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WASTE MANAGEMENT AND GREEN PRODUCTIVITY IN INCREASED PRODUCTIVITY AND ENVIRONMENTAL PERFORMANCE

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ABSTRACT: Increased productivity raises many environmental problems. The production process creates material and energy discharges that will burden the environment. The purpose of the present study are to identify the problems in the production process that affect productivity, to measure the levels of productivity and Environmental Performance Index (EPI) and to devise alternative solutions to improvements by using the Green Productivity approach. This research is applied research, which is directed at taking action in changing the state of competition and solving real environmental problems. Results of the study were the utilization of solid waste of fish offal, heads and bones into composts, the utilization of fish-steaming wastewater into a fish paste and the recycling of fish-washing wastewater using the filtration process. Solid and liquid waste were utilized in order to reduce the volume of waste generated which ultimately would result in an increased productivity and environmental performance.

Keywords: Productivity, Environmental performance index, Green productivity

1. INTRODUCTION

Productivity is one factor that is important in influencing the progress and decline of a company. Increasing productivity means improving the welfare and quality of the company. Therefore, it is necessary to conduct a productivity measurement in a company that aims to find out the productivity benchmarks that have been achieved and is the basis of planning for future productivity improvement [1]. The productivity of all industry sectors is obliged to use technology and produce environmentally friendly products so that all companies are required to produce environmentally friendly in addition to profit. Aligning between the big profits that are expected by the company with environmentally friendly is known as the Green Productivity concept [2].

Green Productivity (GP) is a strategy to increase company productivity and environmental performance simultaneously in social-economy development as a whole [3]. Implementation of GP is the appropriate technique, technology and management system to produce eco-friendly goods and services. This company implementation of GP is considered relevant since GP starts from a strategy to improve productivity and environmental performance. Starting with analyzing inputs, processes and outputs, GP can generate significant benefits for increased productivity. GP also demonstrates how to effectively reduce the environmental impacts that can lead to cost savings and risk reduction [4]. In fact, companies that implement GP would experience productivity improvements through reduced spending on environmental protection, such as resource depletion, waste minimization, pollution reduction and better production [5].

Increased productivity raises many environmental problems in the vicinity. The problem is caused because the production process often leads to the disposal of materials and energy that will burden the environment. A good production process not only takes into account the safety and side effects of the waste process but also reduces the waste produced [6]. Environmental issues are a hotly discussed issue. It is important for the company to pay attention to the environmental aspects in each production process undertaken in order to create harmony with the surrounding environment [7]

The production process is a series of processes from the initial process to the final process in a product [8]. The production process of shredded fish using the main raw materials of fish and other spices. Figure 1 was the production process of making shredded fish.

The volume of waste generated is due to (1) lack of facilities and equipment to process and accommodate waste. (2) Waste does not have economic value because the waste is easy to decompose (3) Inexperienced manpower capability. (4) Lack of knowledge about waste

treatment so that waste is not utilized optimally. Among the efforts to reduce fish-washing wastewater, tuna steaming wastewater, tuna frying and shredding oils as well as solid waste in the form of tuna offal, bones and heads are to recycle the resulting waste. With recycling, the amount of waste produced can be reduced and companies can indirectly improve productivity and environmental performance.

The purpose of the present study was to maximize waste utilization. The target of the study was the utilization of solid waste of fish heads and bones and utilization of wastewater. Purpose and target of the study showed that: (1) utilization of solid waste (fish heads and bones) could be maximized by making it into useful byproducts. (2) utilization of fish steaming liquid waste of could be maximized by making it into a byproduct of fish paste. (3) Fish washing wastewater could be treated by means of water filtration for re-washing use.

