Journal of Management Practices, Humanities and Social Sciences

Vol 4 Issue 1 pp. 5-11

https://doi.org/10.33152/jmphss-4.1.2

ORIGINAL CONTRIBUTION

Practical Approach of Environmental Awareness to Broadening Community Participation: A Case Study of Pindad (Persero)

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Abstract— The purpose of this study is to discuss the activity in the manufacturing industry, consisting of energy efficiency and responsible resource consumption to reduce waste emitted to the environment, taking into account the life cycle thinking. Manufacturing industries, both in commercial and strategic defense sectors are in trends to start their changing paradigm on environmental management. PT Pindad (Persero) as one of national manufacturing industry in Indonesia has been initiated related programs for the last few years. Starting year of 2020, the industry have implemented new transformation on energy and environmental preservation program, which also simultaneously conducted in community development area. This paper has collected both primary and secondary data depending upon onsite data availability. Data is obtained in several related divisions that responsible to do monitoring periodically. Therefore, range of data used in this paper started from 2018 onwards. Results shows that life cycle thinking of the Weapons Division consist of Design, Development, Manufacture, and Assembling activity, have potential impact in wastewater toxicity and air emission. This impact somehow drives the industry to reports the improvement program comprehensively, mainly in manufacturing area. Moreover, in the same objectives to spread environmental concern, the industry also conducted ex-situ conservation and land rehabilitation, while also develop awareness on environmental, safety, and health aspect to the long-run community empowerment.

Index Terms— Manufacturing Industries, Environmental Concern, Community Involvement, Life Cycle Thinking.

Received: 17 October 2019; **Accepted:** 11 May 2020; **Published:** 28 June 2020

Introduction

As the growing of manufacturing and industrial sector in developing countries, Indonesia, one of developing country with massive energy and natural resources, drives the adoption of global environmental issues towards sustainability (Hidayatno et al., 2019). Main concerns of the environmental for nowadays industrial sector consist of life cycle thinking (Klocke et al., 2015), responsible resource consumption Kumar & Mani (2019), biodiversity conservation (Hotimah et al., 2015), and also community development (Sayekti, 2015). This paper mainly discussed about the industrial concern to conduct environmental activity in defense manufacturing industry of PT Pindad (Persero).

PT Pindad (Persero), situated in Central Bandung City (see Fig. 1) (Marlinawati et al., 2019), West Java Province, Indonesia, is one of national strategic defense industry that starting their environmental concern for years. By the objective to improve environmental quality and performance in every manufacturing division, the industry has begun several initiatives in conducting best practice of environmental both in manufacturing area and outside operational area. Hence, the industry then focused on environmental impact management by optimizing it positive side while minimizing negative impact throughout good practice according to its magnitude to surrounding environment.

In this paper, a practical approach on enhancing environmental awareness in the industry operational area, and also by broadening community participation to the impacted outside area is presented. Main focus of the approach is to improve value of environmental preservation, such as waste management, water and biodiversity conservation, while also improving community income in economic perspective. Moreover, significant point of the approach is the progress on environmental improvement on site and out site of the industry represents as calculated reduction of energy consumption and emission (Okpala et al., 2017; Sparrevik & Utstøl, 2020), increasing number of planted crops, etc. The effectiveness of the program reported in governmental instrument as one of participation of the industry to support environmental beyond compliance in Indonesia, particularly represents as metal manufacturing sector (Sutrisno et al., 2018).

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Fig. 1. *Manufacturing location of PT Pindad (Persero), West Java, Indonesia*

This paper also has long term goals to achieve sustainability awareness on environmental beyond compliance, with the focus of pursuing balance between the environment and the manufacturing process itself, by considering people as the actor of overall activity in resource consumption and conservation. We wish that in the future the implemented program can be improved gradually and resulted advantage to the surrounding community. Thus, periodical monitoring and evaluation of the program plays important key factor to determine the next action plan on each improvement activities.

Literature Review of Environmental Assessment Instrument for Industry in Indonesia

In Indonesia, government in many sector has adapt industrial assessment based environment to measure performance of industries. The focus is depending upon the core of certain governmental sector, though main objective is the same on bringing environmental perspective towards sustainability of developing country. This paper introduced the very comprehensive environmental assessment instrument conducted from Indonesian Minister of Environment and Forestry, known as PROPER, controlled under Minister of Environment Regulation No 03/2014 (Environmental Compliance and Beyond Assessment for Measuring Environmental Performance of Industrial Sector).

