Environmental risk assessment on ship repair work at cilegon national shipyard company

Rachmat Ashari¹, Emil Budianto² and Herdis Herdiansyah¹

¹School of Environmental Science, Universitas Indonesia, Salemba, Indonesia
²Department of Chemistry, Universitas Indonesia, Depok, Indonesia

*Email: herdis@ui.ac.id

Abstract. The main objective of this study is to develop an Environmental Risk Assessment at PT. X shipyard in the ship repair process by developing a risk matrix and identifying potential that can be caused when repairing the ship. Ship is an important and vital facility particularly as transportation mode and as part of inter-regional Community’s Economic Development Infrastructure Data obtained from national shipbuilding companies in the Cilegon area. Data collection and analysis is carried out following the ship repair process. Environmental risks that are classified as heavy are sandblasting dust and the ship painting process which is classified as heavy in the category of environmental pollution standards from other activities.

1. Introduction
Ship is an important and vital facility particularly as transportation mode and as part of inter-regional Community’s Economic Development Infrastructure and can be functioned as the main device of State Defense System [3]. A Ship existence is always closely related with Shipyard due to required periodic Maintenance and repair at the dock or known as docking undertaken once in two years that has been stipulated by IACS regarding the regulatory dry docking for ship [6]. A ship repair is the process of restoration or replacement of the parts that are unusable and below minimum standard of seaworthy in both statutory and class regulation. Repair itself is generally involved three things, they are the hull, machinery and outfitting [8]. This maritime axis policy has five main pillars [10] The five pillars include rebuilding Indonesia’s maritime culture, safeguarding and managing marine resources, giving priority to the development of maritime infrastructure and connectivity by building the Sea Toll, deep seaport, logistics and shipping industry), maritime diplomacy, and building maritime defense forces [2].

The shipyard industry which performs ship repair work which has the potential to produce liquid waste (ballast water, hull painting and produce B3 waste) and produce gas and dust waste from sand blasting activities and painting for a size of more than 50,000 DWT must be completed with Amdal Based on the regulation of the Minister of Environment number 11 of 2006. Increased ship repair activities cause ocean pollution. Water is an object that is very susceptible to pollution in addition to air and soil. Pollution is something that is not desirable also in amounts that exceed the limit [7]. Environmental pollution is the entry or inclusion of living things, substances, energy and or other components into the environment by human activities or natural processes, so that environmental
quality drops to a certain level, which causes the environment to no longer function in accordance with its designation (UU Lingkungan Hidup No. 23 Tahun, 1997). The shipyard industry has referred to the international environmental regulations listed in MARPOL (Marine Pollution) which are divided into 6 annexes: (1) protection from oil, (2) protection of bulk NOx liquids, (3) protection of dangerous goods in packaging, (4) protection from dirty water / waste water, (5) protection from waste and (6) protection from air pollution [1].

The role of shipyards to do these things is very large, especially shipyards engaged in reparations, in terms of ship repair, maintenance and maintenance work, the frequency of this work is higher than the construction of new ships [9]. Ship maintenance can be defined as the activities required to maintain management and material to certain extent of condition. In broad sense, Ship maintenance encompasses every kind of activity intended to maintain the ship to always be in good sea worthy and is operable for sea transportation any time with capability above certain minimum condition. Shipbuilding industry and shipping sector comprise of various complex production and operating processes, which consist of manufacturing, operation, repair/maintenance, scrapping / dismantling / recycling [4]. As for the flow section of the production process for ship repair that has been applied to all shipyards to minimize the impact that will occur before the ship does the docking or after the ship is docking to get maximum results in carrying out ship repairs.

| Process Name                        | Activity                                                                 | Impact Type                  |
|-------------------------------------|--------------------------------------------------------------------------|-----------------------------|
| Docking                             | The process of lifting or placing a ship to be repaired                  | -                           |
| Ship Cleaning                       | The process of cleaning the ship from barnacles, rust and etc.          | Rust and impurities         |
| Ship Repair                         | The process of checking the damaged parts, repair and replacement         | Remaining welding           |
|                                     | and replacing them with new ones, welding.                               | wire residues, dust, noise.  |
| Smoothing                           | Grinding process results from welding and rust cleaning with a blasting process | Dust sandblasting, TSP dust, noise |
| Machine maintenance and repair      | Process or repair work of ship engines and equipment on board            | Used lubricants and used oil |
| Repair of electronic devices        | The process of repairing electrical devices, cables and etc               | Residual cables and         |
|                                     |                                                                          | replacement cable pieces    |
| Painting                            | The process of painting the walls of the ship                           | Spillage / residual         |
|                                     |                                                                          | paint, solvent vapor,       |
|                                     |                                                                          | packaging                   |
| Launching                           | After the entire process is complete, the ship launches into the sea     | Turbidity, shipping         |
|                                     | and tests                                                                | disruption                  |

In Research [1] conducted an analysis of environmental risk assessment on new building work in Surabaya sub cluster shipbuilding company by combining several methods to find research gaps to be developed, which aims to be able to apply the Environmental Risk Assessment by knowing the assessment of environmental risks due to operations in shipyards which can then be used as a
reference for the work of new shipbuilding or ship repairs. Researchers will use this method so that it can facilitate researchers to research at PT. X in the Cilegon area.

2. Methodology
The flow of research developed to get the purpose of the study.

Researchers use Fishbone / Cause and Effect to identify and organize which causes arise from specific effects and then separate the root causes. Starting from the shipyard to find out the operations carried out by the shipyard then continued with statistics, Deterministic, Environmental Risk Analysis and Bayesian networks as the root of the problem to know Potential Hazards, probabilistic, risk matrices, environmental risk mitigation models. Environmental risk assessment model for shipyard company operations. Standard environmental risk assessment on shipyard company operations. which will subsequently produce settlements for the environment for shipyards.

