or case studies was linked to the economic situation of the Bangladesh, which appears in the form of facility. Lastly, the relationship between "European union and ship owner" demonstrates how stakeholders are taken into consideration by EU ship recycling legislation.

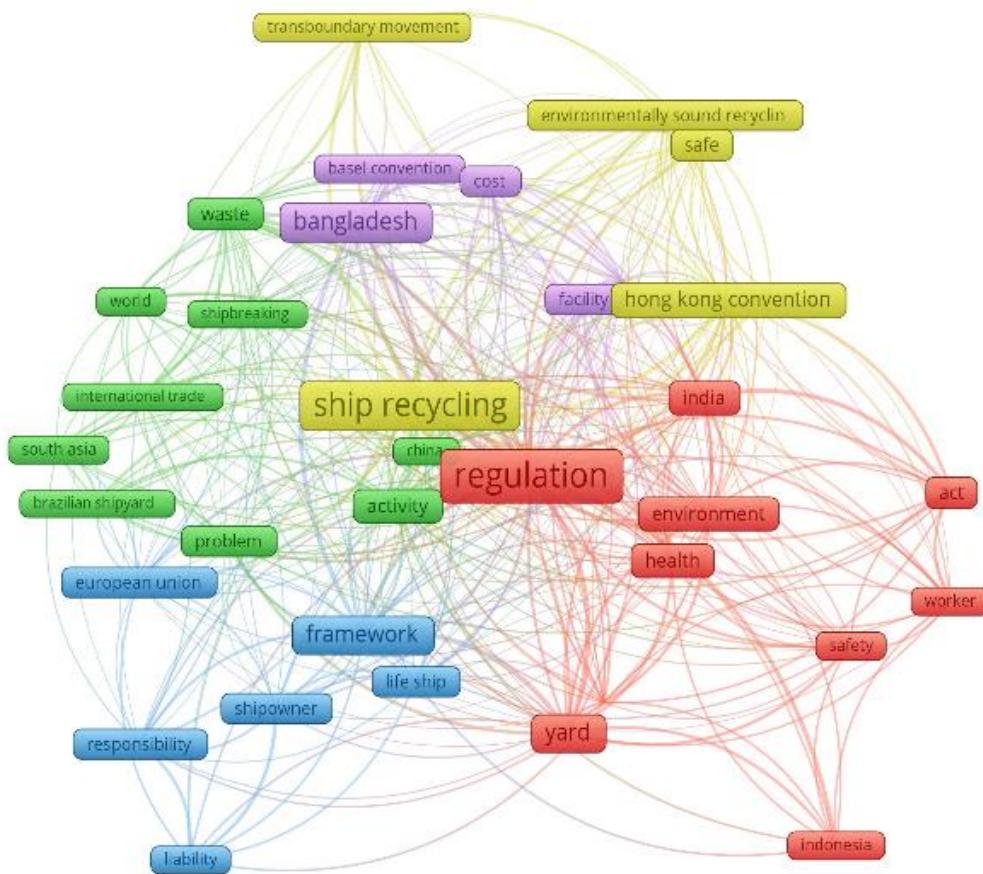
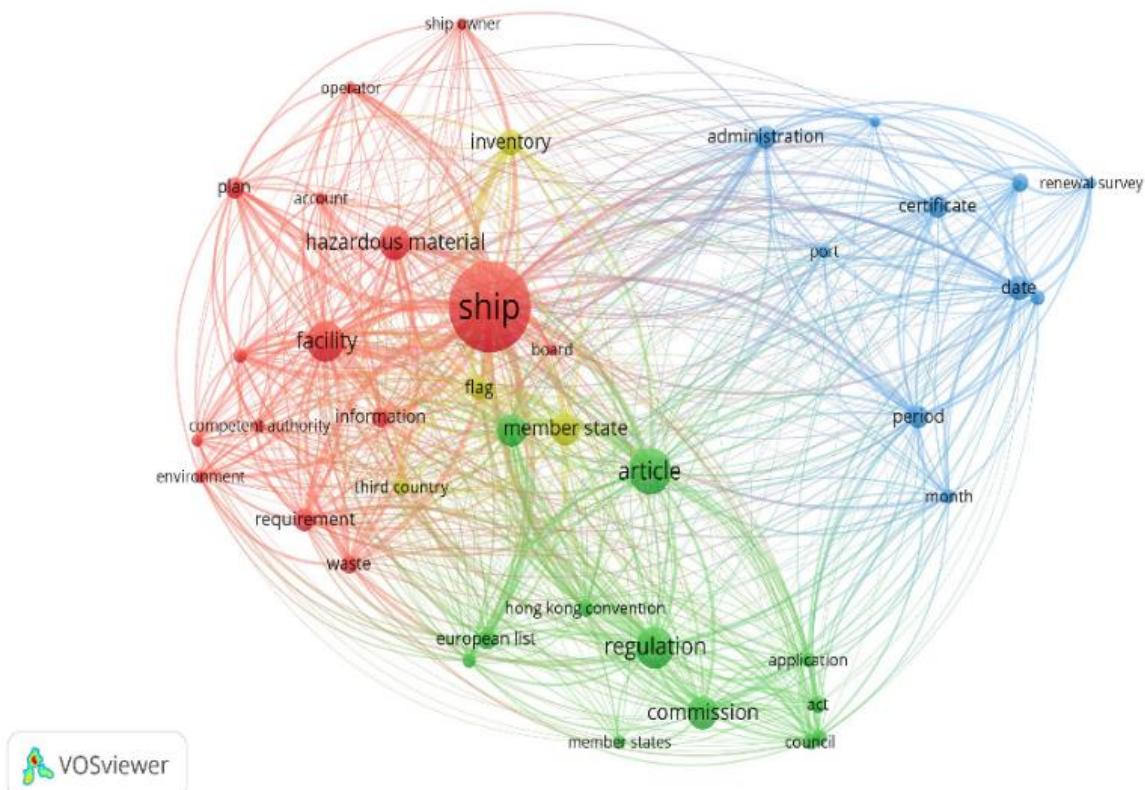