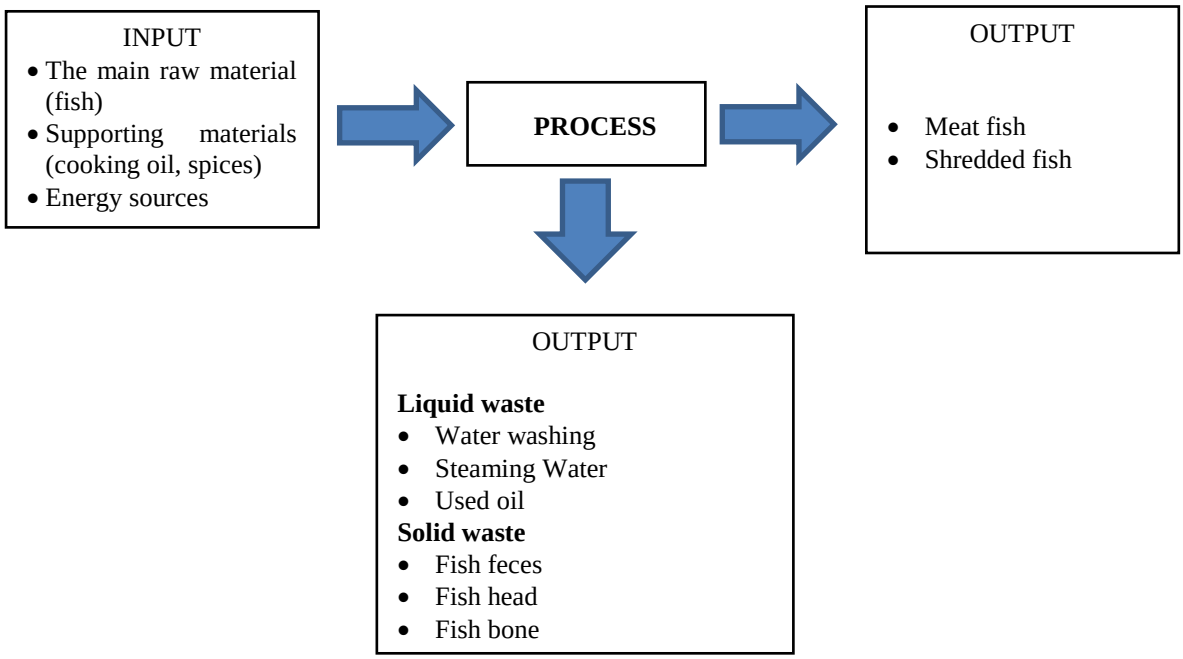

Fig. 1 The production process of making shredded fish

2. THEORETICAL BACKGROUND

2.1 Productivity

Productivity in an integrated way involves all human effort. Productivity contains a sense of mental attitude that always has the view that life today should be better than yesterday and tomorrow is better than today [9]. Production and productivity are two different meanings. Increased production shows the increase in the number of results achieved, while the increase in productivity contains a sense of an increase in yield and improvement of production mode. Increased production is not necessarily due to increased productivity, as production may increase even if productivity remains or decreases [10]. Productivity is the relationship between the input and output of a production process within a company. Input is a resource used in the production process, while the output is a product produced from the production process. Productivity is very important for a company as one effective way to know the performance of production [11].

Increased productivity can be seen in three forms namely [4]:

a. The number of outputs in reaching the destination increases by using the same input.
b. The number of outputs in achieving the same or increased goals is achieved by using fewer inputs.
c. The number of outputs in achieving a much larger goal is obtained with relatively smaller input increments.

Human resources play a major role in the process of increasing productivity because the means of production and technology are essentially the work of human beings.

Productivity can also be used to measure the effectiveness and efficiency of a company's production process. Effectiveness is a measure that gives an idea of how far the target quality and quantity has been achieved. While efficiency is a measure of input use in the

planned with the actual input used to produce a certain output. By measuring productivity, then a company will know the level of performance and it can be used as a reference to make improvements in the long term. By knowing the level of productivity, it will be known also large input efficiency that has been in sparingly [12].

2.2 Waste

Waste is the discharged materials generated from production activities and processes, either on the scale of household, industry, mining and so forth. Waste may be in gas and dust, liquid or solid form. Among the various types of waste there are toxic or dangerous ones locally known as Hazardous and Toxic Waste [13]. The more the human activity increases, the more the waste would be generated.

According to Singh *et. al.*, [14], the characteristics of wastewater are as follows:

1. Physical characteristics, consisting of several parameters, such as (a) total solid (TS), which is solids in water comprising organic and inorganic materials that dissolve, precipitate, or are suspended in water; (b) total suspended solid (TSS), which is the weight in mg/l of dried mud present in wastewater after a filtration with a membrane measuring 0.45 microns; (c) color, which is basically colorless for clean water, but over time and with the increase in anaerobic conditions the color of waste changes from gray to blackish; (d) turbidity, which is caused by suspended solids, either organic or inorganic; (e) temperature, which is an important parameter due to its effects on chemical reaction, reaction rate, aquatic life and use of water for a variety of daily activities; (f) odor, which is air generated by the decomposition of materials or addition of substances to the waste. Odor control is crucial since it is associated with aesthetic issues.
2. Chemical characteristics, consisting of several parameters, such as: (a) biological oxygen demand (BOD), which is the amount of dissolved oxygen required by living organisms to decompose or oxidize discharged materials in the water; (b) chemical oxygen demand (COD), which is the amount of oxygen in the water required for chemical reaction to decompose pollutants. COD is expressed in ppm (part per milion) or 0.2 ml /liter; (c) dissolved oxygen (DO), which is the level of dissolved oxygen required for aerobic microorganisms' respiration. DO of water is highly dependent on temperature and salinity; (d) ammonia (NH_3), which is the cause of irritation and corrosion, promotes the growth of microorganisms and disrupts the disinfection process with chlorine. Ammonia is present in solution and may be a compound of ammonium ions or ammonia depending on the pH of the solution; (e) sulfides are reduced to sulfides in sludge digester and may interfere with biological waste treatment processes when their concentration exceeds 200 mg/L. H_2S gas is corrosive to pipes and may damage engine; (f) phenols are easy to enter through the skin. Chronic poisoning causes gastrointestinal symptoms, difficulty swallowing, and hypersalivation, renal and hepar damage, and death; (g) degree of acidity (pH) may affect biological life in water. A too low or too high pH may kill the microorganisms' life. The normal pH for aquatic life is 6–8; (h) heavy metal, which its excess concentration may be toxic so that the measurement and treatment of heavy metal-containing waste are required.
3. Biological characteristics used to measure the quality of water, especially water consumed as drinking water and clean water. The commonly used parameter is the number of microorganisms contained in the waste water is the number of microorganisms contained in the waste water.

2.3 Green Productivity (GP)

GP is a strategy to increase productivity and preserve the environment for socio-economic development. This program is the application of appropriate techniques, the use of technology and management systems in order to produce goods and services that are environmentally friendly. GP Productivity can be applied in the assembly industry, service, agriculture and the general public. Through the implementation of GP can be achieved corporate productivity and simultaneously control the environment as an ongoing development effort [15].

GP applies productivity with appropriate tools, techniques, environmental management technologies, to reduce the environmental impact of organizational activities. The first step is to identify the source of the cause of the waste, followed by setting goals and targets. The final step is to discuss the existing issues, select the resources and information available to construct GP alternatives [16].

Effective use of GP can lead to positive changes in socio-economic development. The biggest GP attribute is the potential to integrate environmental protection into business operations as a means of increasing productivity. GP may result in increased profitability, or

better cash flow [17]. The concept of Green Productivity is derived from the incorporation of two important points in the development strategy [18]: (1). Environmental Protection (2). Productivity Improvement, The GP has four general objectives in order to improve the environmental and economic quality of production when implemented on the production floor: a). Waste Reduction, b). Material Management, c). Pollution Prevention, d). Product Enchancement.

3. METHODS

The type of research used in this research is applied research. This research is directed at taking action in changing the state of competition and solving real problems [19]. Problems were identified using the cause-effect diagram to obtain the ultimate problems as shown in Figure 1.

