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Development of ship-specific recycling plan to improve health safety and environment in ship recycling yards

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ABSTRACT

The recycling of end-of-life vessels has been identified as a key economic activity for sustainable development. India is the world's leading ship recycling (*i.e.* breaking, dismantling) country working on the principle of waste to wealth. However, the nature of operations carried out at ship-recycling facilities has raised concerns relating to occupational health, safety and environment (HSE). Though the efforts made by both Hong Kong Convention (HKC) and European Union (EU) legislation on *safe and environmentally sound ship recycling* are commendable, there exists no standard example or case report showing how to prepare the ship-specific recycling plan (SRP). Also, a clear guidance does not exist on preparation of the "ship-specific recycling plan" required for the three-step risk assessment method (reported in our earlier research).

Nearly 80% of the vessels dismantled in Alang ship recycling yards in India include bulk carrier, container and general cargo ships. Therefore, two bulk carrier ships, two general cargo ships and two container ships were tracked (one ship at a time) from beaching to complete recycling in this study and the life cycle of recycling process was investigated in-depth aiming at articulating the so called "ship-specific recycling plan". At the outset, it was understood that the lateral knowledge of experts involved in risk assessment exercise needs to be complemented with the cause–effect relationships. Therefore, what-if-analysis was employed to articulate the HSE issues associated with the above six ships selected for investigation. In addition, the inventory of hazardous/non-hazardous wastes generated during the course of recycling of six ships under investigation were classified as per the *Inventory Guidelines* prescribed by International Maritime Organization (IMO).

It was observed that bulk carrier, general cargo and container ships were broken in a similar manner. There are certain limitations with respect to the number of workers that could be engaged and size of the ship that could be beached in a given yard for recycling resulting from the physical size of the yard and fluctuations in the price of steel in international market. It was articulated that, on an average, 1.762 ± 0.026 man days would be required to dismantle one LDT of a given ship. The number of man days required for complete recycling of a given type of ship can indeed be used as the most important parameter while developing and planning for recycling of a given ship. The ship-specific recycling plan, what-if-analysis and wastes inventory developed in this research will further strengthen the three-step risk assessment method. Also, it is hoped that the results of this research will play a major role in fulfilling the legal obligations and eventually help in achieving the *safe and environmentally sound ship recycling* as desired by HKC and newly passed EU legislation.

1. Introduction

Global steel production has reached approximately 1607.2 Mega tonnes in the year 2013 (World Steel, 2013). As steel production at such a huge magnitude impose heavy burden on environment in all its phases, it's essential to lessen the burden on natural resources and maximize the steel recycling and find all the possible sources for secondary steel production. It is interesting to note that one such potential secondary source of steel is ship recycling industry.

It is well known that ships are an integral part of world trade and serve as a key link in world manufacturer's global logistical chain. Approximately 90–95% of international commercial goods are transported by sea routes (Demaria, 2010; Chang et al., 2010;

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Neşer et al., 2012; Hiremath et al., 2015). According to the study carried out by International Maritime Organization (IMO) in the year 2010, total 104,304 merchant ships were found to be involved in trading activity (IMO, 2012). Such huge number of ships needs to be disposed off from the ocean at the end of their useful life.

Typically, the need for breaking and recycling of a ship arises under two conditions. First, when the cost of operation of the ship becomes greater than the revenue which it can generate, and second, when the age or market conditions make a ship not-profitable to operate for the owner (Moen, 2008). It is to be noted that recycling of end-of-life vessels is an inevitable activity which reduces the maritime burden of ships after their profitable operation (Deshpande et al., 2012). Ship contains more than 95% of steel and the scrap value usually depends on the price of steel in the market (Reddy et al., 2003; SRIA, 2014; Demaria, 2010; Deshpande et al., 2012).

The magnitude of items recovered from ship recycling varies from valuable machineries and equipments, household accessories to things that are as trifling as screws and nut bolts. Ship recycling industry can also be considered as a green industry as almost entire product can be reused, recycled and resold (Sarraf et al., 2010).

Ship recycling industry provides direct and indirect job opportunities to approximately half one million workers in both India and Bangladesh. Country like Bangladesh is scarce in terms of Iron ore. In the year 2004, Bangladesh ship recycling industry contributed as high as 80% to the country's ever increasing steel demand (Kumar, 2013).

In case of India, ship recycling activity contributes to approximately 1–2% domestic steel demand – which is approximately 28% of country's total imported ferrous scrap (Ravichandran et al., 2012; Mikelis, 2013). Therefore, ship recycling activity, if promoted, can become a great tool to fill this void of steel demand.