Figure 2: A bibliometric analysis chart for the title and abstract of 30 legal ship recycling research papers.

Moreover, figure 3 shows the European union ship recycling regulations gap analysis via Software: VOS viewer 1.6.19 which indicates that there is a relationship between "ship, shipowner, information, facility, hazardous materials, requirements and plan" this means that it is required from the ship owner to provide the ship recycling facility with all ship's information and inventory of hazardous materials in order to

prepare the ship recycling plan. Further, the ship owner must supply ship recycling yard with a list of hazardous materials in order to protect the environment.



**Figure 3: A bibliometric analysis chart for European union ship recycling regulations.**

In addition, there is connection between "shipowner, operator, plan, facility, competent authority, requirements and waste" this indicates that the operator (ship crew) maintain the list of hazardous materials in order to be approved from the classification society on behalf of the competent authority. Furthermore, the ship recycling facility prepare the ship recycling plan to approve it from the competent authority. Additionally, there are a number of joints between "member state, article, Hong Kong convention, European list, regulation and application" this determine that it is required from each member state to apply the articles and regulations of the Hong Kong convention after entered into force and the European list according to the convention includes the approved ship recycling facilities which apply safe and environmentally sound recycling of ships. Also, the connection between "inventory, flag, third country" which means that it is required from all flags of third countries to provide the ship recycling facility with the inventory of hazardous materials.

In addition, figure 4 indicates Hong Kong convention for safe and environmentally sound recycling of ships gap analysis by using VOS viewer software. The first insight from chart is the connections between "ship, guidelines, hazardous materials, ship recycling, worker, operation, convention, environment and state" which determines that the ship recycling process and hazardous materials identification that applied on the ship must be according to IMO guidelines which the Hong Kong convention depends on it. Also, it is required from every state that signed on the convention to apply all articles which are focused on worker safety and environment.

