# An online risk assessment tool to improve the standards of ship recycling operations.

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**ABSTRACT**

Ship recycling process is a tricky business and accepted as one of the most hazardous working environments if not done correctly. Ship recycling has many severe risks and most of the times it is lacking proper planning. Due to its complex procedure and the risks involved, there is a need of structured and guided way of approaching job tasks, and in addition, incorporating hazard identification and risk management for various experts is needed. A web base structured risk assessment tool dedicated to various professions related to ship recycling is developed. In this paper, the principles behind this web-based tool 'Three Step Online tool' are introduced, and its methodology is explained. Moreover, a case study of a ship recycling job task in Indonesia is presented. The result shows that this online based tool has been well received by multiple experts such as occupational health & safety experts and ship recyclers.

**Keywords:** *Ship Recycling, Ship Breaking, Risk, 3 STEP Online, web base. Indonesia*

## 1. INTRODUCTION

### 1.1 SHIP RECYCLING

Ship recycling covers various activities such as dismantling old and non-functional ships, allowing reusing of valuable materials (Ozturkoglu et al., 2019)., Like any other recycling industry, ship recycling can be considered the most environmentally friendly option for end-of-life ships than other options such as reefing or abandoning the vessel (Du et al., 2018, Favi et al., 2018, Gunbeyaz et al., 2019).Nevertheless, ship recycling is considered one of the most dangerous jobs globally due to a very high rate of accidents and diseases compared to other industries (Graham-Rowe). Ship recycling is a dangerous industry and workers', health and safety is being compromised daily (Kurt, 2013). Recycling end-of-life vessels in an environmentally friendly manner is a significant challenge faced by ship owners, shipbreaking yards, and government agencies worldwide (Du et al., 2018). Therefore, the maritime community acted on this. As a result, new regulations are coming up to force which encourage ship recycling yards to improve their facilities in terms of health, safety, and environment, such as IMO, ILO, the Basel Convention, and Hong Kong Convention. International Maritime Organization, especially through Hongkong Convention addresses the rules which cover the entire lifecycle of ships, from building to recycling, and disposing for safer operations, with the focus on hazardous and toxic material in ship design and construction as the causes of risks in ship recycling process (International Maritime Organization, 2012). International Labour Organization has standards for occupational health and safety in ship recycling activities (International Labour Organization, 2004). Furthermore, Basel Convention guide the transportation of ships that are defined as

hazardous waste from developed to the developing countries.

### 1.2 THE CHARACTERISTIC OF RISKS ON SHIP RECYCLING PROCESS

As specified in all these worldwide guidelines, ship recycling involves many severe risks specially if not done correctly. In the previous research project, various ship recycling practices to identify areas of improvement has been analysed, and one of the key areas for improvement noted by researchers was the lack of planning and awareness amongst all levels of ship recycling employees (DIVEST, 2010). Furthermore, ship recycling yards usually do not have proper standard operational procedure, so the process becomes more complex. Hazard identification in ship recycling process is of vital importance to define the risks and this is not always easy when is done not systematically and only by one expert because it consists into a multidisciplinary process, (from environment, to materials, and health and safety of the workers). To our approach, the core of the method relies on the fact that a **structured group** reviews the process of hazard identification aiming at identifying the causes and effect of accident and relevant hazard. The group carrying out such structured reviews should include experts in various aspect to assist in the hazard identification. Therefore, the **structured and guided way** of approaching job tasks while incorporating hazard identification and risk management for multiple experts is needed. Furthermore, a web base structured online risk assessment tool on for multiple experts, is specially developed for ship recycling process. In this paper, the principles behind the Three Step Online tool will be introduced, its methodology explained, and a case study of a ship recycling job task will be presented.

## 2. THREE STEP ONLINE TOOL

The first generation of risk assessment tool for ship recycling is the Three Step Method (Kurt, 2015), which was developed as part of a European Union funded project called 'Dismantling of Vessels with enhanced Safety and Technology' (DIVEST). 3 step online web base tool for risk assessment is the advance development of the Three Step Method The most developed thing is online base tool which can be accessed anywhere by multiple experts who are registered into the system. The tool can be accessed from www.eolplatfrom.com as a part of SSRII (Sustainable Ship Recycling Industry for Indonesia), a joint institutional project between UK and Indonesia. Besides, there are several improvement including the updated list of job task and hazard involved. Detailed of tool features are shown below.