3. Result and Discussion
Environment is everything that is around humans and affects the development of human life. The environment consists of abiotic and biotic components. Abiotic components are all lifeless things like water, air, soil, moisture, bundles, light. Whereas abiotic components are all things that have lives such as humans, animals, plants and micro-organisms. The environment is very closely related to the activities that humans do. These activities will certainly cause environmental impacts, for this purpose a law is set up which regulates companies in managing the environment, namely (Law Number 23 of 1997).

Assessment of a risk in the environment is to assess the use of natural resources to meet human needs. In this case, the process carried out by PT. X in the Cilegon area on ship repair activities that can be based on the environment and ecology around the shipyard. In every ship repair work activity there are several work activities that can risk polluting the environment. These activities can be seen in the following picture.

![Figure 1. Research flow method](image-url)
Figure 2. Ship repair process  
Source: PT. X 2018

Potential environmental hazards that can be generated from ship repair activities by determining the degree of frequency by using the environmental risk risk assessment matrix for ship repair. Ship repair activities begin with the loading and unloading process such as oil and fuel and free gas that is carried out before entering the shipyard Average frequency for event 1 within one month. The resulting impact is classified as heavy because of the lack of equipment in PT.X Shipyard which can produce odors due to the tank cleaning and free gas processes. Then the ship will be assisted by a tugboat to enter the shipyard. The ship will be repaired as needed. In the repair process using Air Bag is done by raising the ship to the dock. Average frequency for event 1 within one month. The resulting impact is classified as mild / not heavy because it does not cover which can cause smoke.

After the ship is docked, cleaning or ship cleaning activities will be carried out from dirt such as barnacles, rust and others. Furthermore, activities will be carried out to clean up fresh water tanks and ballast tanks, which are carried out by spraying pressurized water onto the surface of the tank wall. Average frequency for event 12 within a month. The resulting impact is classified as not heavy because it is done in an open place. Maintenance of machine products, including: Inspection of main machines, auxiliary machines, and other machine tools. Average frequency for event 5 in one month. The resulting impact is classified as heavy because it is done in a closed place and lack of equipment.

Maintenance Shipyard includes, Replacement of ship’s engine and electrical components; electric aircraft, pumps, compressors, rudder, bushings, propellers, shafts, etc. "Hull" or other hull and steel components, in this activity include sandblasting. Maintenance and replacement work for pipe and telecommunications installations. Painting work is carried out after sandblasting surface preparation work. Average frequency for event 5 within a month. The resulting impact is classified as heavy because it is done in a closed place and lack of equipment. After the launch of the vessel is completed in its entirety, a ship launch / float is carried out from the dock. Average frequency for event 1 within one month. The resulting impact is relatively light because it is done in an open place and only finishing work.

4. Conclusion
Activities that are very potential for pollution are dust from sandblasting and staining. This is included in the weight category because it is done in an open and closed room with a large volume and is not equipped with adequate equipment in Shipyard PT.X. The resulting impact is relatively light because it is done in an open place and only finishing work.

Acknowledgement
This research is funded by the Grant of Indexed International Publication for Final Project of Students/Publikasi Terindeks Internasional Untuk Tugas Akhir Mahasiswa (PITTA) Universitas Indonesia 2018 with contract number 2578/UN.R3.1/HKP.05.00/2018
References

[1] Basuki, Santoso, A. (2016). Proceedings of the National Seminar on Application of Science & Technology (SNAST) Yogyakarta, 26 November 2016 ISSN: 1979 - 911X eISSN: 2541 - 528X, (November), 2011–2014.

[2] Haidir, S., Perkapalan, J. T., & Kelautan, F. T. (2017). Shipyard Capability Analysis in Indonesia to Build Sea Toll Vessels in Supporting Maritime Axis Policy Implementation, 4 (1).

[3] Hasbullah, M. (2016). National Shipyard Strengthening Strategy in Order to Strengthen the Effectiveness and Efficiency of the National Domestic Shipping Fleet 2030. Journal of Marine Research and Technology (JRTK), 14 (1), 103–112.

[4] Hidayat, Taufik, Benefits, Djauhar & Ma'ruf, B. (2015). Competitive Strategy of Shipbuilding Industry in Surabaya.

[5] Indonesia, P. R. (1997). Management of the environment. Environmental Management, (23). https://doi.org/10.1017/CBO9781107415324.004

[6] Muhtadi, A., Pribadi, T. W., Baihaqi, I., Lapangan, K., & Implementation, S. (2016). Study of Implementation of Reliability-Based Ship Repair for Shipyards, 5 (1), 1–7.

[7] Nedi, S., Pengajar, S., Kelautan, I., Perikanan, F., & Riau, U. (2012). Stakeholder that plays a role in Oil Pollution Control in the Rupat Strait. Journal of Fisheries and Marine Affairs, 171, 26–37. Retrieved from https://ejournal.unri.ac.id/index.php/JPK/article/viewFile/61/56

[8] Nurwanti, R., & Wuruk, T. (2016). Analysis of Quality Improvement of Ship Repair Services in East Java Shipyard. Journal of Engineering ITS, 5 (1).

[9] Rahman, A., & Supomo, H. (2012). Customer Satisfaction Analysis on Ship Repair Work with Quality Function Deployment (QFD) Method. Technical Journal of ITS, 1 (1), G297 - G302.

[10] Tjoneng, A. (2016). Realizing Indonesia as a World Maritime Axis Country. Dialogia Iuridica, 7 (1), 47–55.