PROPER assessment hosted by the Indonesian Minister of Environment and Forestry periodically (every half 2nd Semester of previous year and the other half of 1st Semester for ongoing year) for industries that meet standard of compliance and even beyond compliance criteria. There are certain steps of PROPER assessment, based on current regulations [9] and its recent adaptation.

Preparation

It is the very first step, consists of time series data collection (at least 4 consecutive years), benchmarking of practical lesson learned from the best companies awarded on previous PROPER result, and program inventory of the ongoing year activities. Industries also have to update their company's basic information such as profile, numbers of employees, and realization of production capacity.

Compliance assessment

In compliance assessment every participant of the industry should report basic environmental documents and its monitoring data. There are several environmental aspects for the manufacturing sector such as water and air pollution control including ambience and continuous monitoring, hazardous waste management and permitting, environmental permits (EIA, sub-EIA, etc.), and environmental management systems (new adaptation criteria since year of 2019). This step delivers the percentage results which divided into Comply (Blue Ranking), Near-Comply (Red Ranking), and Not-Comply (Black Ranking).

Beyond compliance assessment

Candidates of this step were selected based on the results of compliance percentage. Only "100% Compliance" participants will be invited to propose their PROPER beyond compliance reports as listed in the regulation. There are several aspects assessed: the Summary of Environmental Performances, Life Cycle Assessment (a new adaptation in 2019 criteria, replacing Environmental Management System which became compliance criteria), Energy Efficiency, Hazardous Waste Management, Solid Waste Management, Emission Reduction, Water Efficiency, Wastewater Management, Biodiversity Protection, and also Community Development (a CSR non-charity paradigm). Results on this step categorized as 25% bottom percentile (back in Blue Ranking), in between 25% to 75% percentile (Green Ranking), and 25% highest percentile (promoted to the Gold Assessment – latest known as Gold Candidate).

Gold assessment

It is the last but the hardest step to follow. Only the top 25% per sector can be promoted. There is also a consideration of environmental consistency as in PROPER required at least twice Green Ranking in a row of previous periodic assessments (last 2 years). The chosen candidates will present their Not-Business-as-Usual and innovative ways of thinking including awareness to the local community, and if necessary, there will be field verification to ensure the effectiveness of each program. This step delivers Gold Ranking and Green Ranking.

PT Pindad (Persero) has a goal to achieve balance sustainability in business and manufacturing process, environmental management, and also to their empowered community. This is in line with triple bottom line paradigm (people, planet, profit) and also supports the Sustainable Development Goals (SDGs). In terms of community empowerment, the industry has successfully support economic creative group including related capacity building required to activity, which in the future appealed to having concern in environmental and other health-safety awareness.

Methodology

Materials and methods

This paper has collected data both primary and secondary depending upon onsite data availability. Data is obtained in several related divisions that responsible to do monitoring periodically. Therefore, range of data used in this paper started from 2018 onwards, which also depends on year of program commissioning in each aspect discussed. Other than that, materials discussed in this paper represent each program implementation that depends upon in-charge division. We divided methods into big-frame activity such as retrofit of equipment, efforts on waste utilization, biodiversity conservation, and local community engagement as discussed below.

Retrofit and replacement

The industry has a long-run strategic plan to replace and also retrofit some old-operated equipment in every division. For retrofit of compressor have been conducted since the equipment reached end of lifetime where also the maintenance components already discontinue in the market. This was also related to environmental issue to reduce resource consumption that emitted more impact to the surrounding. Replacement program such as lubricant transformer oil and the change of piping system using HDPE were conducted along with leakage prevention, waste minimization, and responsible natural resource consumption. These programs implemented gradually for five years period along with the strategic planning of energy and resource efficiency of the industry.

Waste reuse and utilization

Waste utilization aimed to substitute consumption of raw material and also to reduce quantity of waste generation from the industry. Therefore these 3R thinking and utilization program is a good starter to improve environmental awareness, and in the future have a potential to involving local community participation.