### 2.1 THREE STEP ONLINE TOOL FEATURES

1. Terms & Condition
2. Create new project (project name, created date, activity type, facility name, status) or Export the project (Project name, created, Exported by, Date- Time)
3. About Tool (about using this software, Warranties and Liability)
4. User Guide and Help
5. Sign Up (Full name, email address, sector, password, password verification, accept privacy policy for EOL Platform.
6. My Profile
7. My expert (Expert Name, added by, Date-time, Add experts)
8. Expert Pool (The experts detail: name, year of experience, biography, education, occupation)
9. Assign Expert (From Expert Pool or New expert; an invitation has been sent to expert) as shown in figure 1.
10. Automatically generate the report

### 2.2 THREE STEP ONLINE TOOL METHODOLOGY

The objective has been to articulate and implement work-able strategies for

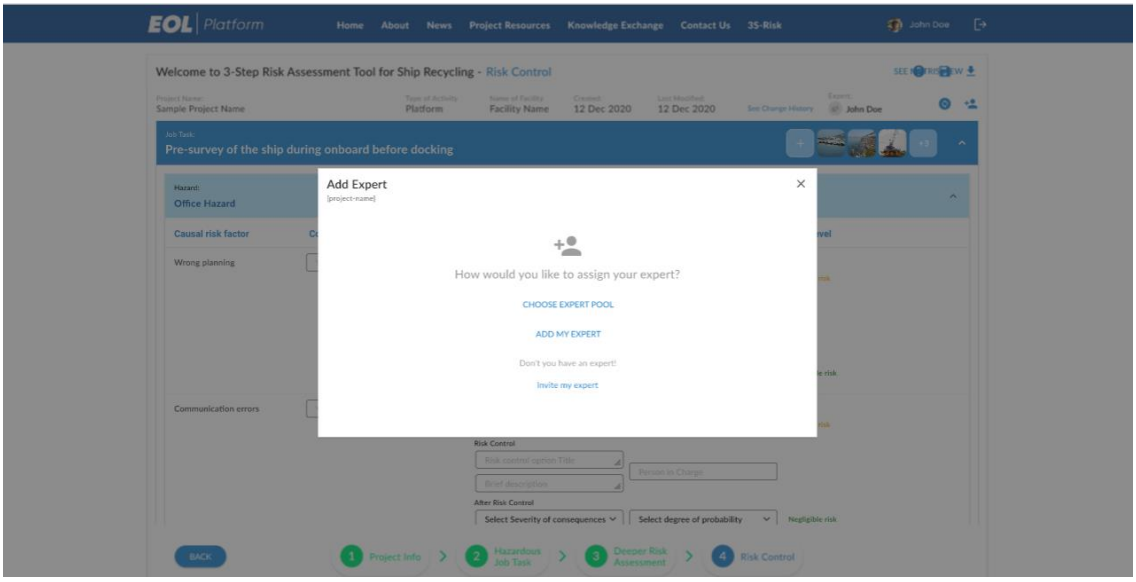



Figure 1. Assign an expert interface.

minimization of risks in ship recycling process. It was mentioned above that a simplified yet scientifically and structured risk assessment.

tools had to be evolved. It was felt that the multiple experts would assess the risks more proficiently. So, to facilitate that matter, 3 step methodology has performed as shown below in figure 2.

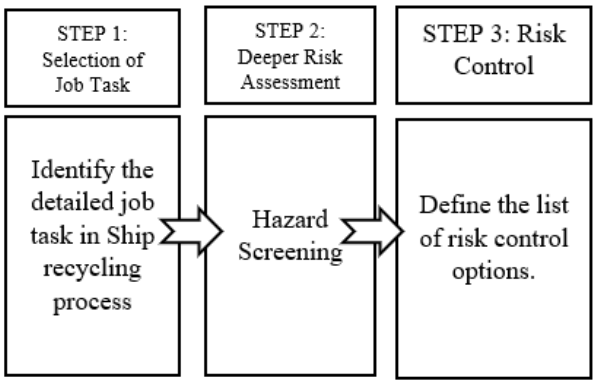



Figure 2. The Three Step Online Tool Methodology

### 2.2.1 Selection of Job Task

First step is the selection of job tasks that needed to be evaluate. On this tool, ship recycling activities are divided into 6 different activities zones: Pre-recycling, Primary block breaking area, Secondary block breaking area, Storages Area, Waste disposal facilities, Office buildings and emergency facilities as shown in Figure 3. The main reason is to create more focus and structured assessment.