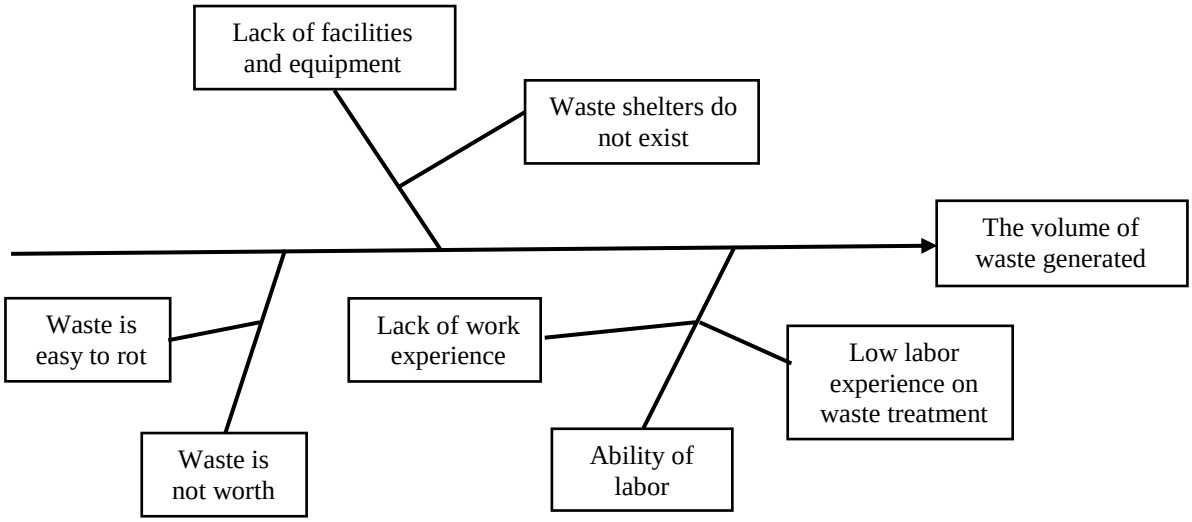

Fig. 2 Cause-effect diagram of a waste

The present study consisted of the following stages: (1) Measurement of productivity by comparing the total output with total input [20]. The company's total productivity level was measured uses the following equation:

$$\text{Productivity Index} = \frac{\text{Input}}{\text{Output}} x100. \quad (1)$$

(2) Waste testing to determine the chemical contents in the waste parameters. Fishery waste contains the parameters of BOD, COD, TSS, oils and fats and pH (degree of acidity). The production process is controlled to reduce the levels of pollutants so that water meets the established quality standard [21]; (3) Measurement of the environmental performance index (EPI), which is a benchmark of a company's environmental performance [22]. EPI is calculated using the formula:

$$\text{EPI} = \sum_{i=j}^{k} \text{Wi. Pi} \quad (2)$$

where *k* is the proposed number of waste criteria, *Wi* is the weight of each criterion, *Pi* is a deviation of the government standard from the results of the analysis [23].

$$\text{Pi} = \frac{\text{Standard - Analysis}}{\text{Standard}} x100. \quad (3)$$

(4) Development of alternative solutions tailored to the set goals and targets. Conducting several alternative solutions to solve existing problems and aims to reduce the amount of waste generated while improving the productivity of the company [24].

4. DISCUSSION

Process Flow Diagram is a special flowchart that regulates the sequence of work activities together with each material and energy flow in a particular process or factory after the survey runs. Process quality will affect the quality of the products produced, including the amount of waste produced by the production process [25]. Figure 3. Shows The flow of shredded fish production process.

Washing is an initial process by inputting the main raw material and support. The main raw material of shredded fish is 200 kg which will be washed with supporting material (water) of 200 liters. This initial process produces 200 kg of fish output and 200 liters of waste water.

Steaming is done to facilitate the separation between meat and dirt, head & fish bone. Steaming is done by inputting tuna fish steamed in water as much as 50 liters. This process produces 35 liters of waste water and 206 kg of fish meat. The next process is the separation between meat, head and fish bones. The separation process of 206 kg of fish will produce the output of solid waste (dirt, head and fish) as much as 92 kg.

Mixing fish meat as much as 92 kg with spices that have been smoothed and produce shredded fish output as much as 135 kg. Frying fish meat 135 kg in 5 liters of cooking oil and produce waste water output (used oil) as much as 3 liters and shredded fish as much as 136 kg. Fish meat pressing is 136 kg and produces 1.5 liter liquid waste (used oil) and fish meat 129 kg. Fish meat 129 kg then in the oven and then in a sieve to separate the fish bones are smooth with fish meat. of this sieving will produce solid waste (fish bone) as much as 2 kg and shredded fish as much as 127 kg. The last process is shredded fish as much as 127 kg in the pack in plastic. One package weighing 1 ounce. So 127 kg of shredded fish will produce 1270 packs.