Biodiversity conservation

Conservation point of view in this paper refers to in-situ activity of biodiversity protection, both flora and fauna. Method used in the program is direct measurement and calculation of biodiversity index to conduct trend line analysis in the future. Moreover, capacity building to the involved community and biodiversity stakeholder will play important role of the success of each program.

Socio-empowerment

Besides focus on environmental management and resource optimization in operational area, the industry also put attention in surrounding community as one of Corporate Social Responsibility (CSR) (mainly in the nearest area as Ring-I community area). As an extra-miles community development, the industry also empowered local community that has similarities activity to the industry. It aimed to be a pilot project as a reflection of environmental good practice journey of the industry. In the future, along with the strategic planning, community development program will be developed not only in the economical point of view, but also in the environmental awareness as a key factor to the sustainability success of home industries.

Life Cycle Thinking

PT Pindad (Persero) has begun their life cycle thinking since early year of 2019, there are several strategic manufacturing divisions that started the preliminary inventory of life cycle product. This section shows Life Cycle Inventory (LCI) of commercial manufacture process (see Fig. 2).

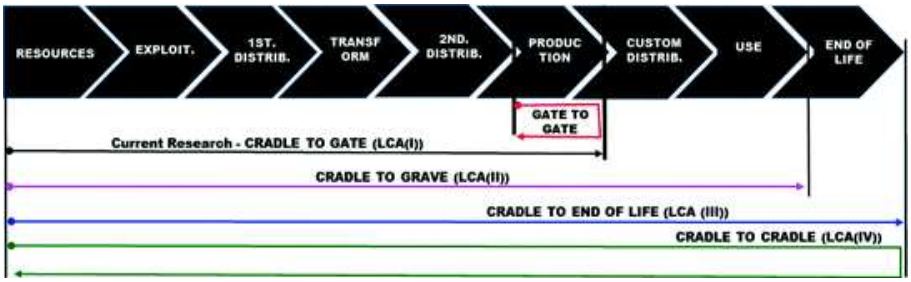

Fig. 2. *LCI of commercial manufacture process*

In commercial manufacturing process there are several product of metal-based such as heavy equipment for industries, railroad tools, etc.. Functional Unit is per one specific product. LCI resulted from monthly manufacturing data during 12 months in year of 2018. Additional information was referred to the EIA document and other related supports document. This life cycle preliminary inventory will be used to determine and identify the hotspot of environmental impact potential and prioritize environmental management program as part of continuous improvement. Inventory analysis referred to adopted international standard to Life Cycle Assessment in Indonesian National Standard.

Input and output

Input of the Life Cycle Analysis has begun with inventory of raw material, which consist of main materials and supporting materials. Main raw material of commercial manufacturing process is dominated by metal

alloys, round bar, steel plate, stainless steel, and many metal-based materials (Ramdhani et al., 2019). There are also some auxiliary materials such as chemicals, silica sand, Argon, CO_2, O_2, etc. Output of the manufacturing process is the products itself, such as electroplating-based products, casting-based and forging-based products, heavy equipment, etc. Prior to further analysis of input and output of the product system, it is very important to measure mass balance and energy balance of the manufacturing system. Other data required such as: raw material information, production volume and number of output, production data, environmental monitoring, GHG inventory, water and wastewater balance, etc. Life Cycle Assessment of the industry is planning to be conducted; the boundary system will be gate to gate which will be published in further publication.

Results and Discussions

This paper mainly discussed about the most recent effort of each energy and living environment perspective towards improving awareness on sustainable development for strategic manufacturing industry in Indonesia. Thus, many program still implemented partially, even though it's have similarities in background.

Energy efficiency: Gradual retrofit of standard compressor to inverter compressor

This program has initiated since early year of 2019, which conducted in overall area of the industry that used Room Air Conditioner (AC). About 250 units of AC (1.5 to 2 PK) equipped with Standard Compressor, where 10 percent of it already replaced with Inverter Compressor. It is targeted to be completely replaced with Inverter technology for the next 5 years period. Activity of Inverter Compressor installation is depicted in Fi. 3.

Fig. 3. *a. Conventional air conditioner, b. Inverter air conditioner*

This program has effectively reduced energy consumption about 1.79 Giga Joule per year. Monitoring will be conducted every 6 months to measure the progress of energy efficiency. Improvement of related efficiency energy program also will be discussed in further publication.