Though there are some suggestions of job task list for each zone including its additional information, but the user can also put other activities/ additional job tasks in accordance with their real situation, for further analysis.

### 2.2.2 Deeper Risk Assessment

The second step is identification of hazardous job tasks. The hazard screening list was developed with the intention to find casual risk factor to identified hazard based on the International Labour Organisation had suggested a comprehensive list of hazards which was selected for utilisation in. To add extra support, additional causal risk factors were added from further sources including.

1. Job Safety Analysis (Harms-Ringdahl),
2. Safety and health in ship breaking, Guidelines for Asian countries and Turkey, ILO,
3. Occupational safety and health manual, for the ship recycling workers within the SAFEREC project 2003–2007.

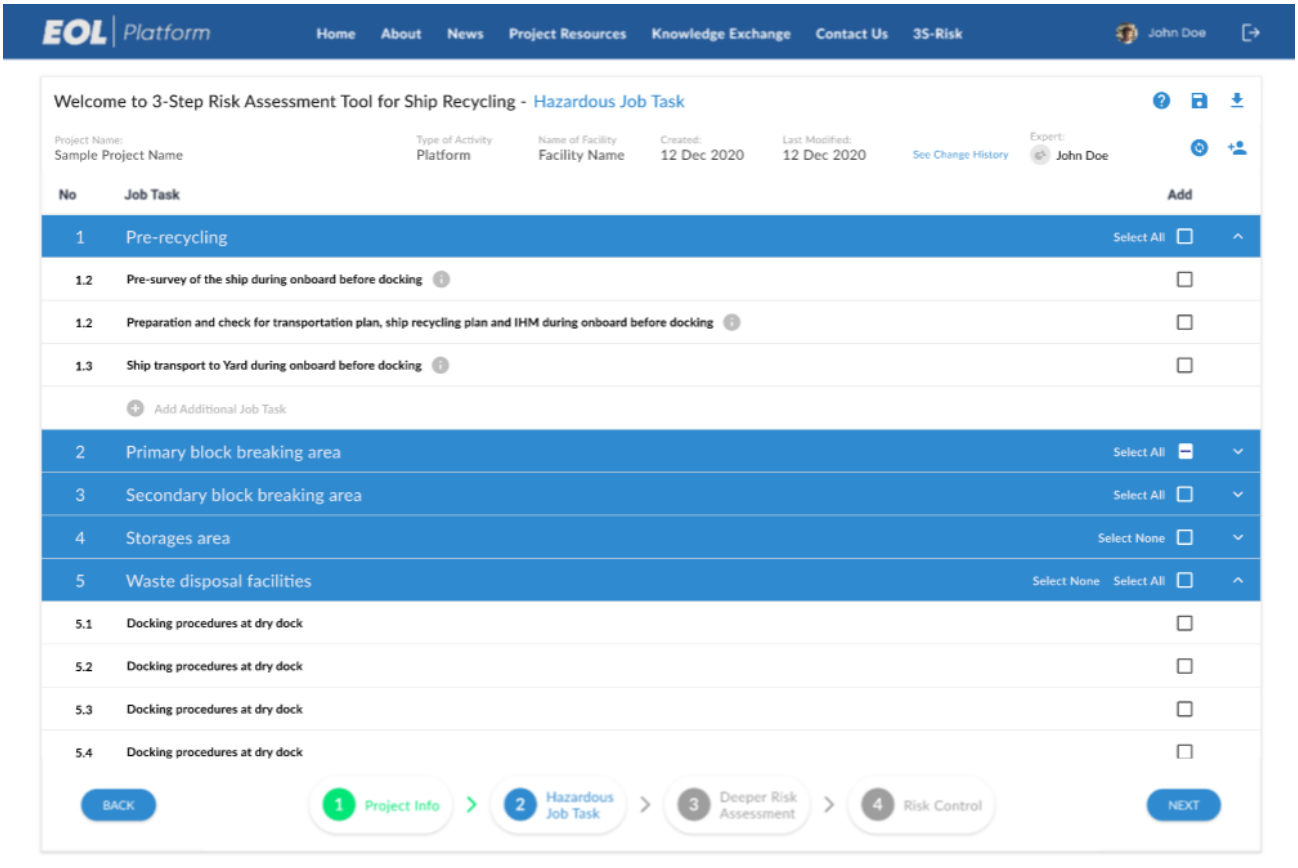



Figure 3. Job Task Selection Interface.