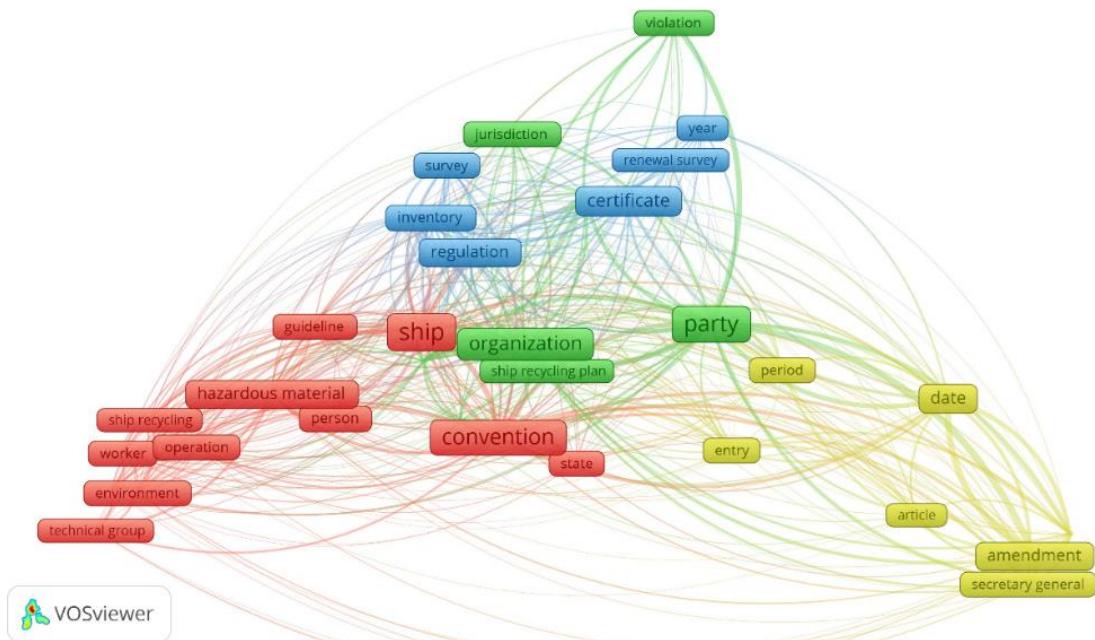


Figure 4: A bibliometric analysis chart for Hong Kong convention for safe and environmentally sound recycling of ships.

Moreover, the second insight is the joints between "organization, party, ship recycling plan, jurisdiction and violation". This means that the organization obligates every party should apply its jurisdiction on any violation occurs during implementation of ship recycling plan. Finally, the third insight contains the words "survey, inventory, year, renewal survey, certificate and regulation" which means that in order to maintain the ship's certificate to be valid, a continuous survey should be applied annually on the inventory of hazardous materials and it is required to make a renewal survey every five years according to the regulations.

Additionally, figure 5 shows a bibliometric analysis chart for IMO guidelines resolutions which indicates the first insight regarded to "ship recycling facility, ship, ship recycling facility plan, competent authority, site inspection, procedure, operation and activity". It means that the competent authority should approve the site of the ship recycling facility through inspection and follow the procedure, operation, activities which are applied during ship recycling process. The second insight determines the connections between "convention, competent authority, regulation, environment, inventory of hazardous materials (IHM), waste and ship recycling plan" that indicates the ship recycling plan should be applied according to the regulations included in the convention and must be approved from the competent authority. Also, the competent authority should approve the inventory of hazardous materials for every ship send for scrapping in order to protect the environment from waste disposal. The third insight was regarded to "hazardous materials, inventory, certificate, administration shipowner, information, survey, location, structure and equipment" all these words are connected to each other which means that regarding to IMO resolutions it is required from the administration ship owner to provide the ship recycling facility with ship's information that include inventory of hazardous materials and IHM certificate.

Moreover, a survey should be applied for the structure of the location and its equipment of the ship recycling facility. Finally, the fourth insight was regarded to "competent person, condition, work, entry, safe and hot work" which indicates that the competent person should inspect the condition of the ship recycling facility that apply all the precautions which include "safe for entry and safe for hot work".