1.1. Issues associated with ship recycling

The recycling of end-of-life vessels has been identified as a key economic activity for sustainable development. However, the nature of operations carried out at ship-recycling facilities has raised concerns relating to occupational HSE. The reason is twofold. First, in addition to economically re-usable materials such as steel, vessels also contain hazardous materials such as heavy metals, asbestos, glass wool, thermocol, oily rigs, oily sludge, oily sand, polychlorinated biphenyl (PCB), polyaromatic hydrocarbons (PAH), and organotins like tributyltin (TBT) *etc*., to which the workers get expose during breaking process as well as fraction of hazardous wastes may get release into the surrounding environment (Reddy et al., 2004; Asolekar, 2006; Neser et al., 2008; Mahindrakar et al., 2008; Demaria, 2010; Chang et al., 2010; Deshpande et al., 2012, 2013; Kusumaningdyah et al., 2013; Hiremath et al., 2014, 2015; Garmer et al., 2015). Second reason is, due to the structural complexity of ships many physical risks to workers takes place during recycling activity leading to severe injuries and even fatal accidents. For example, Demaria (2010) reported an average annual incidence of fatal accidents in the Alang ship recycling industry in India as 2.0 per 1000 workers (based on official data from 1995 to 2005).

1.2. Ship Recycling Regulations and guidelines

The Marine Environment Protection Committee (MEPC) was set up by the IMO, the United Nations legislator of the shipping industry to address the environmental issues relating to ship recycling and addressing the violations of the 1989 Basel Convention on the Control of Trans-Boundary Movement of Hazardous Wastes (Chang et al., 2010). However, ship owners from developed nations find ways to evade these regulations by selling ships to flag states of convenience, from where they are eventually sent to ship recycling companies located in Asian countries (Garud, 2012).

The International Labour Organization (ILO) published a report entitled: Safety and Health in Ship Breaking: Guidelines for Asian Countries and Turkey in 2004. The guidelines are designed to follow the ILO standards, codes of practice and other guidelines on occupational safety and health and working conditions. The guidelines contain practical recommendations for use by all those who are responsible for occupational safety and health in ship recycling operations.

The Hong Kong Convention (HKC) held in May, 2009 aimed at ensuring that ships being recycled do not pose any unnecessary risks to human HSE and highlighted the importance of inventorization of hazardous materials, development of ship recycling plan, authorization of ship recycling facilities and safe and environmentally sound recycling of ship. The HKC addresses issues of environmentally hazardous substances like asbestos, hydrocarbons, ozone-depleting substances *etc*. The HKC is currently being negotiated based on the draft formulated by the IMO under the auspices of United Nations Organization (Deshpande et al., 2012; IMO, 2013).

The European Commission has also passed a new legislation entitled: “Ship Recycling Regulation” – which was published in an Official Journal of the European Union on 10 December, 2013 (EU, 2013). As per this regulation all ships entering European Union (EU) ports as well as EU-flagged ships should have an inventory of hazardous materials (IHM). Ships departing for recycling should have an IHM as soon as the EU list is published, but not before 31 December, 2014. The requirements for an IHM are expected to be detailed than for the Hong Kong Convention's IHM, specifically concerning accuracy and comprehensiveness.

Even though the share (%) of wastes is minimal compared to the size of the ship, the wastes magnitude is huge (Hiremath et al., 2015). Therefore, HKC and EU regulations have highlighted the importance of preparing an inventory of the hazardous materials in the vessel. The literature review suggests no published case study so far on recycling of particular type of ship - which may become the basis for assessing the potential damage that can be caused by recycling obsolete vessels.

As stated earlier, the cost of obsolete vessel highly depends on the price of steel and scrap value in the international market. The costs associated with improving health of workers, safety related equipments in yards as well as environmental degradation caused by ship recycling, however, is not included while estimating the cost of obsolete ship. It is to be noted that both HKC and EU legislation understood and reported the importance of improving HSE conditions at the yards for achieving sustainability of the sector. Thus, internalizing the HSE costs needs thorough knowledge of ship-specific recycling plan, occupational risks posed to workers and surrounding environment along with the quantity and location of wastes in a given ship.

Gujarat Maritime Board (GMB), Government of Gujarat, administers and regulates ship recycling activity in Alang from last two decades. There are two landmark regulations made by GMB to make ship recycling activity environment friendly 1) “The GMB (Prevention of Fire and Accidents for Safety of Workers and Protection of Environment During Ship-breaking Activities) Regulation, 2003” and 2) “The GMB (Conditions and Procedures for Granting Permission for Utilizing Ship Recycling Plots) Regulation, 2006”. The GMB regulations, 2003 regulates ship recycling activity and its safety, hazardous waste management, beaching permission, *etc*., while GMB regulation, 2006 contains the terms and conditions that are required for getting ship recycling plot and renewal of existing plot.