By providing a list of hazards, risk factors and examples of hazardous job tasks to the risk assessment team it allows for all potential hazards to be considered in a systematic way. It also provides potential education to the users in terms of considering hazards which they might not have thought of before, as shown in figure 4. The user will define one specific job task and perform a pre assessment of all potential hazards which are shown in the Job tasks. When the hazard is considered as not OK, there is always a need to go further into deeper analyses in terms of severity and consequence for each hazard. Furthermore, the experts group inputs information in relation to casual risk factors, location, potential effects and then calculates a risk level (R) based on the severity (S) and probability (P) the group deems the hazard to have as shown in table 1.

Table 1. Degree of probability, severity of consequences and rating

| Degree of Probability | Rating |
|---|---|
| Very frequent, once a day | 5 |
| Frequent, once per week | 4 |
| Quite frequent, once per month | 3 |
| Quite unusual, once a year | 2 |
| Unlikely, once per 10 years | 1 |
| Very unlikely, once per 100 years | 0 |
| **Severity of Consequences** | **Rating** |
| Death or several deaths | 5 |
| Disability | 4 |
| Longer reporting sick >14d | 3 |
| Shorter reporting sick <14d | 2 |
| Injury without reporting sick | 1 |
| Negligible or harmless injury | 0 |

### 2.2.3 Risk Control

The third step is the identification of risk control options and assessment of the control options as a function of their effectiveness against risk reduction. Step 3 aims creating risk control options that address both existing risks and risks

introduced by new technology or new methods of operation and management. Both historical risks and newly identified risks (from steps 1 and 2) should be considered, producing a wide range of risk control measures.

### 2.2.4 Generated Risk Matrix

For hazards which are rated 2 or above in the risk matrix hazard control/safety measures should be defined and re-assessed as before. Multiple measures and iterations of the risk assessment process may be required before an acceptable solution(s) is found. An action for implementation, responsibility and due date should be assigned during by the group during the risk assessment meeting. The process is then repeated for additional hazards and job tasks.