Emission reduction: The use of biosolar B-20 of panser komodo special vehicle

This program has initiated since year of 2018, to replace diesel fuel consumption into bio-solar which more eco-friendly than conventional fuel. One of special vehicle type of Panser Komodo has been on trial to use bio-diesel B-20. Activity during the experimental process is then depicted in Fig. 4.

Fig. 4. *Activity of bio-diesel trial in Panser Komodo*

This program is in progress to perceive the effect of bio-diesel consumption in special vehicle, whether it has an effect to the technical operation of the vehicle or has not. The use of bio-diesel also impacted to the emission released to the atmosphere, mainly in greenhouse gases potential as calculated in Fig.5.

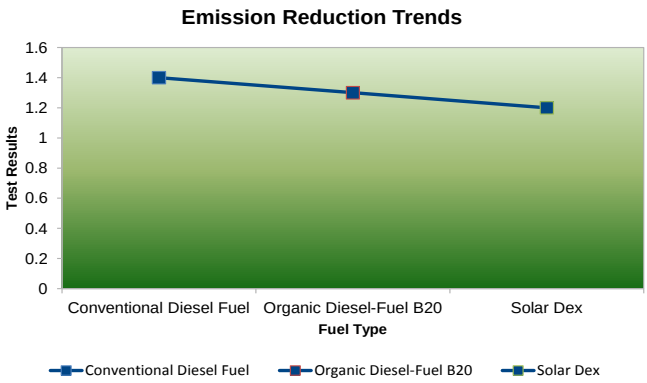

Fig. 5. *GHG Reduction of bio-diesel usage in special vehicle manufacturing product*

Based on preliminary fuel type experiment, it is shown that organic diesel-fuel or commonly known as bio-solar type B20 has lower GHG emission compared to conventional diesel fuel. Although Solar-Dex type has the lowest emission, it is also prefer to recommend the use of organic diesel fuel as it processed throughout eco-friendly raw material which also supported to the global warming mitigation.

Hazardous waste management: Replacement of lubricant transformer oil to dry transformer technology

For the last 30 years of operations, the industry has been using lubricant oil in their transformer unit which generated hazardous waste. About 20 units of transformer within 380V of voltage current have planned to be replaced with dry transformer which using no lubricant oil on its operations. This program will potentially reduce hazardous waste generation about 0.14 ton of lubricant oil per year per unit. Current conventional transformer in the industry is depicted in Fig. 6.

Fig. 6. *a. Conventional transformer, b. Dry transformer*

Solid waste management: Iron scrap utilization for product counterweight of excavator component

Iron scrap, one of dominated non-hazardous waste generated from mostly special vehicle and heavy equipment manufacturing process in the industry. One of major products in the divisions is excavator within various types, where the remaining cutting iron considered as scrap. In order to minimize this metal waste, the industry then utilized it to replace conventional counterweight of excavator component. The scrap and the product counterweight are then depicted in Fig. 7.

Fig. 7. *Iron scrap from metal cutting (Left) and after-utilization as counterweight (Right)*

About 100% of total metal scrap has been utilized since 2016, within total utilization 60 ton scrap per year equals with 81 of counterweights (Sustainable Finance, n.d.).

Water conservation: Replacement of galvanic piping system to hdpe for leakage prevention

Water supply, both for domestic and manufacturing process, in Pindad area mostly supported from groundwater deep well. It is distributed to overall area in the industry using galvanic piping system, which after years of operation resulted ineffectiveness on water leakage. This has also impacted on corrosion and potential contamination into the water. This situation drives the industry to partially replace the galvanic to HDPE pipelines, as depicted in Fig. 8.

Fig. 8. *Replacement of galvanic to HDPE pipelines*

About 60% of galvanic pipelines have been replaced with HDPE since mid-year of 2019. For the first month of replacement, this program has prevented water leakage up to 100 m3. It is also monitored periodically to measure effectiveness of water efficiency along the pipelines area.

Wastewater management: Reuse of electroplating wastewater for groundwater substitution

Pindad operates Wastewater Treatment Plant (WWTP) unit in Weapons Manufacturing and Assembling Division (see Fig. 9). It treats electroplating wastewater influent (previously was a clean groundwater) prior to be flowed into water body. As part of strategic plan started in year of 2019, there will be wastewater effluent management to reuse the electroplating wastewater as a substitution of groundwater usage.

