

Water resources management at the fish processing industry using waste minimization approach

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Abstract. This study investigated waste minimization opportunities and implementation strategy at the fish processing industry. This study used quantitative approach with field observation and open list of questionnaire method to identify resources saving. The result of this study showed that fish processing industry (Company XYZ) was not implemented a waste minimization approach. The water resources saving reached 89.76 m³ or 27.2% from fresh water per a week of the production process and water consumption saving for washing process reached 30%. The utilization of solid waste can generate economic potential reached 26% of raw material, while liquid waste reached 51% of water consumption. The waste minimization approach hopefully would assist interested the company and bring both increase environmental performance and competitive advantage in the whole fish processing industry, especially in Indonesia.

1 Introduction

Sustainability is an important issue related to the exploitation of natural resources which includes ecological, economic and social factors simultaneously [1]. Growth trends in industries that adopt the principle of sustainable development have changed the way marketing products or services and also the management of company operations. Companies that follow this principle are required to pay attention to meeting the needs of consumers without sacrificing resources and long term. In order to achieve sustainable development, companies are required to manage business not only in terms of economic capital, but also in environmental capital and social capital.

The fish processing industry is one of the agro-industries that utilize fishery products as raw materials to produce a product [2]. Like other industries, the fish processing industry not only produces products, but also produces waste.

The increase of environmental problems due to the activities of the fish processing industry that are not environmentally sound, can cause the fishing industry to potentially pollute the environment. Generally, the fish processing industry used large amounts of clean water (80%), so the amount of industrial waste produced is also large at 20 m³/tonnes. The products produced depend on the technology used and the type of fish processed [3, 4].

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The increase of waste needs to be accompanied by an increase in understanding of the environment, especially waste water production processes. This is to maintain the quality of the environment to remain good. So, waste minimization is one of the best approach to meet the sustainability of waste management in the fish processing production process. Considering, the process of producing fish processing mostly uses clean water.

The waste minimization program aims to reduce waste volume, concentration and danger level of waste that comes from the production process [5]. Efforts to minimize waste can be done by reducing from sources and/or utilizing waste through the concept of 3R (Reuse, Recycle, Recovery) [6]. Before analyzing the application of waste minimization, this study has made several considerations in the effort to implement waste minimization. These considerations include the type of material that can be reduce or reuse; the volume of waste produced; efforts to minimize waste; estimated costs to determine possible changes to practice; priority efforts based on applicable regulations, costs, and volume; and identification of waste minimization opportunities, both waste reduction at source, waste reuse, and waste recycling [7].

The importance of the waste minimization application in the fish processing industry, the research was conducted to analyze waste minimization opportunities and the minimization application strategies in each production process. Analysis of waste minimization opportunities aims to evaluate environmental performance that has not been or has been done by the fish processing industry (the Company XYZ).

2 Methods

This study was used quantitative approach. The waste minimization opportunities were evaluated based on field observation and open list of questionnaire to company officials (Company XYZ at fish processing area Fishing Port of Nizam Zachman Jakarta/FPNZJ). Data were gathered on water consumption as well as solid and liquid waste production in the major process. Moreover, the information sources from questionnaire such as water bills as well as process-based record sheets were analyzed.

The daily water consumption data were averaged from March – April 2018. To ensure reliable baseline before water saving applications, field observation were carried out for three days. This average daily water consumption in March – April 2018 was regarded as the baseline situation throughout the study for comparison purposes. Environmental evaluation was done to identify of production process [8]. To allow environmental benchmarking between similar production facilities reported in the literatures specific water consumption (m^3/tonne of raw material) and solid waste generation ($\text{tonne}/\text{tonne}$ of raw material) were calculated.

3 Result and discussion

Based on observations, the Company XYZ has not implemented waste minimization properly. To support good management, minimization analysis is needed. Therefore, efforts to minimize waste are proposed for waste management of the Company XYZ. After obtaining the results of identification of waste quality, identification of waste minimization opportunities at the Company XYZ. Identification of waste minimization opportunities is carried out by calculating the waste load for each process carried out by separating and segregating waste. Separation of waste load for each process includes:

- a. Waste water from the thawing process can be reuse in the same process. Because the levels of BOD and COD in the process are small;

- b. The output water from the cooking and cooling process should be separated. Because the cooking process has the potential to be used as fish oil. Although sampling does not separate between the cooking and cooling processes, the potential for minimization can then be separated between the cooking and cooling processes. Water from the cooling process can be reused for the same process. This can separate the levels of BOD and COD in the cooking and cooling process;
- c. Water from the floor washing process cannot be mixed with other processes. Because the levels of BOD and COD in this process are the highest compared to other processes.