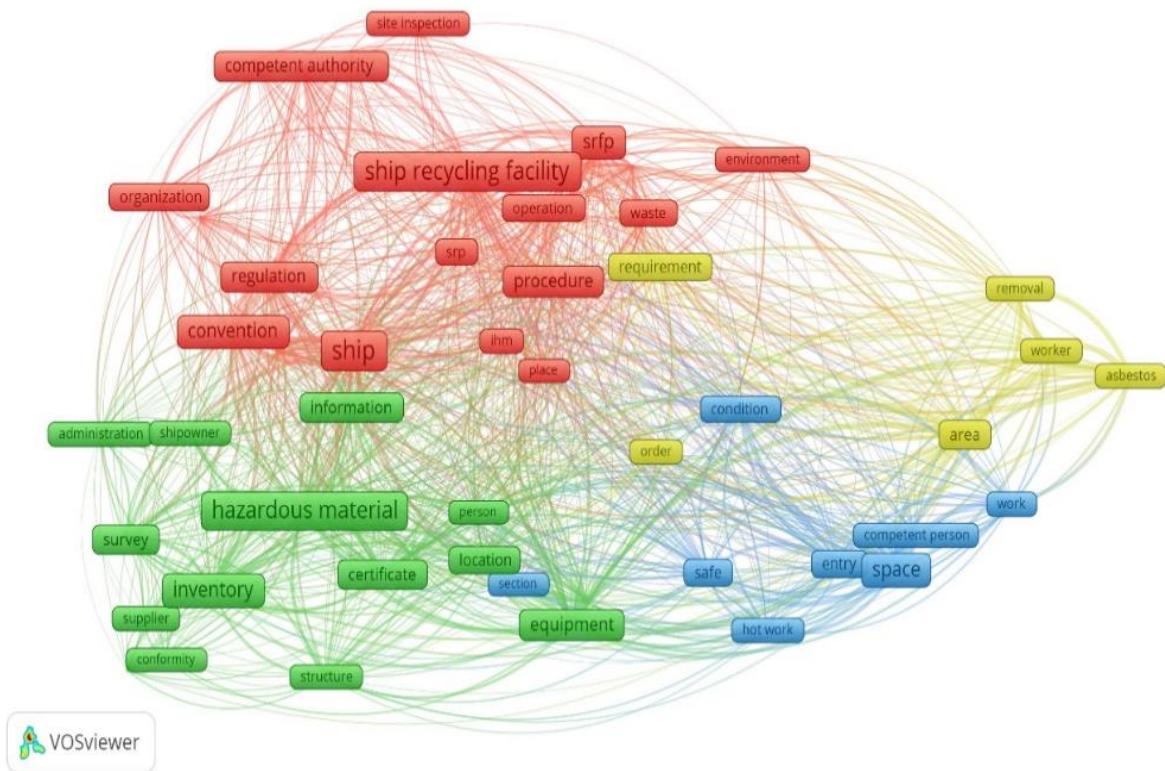


Figure 5: A bibliometric analysis chart for IMO guidelines resolutions.

Furthermore, figure 6 indicates a bibliometric analysis chart for all ship recycling regulations including Hong Kong convention, European Union ship recycling regulations and IMO guidelines resolutions. So, by using this analysis for ship recycling convention, regulations and resolutions it can be find the gap in all of it. The first insight regards to "ship recycling facility, competent authority, document of authorization for ship recycling (dasr), procedure, information, operation, waste, facility and environment" which indicates that the shipowner provides the ship recycling facility with all information about the recycled ship in order to prepare the procedure of ship recycling process. After checking ship recycling procedure, the competent authority will issue (dasr) taking into account the operation, waste disposal and environment.

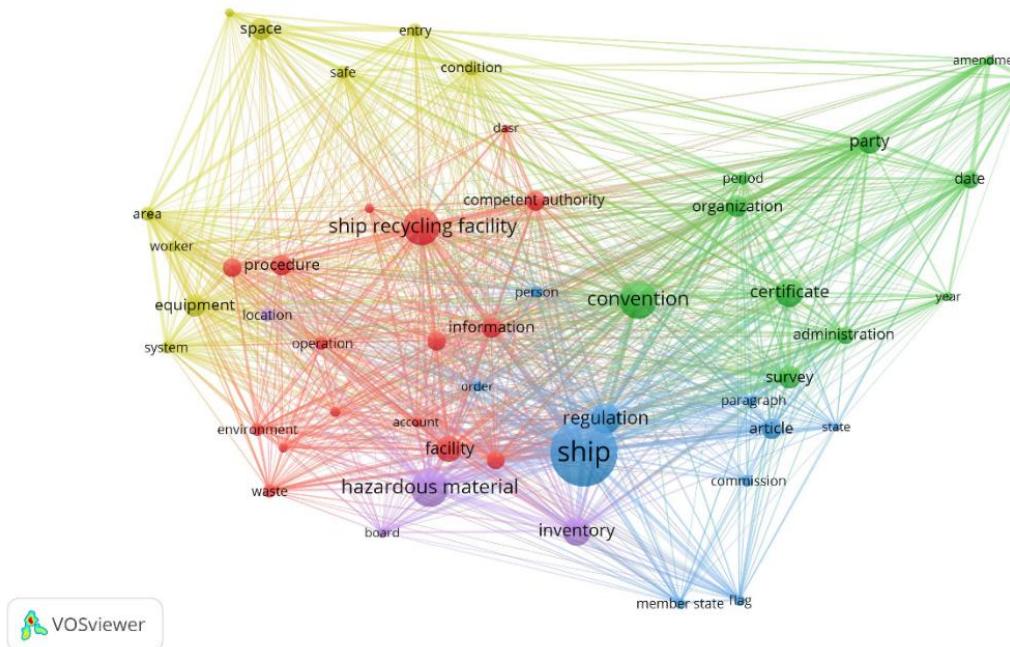


Figure 6: A bibliometric analysis chart for Hong Kong convention, European Union ship recycling regulations and IMO guidelines resolutions.