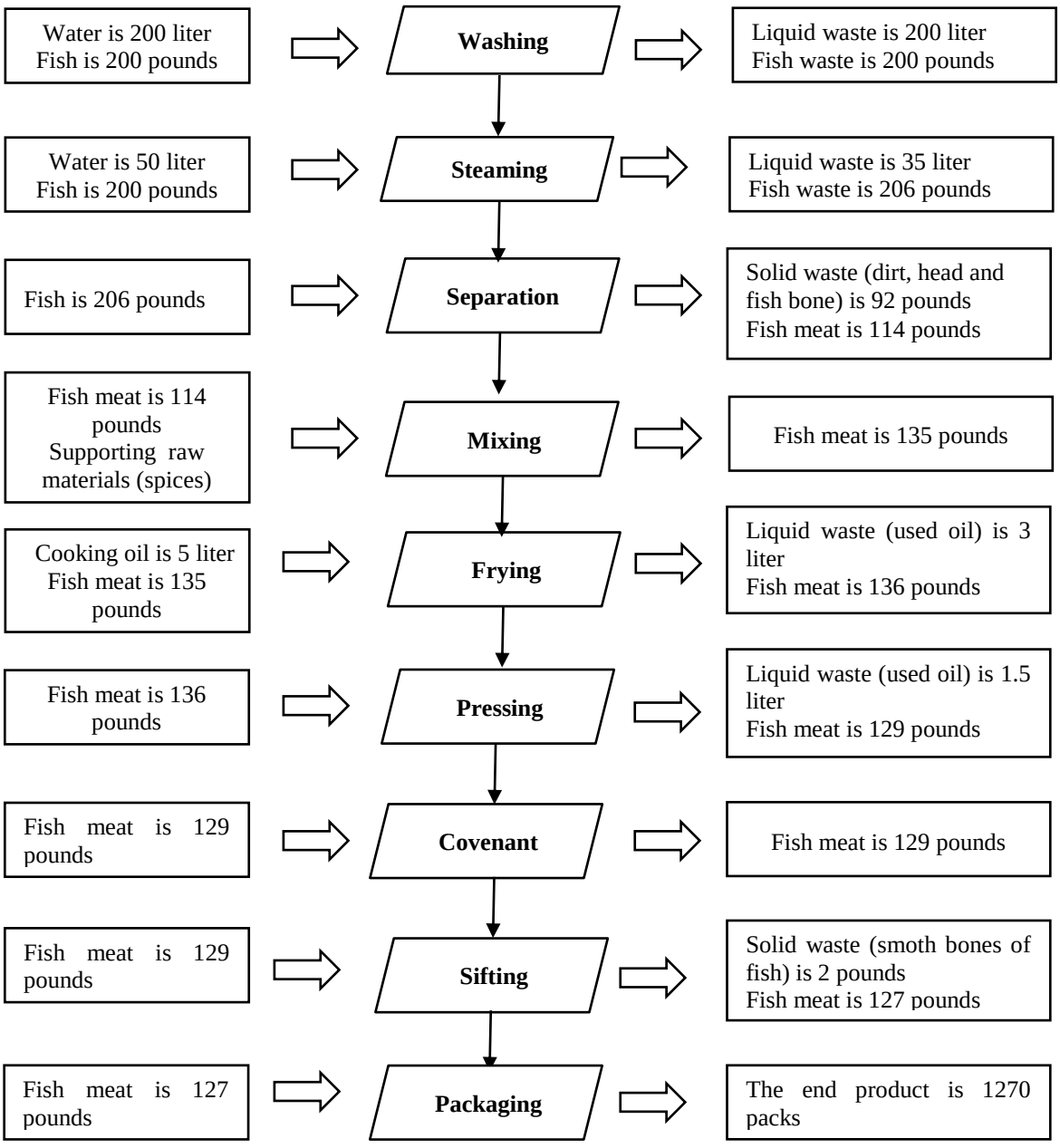

Fig. 3 The flow of shredded fish production process

4.1 Calculation of Productivity

Productivity was measured from periods 1 through 12. Levels of productivity are as shown in Table 1.

Table 1 Levels of productivity

Month	Total input (I) (Rp)	Total output (O) (Rp)	Productivity ($O/I\,x100\%$)
January	47.863.000	46.500.000	97,1 %
Pebruary	46.253.600	46.314.000	100,1 %
March	44.363.000	47.430.000	106,9 %
April	38.792.300	46.500.000	119,8 %
May	38.792.300	46.221.000	119,2 %
June	43.323.300	46.128.000	106,4 %
July	39.040.800	44.640.000	114,3 %
August	46.285.000	46.965.000	101,4 %
September	39.159.000	47.244.000	120.6 %
October	40.779.500	47.337.000	116 %
November	45.490.100	46.407.000	102 %
December	42.948.000	47.244.000	110 %

The productivity value was quite good (97.1 to 120.6%). The productivity value of only 97.1% was due to the more expensive main raw material in January than in other months. The more expensive raw materials automatically affected the total inputs.

4.2 Measurement of EPI

Table 2 EPI value of Sample 1

Number	Parametric	Weight (W_i)	Standart	Analysis results	Deviation (P_i) %	EPI Index (W_i*P_i)
1.	BOD	0.251	100	80	20	5.02
2.	COD	0.224	200	150	25	5.6
3.	TSS	0.18	100	70	30	5.4
4.	Oil Fat	0.17	30	9	70	11.9
5.	pH	0.175	9	7	22.22	3.8885
					Total	31.8085

Sample 1 (tuna washing wastewater) had an EPI value of 31.81.