Based on this, it can be seen the amount of reduction in pollution load as an effort to implement minimization. Table 1 showed that minimization efforts can reduce the amount of waste that comes out to reach 66% for BOD levels and 61% for COD levels. Although the levels and waste load of BOD and COD still exceed the quality standard, the quantity produced still meets the requirements. Efforts to reduce the levels and load of BOD and COD waste can be done by channeling waste from the Company XYZ to be processed at WTU communal. If the waste minimization efforts are carried out by all industries in the FPNZJ area, then indirectly they contribute to maintaining the performance of the WTU communal so that it works optimally.

The process of reducing the levels and load of BOD and COD waste is done by separating the process of washing water from the appliance and floor with other process water, as well as combining and utilizing the cooling and melting process water, and utilizing cooking process water, so that waste water directly flows to the WTU channel only from the floor cleaning process and the equipment. Water from the cooking process can be used as fish oil products, while water from the cooling and melting process can be combined and reused for the process. Because the levels of BOD and COD in the melting process are small, so that it can be combined with wastewater from other processes.

Table 1. Before and after of waste minimization.

Minimizati on Effort	Volume (m ³)	Waste Quantity	Quality Standard of Waste Quantity	BOD Levels	COD Levels	Waste Load of BOD	Waste Load of COD	Quality Standard of BOD Waste Load	Quality Standard of COD Waste Load
	(m ³)	(m ³ /tonnes of raw material)	(m ³ /tonnes of material)	(kg/m ³)	(kg/m ³)	(kg/tonnes of raw material)		(kg/tonnes of raw material)	
Outlet (Before)	55,3	6,14	15	2,33	6,41	14,29	39,38	1,125	2,25
Outlet (After)	32,8	3,64		0,79	2,52	2,87	9,18		
Percentage decrease	40,7%		-	66,1%	60.1%	79,9 %	76,7 %	-	-

The efforts to implement waste minimization can be done by segregating waste generated from each production. Waste segregation aims to separate various types of waste streams according to the type of component, concentration or condition, so as to facilitate, reduce volume, or reduce the cost of waste treatment. Waste from the production process of the Company XYZ is segregated into two, namely solid waste and liquid waste. Based on Figure 1, solid waste from the production process can be minimized by recycle and recovery into economic value products, while liquid waste from the production process and condensate water can be reuse. Furthermore, liquid waste from the production process can be directly processed at WTU communal.

Efforts to reduce waste from sources can only be done if the production process technology at the Company XYZ is repaired or new technology changes. However, such things need to be considered further in terms of technical and cost aspects. Efforts to use

waste with the 3R concept can be done by reusing water from the melting process used for the same process as the water recycling system using water storage [9]. In addition, the utilization of liquid waste from the fish processing industry can be used as an economic value product as one of the efforts to support the blue economy principle. It is mentioned in several studies that liquid waste from the cooking process can be a source of fish oil [10] and nata de fish products [11] , fish bone waste can be a source of high calcium fish meal [12], skin and fins waste into fish skin snacks (crispy skin) [13], red meat waste and meat flakes become a source of food (pet food) [14] .