Fig. 9. *Electroplating WWTP unit in weapons manufacturing and assembling division*

This program is ongoing to be implemented; with the calculated potential of wastewater load reduction is 0.0195 ton per year of Total Suspended Solid (TSS).

Biodiversity preservation: In Situ conservation of Bandung city forest park

Pindad operational area is also covering green forest park, which considered as city lung of Bandung City (see Fig. 10). This green area then maintained by the industry as part of in-situ conservation and has been supported Bandung City in achieving Adipura Award in recent decade Governor of West Java (2019).

Fig. 10. *View of Bandung City Forest Park in Pindad area*

Periodical monitoring for the changing of biodiversity baseline shows that there are currently 1,407 numbers of crops within status of conservation as depicted in Table I.

Table I
Number of non-star hotels and restaurants in Soppeng Regency

No.	List of Crops	Latin Name	Conservaion Status*)
1	Bintuni	Mellocia umbellata O, Stapf	Not Evaluated (NE)
2	Big Mahoni D	Swientenia macrophylla king	Vulnerable (VU)
3	Salam	Eugenia operculata roxb	Least Concern (LC)
4	Mareme	Glocidion arborescens BL.	Not Evaluated (NE)
5	Trembesi	Samanea saman merr.	Least Concern (LC)
6	Sea Sengon	Flacataria molucana	Least Concern (LC)
7	Bungur	Lagerstroemia speciosa pers	Endangered (EN)
8	Tangkil	Gnetum Genmon Linn	Least Concern (LC)
9	Pelatuk Bird	Picus	Least Concern (LC)
10	Perkutut Bird	Geopelia stiata	Least Concern (LC)

The industry take action on maintaining and conserving the forest park sustainability by preventing crops from parasites and conducting cut-down for damage crops. The industry also applied 10 crops rule, where either for cut-down by damage crops or road widening have to be redeem with crops. New employees also have to plant tree in the forest park. They also have to deliver gratitude and consider awareness to the animals as they are the agent of most pollination of the crops.

Community development: Small-medium home industry based environmental, health and safety awareness in Cipacing district

As part of CSR, the industry is mandatory to conduct partnership program to community that have similarities to the industrial product. Therefore, Pindad has empowered community in Cipacing Area in Sumedang District that produces rifles in small-medium industry. Activity of the community is depicted in Fig. 11.

Fig. 11. *Rifles home-industry activity in Cipacing area*

Located in Ring-III of social impacted area, this empowerment activity has been initiated for the last 2 decades, with number of productive youth of 10 individuals (International Organization for Standardization, 2016). This program has broadening potential through its quality of the product which has been used and distributed in many areas in Indonesia. For economic point of view, this program has improved community monthly income 12% higher in comparison to local standard (International Organization for Standardization, 2017).

Limitations and Future Research Directions

This study relied on available primary and secondary sources to gather data, yet maximum data could not be retrieved due to time and resource scarcity. In future, this study could be replicated with extended data to obtain results. To date, the industry also has been conducted environmental, safety, and health awareness throughout activities in rifles home-industry by conducting education, safety signs installation, and some of further development is in progress. It is hoped that in the future this program will be integrated to many environmental aspects as the industry has already begun the effort. As mentioned above that program implemented by the industry is still going partially, which will be improved in the future to have simultaneous awareness in environmental perspective.

Conclusion and Recommendations

We conclude that to begin sustainability effort does take time and long process prior to be completely implemented. Though some preliminary effort has been done by the industry, periodical monitoring and evaluation to measure effectiveness should be taking into account. Pindad industrial manufacturing as one of national strategic industry also play important role to broadening environmental excellent among industries and simultaneously to the community.

We recommend the industry to keep maintaining their effort in every sustainable aspect for continuous improvement. For further development, the industry should be reflections to the empowered community both in economic perspective and also in environmental concern, as health and safety also be considered.

Acknowledgements

We would like to deliver our gratitude and many thanks to the working group for environmental and sustainability PT Pindad (Persero). We also thank to Board of Directors of PT Pindad (Persero) for their continuous support and guidance for the team to having concern in the environmental perspective. Other expression of appreciation also for the community for their kind of cooperation and vibrancy to develop their potential in a good environmental way is also part of the key success of overall teamwork. We wish to enhance the development of sustainability program in the future.

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