Table 3 EPI value of Sample 2

Number	Parametric	Weight (W_i)	Standart	Analysis results	Deviation (P_i) %	EPI Index (W_i*P_i)
1.	BOD	0.233	100	70	30	6.99
2.	COD	0.228	200	100	50	11.4
3.	TSS	0.19	100	65	35	6.65
4.	Oil Fat	0.175	30	20	10	1.75
5.	pH	0.174	9	8	11.11	1.93314
					Total	28.72314

Sample 2 (tuna steaming wastewater) had and EPI value of 28.72.

Table 4 EPI value of Sample 3

Number	Parametric	Weight (W_i)	Standart	Analysis results	Deviation (P_i) %	EPI Index (W_i*P_i)
1.	BOD	0.235	100	70	30	7.05
2.	COD	0.233	200	110	45	10.485
3.	TSS	0.181	100	90	10	1.81
4.	Oil Fat	0.181	30	25	16.66	3.01546
5.	pH	0.17	9	5	44.44	7.5548
					Total	29.91526

Sample 3 (tuna frying and shredding oils) had and EPI value of 29.91.

4.3 Development of Alternative Solutions

There are several alternative solutions to maximizing waste to be useful and of economic value and improve productivity and environmental performance: (1) Organic fertilizer or liquid fertilizer, complete organic fertilizer made from fish raw material has better quality as fertilizer than organic fertilizer ex. compost, manure, or green manure. [26]. For the manufacture of liquid fertilizer is done by hydrolysis process with the help of certain enzymes. All parts of the fish body and liquid waste fish processing can be utilized for the manufacture of this fertilizer. Organic fertilizer using fish offal, heads and bones so that the waste would have an economic value. Doing so would reduce and even eliminate solid waste. (2) Fish-steaming liquid waste could be utilized to produce fish paste [27]. Doing so would decrease the volume of waste generated.

(3) The minced fish, produced from the remains of fish meat attached to the bones and still collected, can be used for the basic ingredients of gel gel products such as meatballs, sausages, nuggets, dumplings, etc [28]. (4) Fish oil can be produced from the remains of fish meat and skin [29]. Processing by extraction, with a combination of cooking, drying and pressing to separate the oil and fish meal. The benefits of fish oil for health can prevent some diseases, including coronary heart disease, excess blood cholesterol, cancer, hair loss, and for immunity. (5) Fish flour and silage, from meat waste, bone, gills can be used as a material for making fertilizer and animal feed/fish. Fish meal is a low water-rich product of protein and minerals, obtained from several processing processes including cooking, pressing, drying and grinding. While silage fish are remnants of fish preserved in acidic conditions by addition of acids (chemical silage) or by fermentation/ability of lactic acid bacteria (biological silage). The resulting fish silage is liquid because fish protein and other structural

tissues are degraded into smaller units of the solution by enzymes found in fish [30].

(6) Collagen and gelatin: Collagen is an important protein that connects cells with other cells. Skin and fish scales is one of the main sources of collagen. Collagen production can be done by extraction either conventionally or enzymatically. Collagen uses are for dietary supplements, cosmetics, and additives in foods and soft drinks. While gelatin is a protein derivative of collagen fibers present in the skin, bones, and cartilage, which is obtained through the process of hydrolysis of collagen fibers. Useful for food processing such as stabilizers, gelling, thickeners, emulsifiers, adhesives, edible coatings, water binders and non-food items such as cosmetics, medical/ pharmaceuticals, paper and others. [31]. (7) Fish washing liquid waste could be recycled means of water filtration for re-washing use. Doing so would reduce the inputs and increase the company's productivity and reduce the volume of liquid waste generated

5. CONCLUSION

The environmental performance index (EPI) of tuna fish-washing wastewater, tuna steaming wastewater, tuna frying and shredding oils was positive, meaning that environmental performance was quite good. The present study resulted in several alternatives to utilizing waste through the recycling of solid waste of fish offal, heads and bones as well as utilizing fish-steaming waste into a fish paste and recycling fish-washing wastewater by means of filtration for reuse for the production process. Implementation of these alternatives would increase productivity and environmental performance.

6. ACKNOWLEDGEMENTS

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