The second insight shows the relation between "ship, regulation, article, state, commission, member state, flag, state and person". In this chart, the analysis showed a repeated key word as a result to the combination between all ship recycling regulations. So, it means that the regulations of EU ship recycling regulations and the articles of Hong Kong convention with referred to IMO resolutions should be applied to every recycled ship. Further, each state or member state should approve the ship recycling plan and issue the document of authorization for ship recycling (dasr) in order to start the ship recycling process. Additionally, the ship's flag state should make a final survey to issue the ready for ship recycling certificate. The third insight regards to "convention, certificate, year, date, party, amendment, period, organization, administration and survey" which determines that the survey should be applied to every recycled ship according IMO resolutions and Hong Kong convention and its amendments. Moreover, the administration of each party should issue a certificate to every recycled ship called international ready for ship recycling certificate. Finally, the fifth insight refers to the following key words "space, safe, entry, condition, area, worker, equipment and system" while the key words safe and condition are joining with certificate. This indicates that there should be a system for checking the space and area which will be used for disposal of hazardous materials. Also, it should be a continuous inspection on the condition of ship recycling facility concerning safe for entry, safe for hot work, worker safety and safety of equipment used in ship recycling process. So, after approving all safety precautions mentioned, a certificate should be issued from the ship recycling state.[10]

## CONCLUSION

It is clear from the previous discussion which is conducted in two areas, the first covers 30 research papers concerned with ship recycling laws and the second covers the European union regulations, Hong Kong convention and IMO resolutions. So, it is noticed that the research papers are not included the European union regulations and IMO resolutions while the focus on the Hong Kong convention. Also, it is found that China and Bangladesh just apply a regulatory frame work. In addition, these countries are related to the waste management which indicates that they don't apply the safe manner of waste

disposal through maritime transportation. On one hand, the countries Indonesia, India, south Asia and Brazil appeared in addition to Bangladesh and China, this indicates that there are problems faced these countries related to ship recycling process, safety of workers, health and environment. Moreover, there is a relation between "Bangladesh, cost, facility" which reflects that the implementation of laws or case studies is linked to the economic situation of the Bangladesh, which appears in the form of facility. On the other hand, there are a relationship between "ship recycling facility, competent authority, document of authorization for ship recycling (dasr), procedure, information, operation, waste, facility and environment" that determine the shipowner should provide the ship recycling facility with all information about the recycled ship in order to prepare the procedure of ship recycling process. After checking ship recycling procedure, the competent authority will issue (dasr) taking into account the operation, waste disposal and environment. Further, each state or member state should approve the ship recycling plan and issue the document of authorization for ship recycling (dasr) in order to start the ship recycling process. Additionally, the ship's flag state should make a final survey to issue the ready for ship recycling certificate.

Additionally, the key words "convention, certificate, year, date, party, amendment, period, organization, administration and survey" reflect that the survey should be applied to every recycled ship according IMO resolutions and Hong Kong convention and its amendments. Furthermore, the administration of each party should issue a certificate to every recycled ship called international ready for ship recycling certificate. This indicates that there should be a system for checking the space and area which will be used for disposal of hazardous materials. Also, it should be a continuous inspection on the condition of ship recycling facility concerning safe for entry, safe for hot work, worker safety and safety of equipment used in ship recycling process. So, after approving all safety precautions mentioned, a certificate should be issued from the ship recycling state. Finally, all research published in the field of study confirms that still there is a need to complete research efforts in order to attempt the gap between ideal laws and what is done in most countries that have the largest share in the ship recycling industry. In view of the laws, it is noticed that there is a gap in an important part of the ship's lifespan which is the recycling process and it is not taken into account at the early design stage. Therefore, a group of research should be conducted to try to fill the gap by concerning that the recycling stage is one of the initial design stages of ships.

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