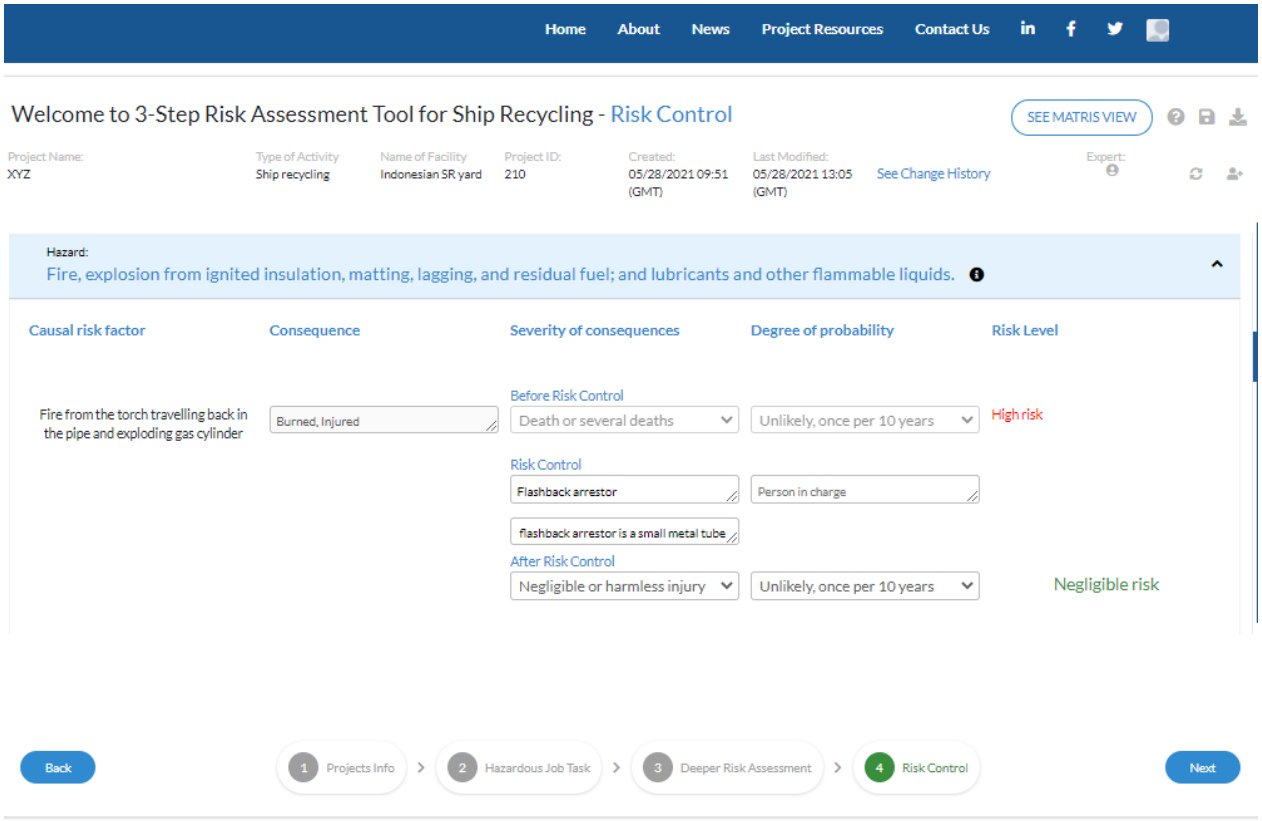
## 3. CASE STUDY

To validate the Three Step Online tool as being applicable to the ship recycling industry, a case study was conducted in a real ship recycling process. The case study involved in secondary zone on ship recycling process in Indonesia which has the potential to develop into a major industry at a national and global scale (Fariya et al., 2016). The job tasks which are involved in secondary zone are: Cutting hull structure into smaller cut and Loading and transportation with crane.

A team of experts and those familiar with ship recycling was formed to conduct the risk assessment. The team had access to detail the documentation of all job tasks mentioned above. The team comprised of 2 ship recycling experts, 2 researchers, 1 health, safety, and environment experts. The result for hazards involved causal risk factor and the risk calculation can be seen in table 2 and 3 respectively.

Table 2. The hazards involved and risk factor.

| **Cutting hull structure into smaller cut including cutting with cutting torch** | | | |
|---|---|---|---|
| | **Hazard Involved** | | **Causal risk factor** |
| **1.1** | Fire, explosion from ignited insulation, matting, lagging, and residual fuel; and lubricants and other flammable liquids. | 1.1.1 | Fire from the torch travelling back in the pipe and exploding gas cylinder. |
| | | 1.1.2 | Flammable materials, due to rest of fuel |
| | | 1.1.3 | flammable due to the paint |
| | | 1.1.4 | Lack of appropriate emergency response, rescue and first aid personnel services |
| | | 1.1.5 | Unprotected disposal/storage place of e.g., fuel, oil, grease |
| **1.2** | Falling on the same level-stumbling, slipping etc. | 1.2 | Slipping on wet surfaces or on something laying or fastening on the walking surface |
| **1.3** | Exposures with long term effect | 1.3.1 | Exposure to hazardous materials |
| | | 1.3.2 | Lack/improper wearing of PPE. |
| | | 1.3.3 | exposure from cutting fumes. |
| | | 1.3.4 | Noise exposure |
| **1.4** | Squeezing or crushing | 1.4 | stuck by moving object. |
| **1.5** | Penetration of sharp objects | 1.5 | Sharp-edged tools |
| **1.6** | Hazardous handling, overloading of part of the body | 1.6.1 | Awkward position |
| | | 1.6.2 | Handling heavy objects |
| **Loading and transportation with crane** | | | |
| **2.1** | Hazardous handling, overloading of part of the body | 2.1 | Handling heavy objects |
| **2.2** | Penetration of sharp objects | 2.2 | Sharp objects |
| **2.3** | Impact with a falling object | 2.3 | Improper loading and securing |




| | | | |
|---|---|---|---|
| **2.4** | Squeezing or crushing | 2.4 | Stuck by moving objects<br>Caught in or compressed<br>Shackles, hooks, Cranes, winches, and hauling equipment. |

Table 3. The hazards involved and risk factor.