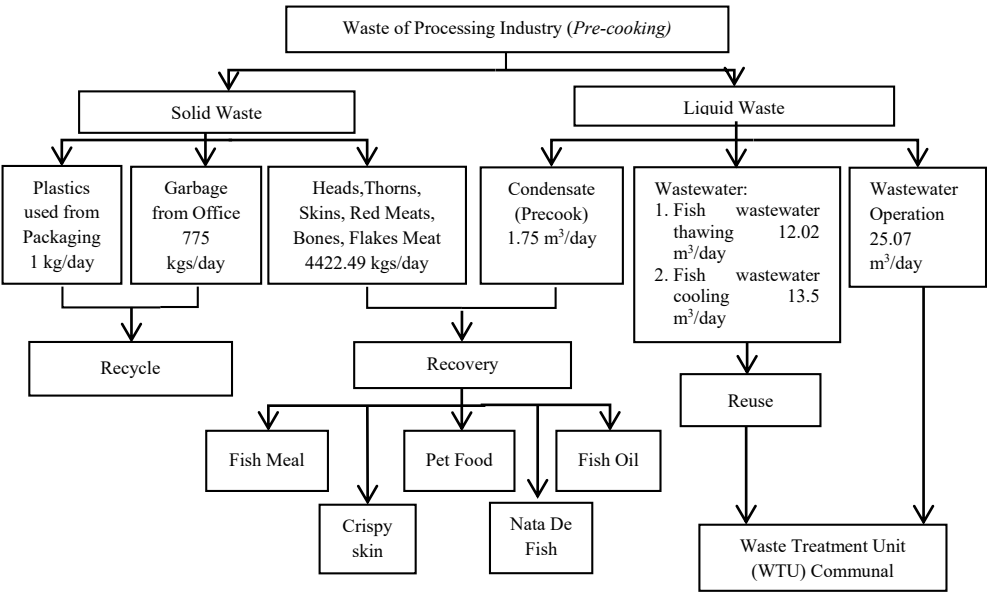


Fig. 2. Fish processing industry of waste segregation.

The production process of the Company XYZ has produced liquid and solid residual ingredients. Liquid waste material includes waste water from the production process, while solid residual material in the form of head, bones, fins, skin, thorns, red meat, and the remaining pieces of fish. If all of the residual material is not handled properly, it can cause pollution such as bad odor, decrease in water quality and aesthetics. Production process waste the Company XYZ on average is discarded, even though the waste can be of economic value if it is used.

Based on the results of waste segregation, the economic value of fish processing waste the Company XYZ can generate economic potential of IDR 11,237,203 per 10 tonnes of raw material per day. Utilization of solid waste can generate economic potential of 26% of raw materials, while liquid waste is 51% of water use. The amount of waste used for utilization is based on the flow of the production process. The value of utilizing waste into new products (recovery), obtained from the total economic value reduced by the total used of thawing and cooling water. This amount can determine the total benefits of using waste per day.

Application of minimization can not only reduce waste pollution from the production process, but also can save resource use. Saving water resources is analyzed, because most of the production process uses clean water. The Company XYZ uses clean water by buying IDR 40,000/m³. Minimization of waste can save water usage by 89.76 m³ or 27.2% of clean water for the production process for a week. The savings in the use of water for the washing

process are also expected to reduce water use by 30%. Water consumption can save well, if supported by employee behavior during production to control water.

4 Conclusion

The waste minimization applications not only reduce waste pollution from the production process, but also can resources saving. The water resources saving in the fish processing industry was able to water saving reached 89.76 m³ or 27.2% from fresh water per a week of the production process. Furthermore, water consumption saving for washing process was able to reduce water consumption reached 30%. As a result of waste minimization applications, the utilization of solid waste can generate economic potential reached 26% of raw material, while liquid waste reached 51% of water used. This study indicated that tangible environmental and economic gains can be achieved if waste minimization applications are successfully realized in fish processing industry.

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References

1. Bruntland, G. H. *World Commission on Environment and Development on Our Common Future* (Oxford University Press, Oxford, 1987)
2. B. Ibrahim, Fisheries Tech. Bulletin. **7**, 1 (2004)
3. B. Ibrahim, Fisheries Tech. Bulletin. **8**, 1, 31-41 (2005)
4. Setiyono, S. Yudo, JAL. **4**, 2 (2008)
5. L. Pudjiastuti, *Cleaner Production (Translation)* (Ministry of education and culture, Jakarta, 1999)
6. COWI Consulting Engineers and Planners AS, *Cleaner Production, Assessment in Fish Processing*. (United Nations Publication, Denmark, 2000)
7. S. Lee, H.S. Palik, Building and Environment, **46**, 1159-1166 (2011)
8. E. Alkaya, G.N. Demirer, Resour. Conver. Recycl. **77**, 89-96 (2013)
9. E. Alkaya, G.N. Demirer. Food and Bioprod. Process. **1**, 1-27 (2016)
10. Harris, H., Efreza, D., dan Nafsiyah, I. J. Hum Dev. **6**, 3, 1-15 (2012)
11. N. Adharani, N. Kurniawati, A. Sulistiono, M.G. Wardhana, Enggano Journal. **2**, 1, 1-10 (2017)
12. W. Trilaksani, E. Salamah, M. Nabil, Fish. Tech. Bull. **9**, 2, 34-45 (2006)
13. S. Haryati, A. Munandar, Journal of Fish. Mar. Affair. **2**, 2, 127-130 (2014)
14. Utamangkabovorn, M., Prasertsan,P., Kittikun, A.H. J.Cleaner Prod., **13**, 6, 547-555 (2005)