| No | P | S | Risk | No | P | S | Risk |
|---|---|---|---|---|---|---|---|
| 1.1.1 | 1 | 5 | High | 1.3.4 | 3 | 0 | Low |
| 1.1.2 | 3 | 2 | High | 1.4 | 1 | 5 | High |
| 1.1.3 | 3 | 1 | Medium | 1.5 | 2 | 3 | Medium |
| 1.1.4 | 2 | 3 | High | 1.6.1 | 2 | 2 | Medium |
| 1.1.5 | 2 | 2 | Medium | 1.6.2 | 2 | 2 | Medium |
| 1.2 | 4 | 0 | Low | 2.1 | 2 | 2 | Medium |
| 1.3.1 | 3 | 0 | Low | 2.2 | 3 | 1 | Medium |
| 1.3.2 | 3 | 0 | Low | 2.3 | 1 | 4 | High |
| 1.3.3 | 3 | 1 | Medium | 2.4 | 1 | 5 | High |

Based on the expert's judgement, the mos hazardous thing in secondary zone is explosion because of fire from the torch travelling back ir the pipe. Then, it will continue to the next stage

Figure 4. Risk Cont

a recommendation from the expert to replace a cutting torch with mobile shear as one of the risk controls options to eliminate the hazard. From the risk's matrix below, the risk reduction can be shown.

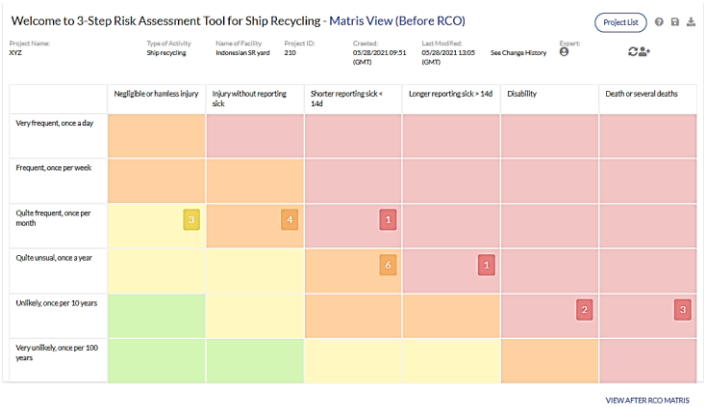



Figure 5. Risk Matrix before risk reduction

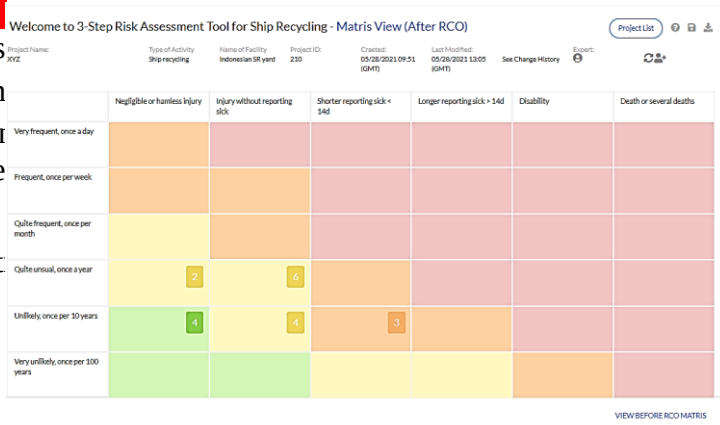


Figure 6. Risk Matrix after risk reduction

## 4. CONCLUSION

Ship recycling is a danger activity which involves severe risks. Ship recycling workers worldwide continue to be placed in danger due to a lack of proper hazard identification and risk management. The Three Step Online Tool aims to address both issues by providing ship recycling facilities with the support and structure to meet their responsibilities in a productive and useful manner in an online web-based system. It helps to lowering the risk with through easy and simple to use risk assessment and risk estimation calculation. The demonstration of the use of an online based risk assessment tool developed for ship recycling industry, and the implantation of this tool to Indonesian ship recycling context by the user shows indicate that this method could be a tool for the multiple experts to serve as a systematic method for risk reduction to enhance health and safety in ship recycling yard. We expect that the tool will be consulted by even more experts in the field and given the necessity in the future we will enrich it with more recommendations which will comply to the future requirements. The tool developed is ready for practical implementation in other countries and will create a real impact by minimizing the hazards and associated in risks, lowering the accidents and incidents in the long term.

## ACKNOWLEDGEMENT

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