Revisi GP_Indah_EPI on food production2.

by Indah Aprilianasari
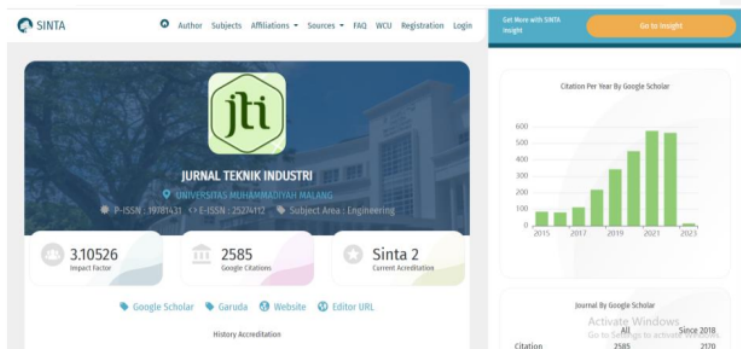

Environment Performance Index Assessment on Food Production : A Case Study in Indonesia

ABSTRACT

Green Productivity (GP) is a strategy to increase productivity and protect the environment which cause of production activities. GP has been widely applied to assess the quality of environment. For example, a seller of crispy fried chicken who drains chicken's wash water, even used cooking oil and slurry down the drain. Obviously, it will be reducing the quality of water. So, the aim of this research is to get the prevent environment damage solution from the production of chicken crispy. The first step must to do is identify waste, and than create material balance diagram, calculate EPI and productivity, and than purpose the alternatives. The result of this research show that pollution are very high. Wastewater from production tested at the Environmntal Service, and showed with a BOD value of 769mg/l, COD 1699mg/l, TSS 2536mg/l, and the EPI Index is -31,05, are exceed of the government standards. Result show that improvement production need to be carried on. And the end of this research was produce several alternative to prevent waste before down to the environment like makes a grease trap.

1. Introduction

The world organization have highlighted the safety and impact of food production that contributes to global climate change by producing greenhouse gases (GHG) [1], [2], wastewater production [3], and other impacts on soil, fish, and other ecosystems [4]. We also found the food production are still using conventional packaging, and the desire of customer to buy the green product are low [5].

The increasing of population in the world are produce and consuming food products every day, have been contributing on environment impacts [6]. Conventional packaging [7], continuous consumption of energy-water-food resource uncontrol [8], and conventional component of technology [9] had high environment impact doe to lower sustainability. Therefore, it is very necessary for business units to evaluate their production process, to increase productivity and environmental performance [10].

Not only on large industries, but small businesses, which are currently increasing in number of product, they will to consume clean water and energy [11]. For example, some fried chicken sellers in Sidoarjo have not treated the water used to wash the chicken and the cooking utensils used for frying. Sediment of cooking oil in the form of flour is simply thrown away in the trash, soil, or the surrounding water flow. [12] predicting that availability of clean water and energy will be decrease simultaneously effect the food production. So, several research study have made an innovative solution to prevent the

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environmental damage [13][14][15]. And to improving the environmental performance, [16] has set a standard with the aim of its production activities. Another methods are educating the customers about potential impact of environment, believed to influence decision of customer to buy [17]. Using material from organic farming [18], promoting the sustainable development goals (SDGs) [19]. Optimizing the production process by making more creative products, especially from products that are not value added or waste, will certainly increase productivity from the use of raw materials, increase the effectiveness of the energy absorbed, and reduce the company's financial costs [20], until provide an environment taxes to reducing emission [21].

Several previous researchers have taken preventive action such as : selection the green suppliers which have the best environment performance using hybrid entropy-TOPSIS-F [22]. They used 32 experts to given weight of criteria and then selected the supplier who had superior environmental performance used TOPSIS. And to verify and sensitivity tested they used entropy-TOPSIS-F. But, the method aren't identify the potential waste from their production activity. To measuring the environment impacts can also using Life Cycle Analysis (LCA) and integrating municipal solid waste management (MSWM), in order to select the suitable strategy. By integrating these, decision maker can choose the best alternative solution [23]. But, in LCA it is necessary to determine the environment impact assessment indicator. When the indicators not suitable, it can't presented the right assessment. And the other hand, measuring the energy efficiency and environmental performance, [24] was setting the indicators and comparation it using Data Envelopment Analysis (DEA) [25][26][27]. Indicators of sustainability used for assessing performance of economic, environmental, and social [28]. In DEA, each indicators examined in one of decision making unit (DMU), and then compare it with another DMU. Purpose of that method is to get the best DMU and become an evaluation for the other DMU. In this method doesn't identify waste production and quantify amount of them.

Another research had used a Lean Six Sigma (LSS) approach and combining with Double Loop Learning (DLL) to identify food waste loss (FWL) during the process production and distribution [29]. In this case, researcher finding the cause of FLW but they not measure the volume of waste production contributed in the environment. Another research using LCA and integrating it with Artificial Intelligence (AI) [30]. In these research, LCA used to evaluate the environmental impact from production activity, and AI used to predicting impact. But, they didn't calculate the environment performance, so they can't measure the environment protecting effort have done. It will be easier when factory have an achievement level (index), to determine the amount of increase level of environmental protection in the next period.

So, the aims of this study is calculate the Environment Performance Index (EPI), dan suggest the alternative solution as a precaution. These concept namely Green Productivity (GP). As explain above, that the food production contributes greatly to environmental damage due to the use of energy and water proper handling. The first step is identify the potential of environment impact in food production in Sidoarjo. Several research conducts an analysis of the environmental impact by output which have produced. These research did not identify waste form each process by making the Material Balance Diagram (MBD). But in this study, we conduct by identify process at once food losess, water and energy have been used. This study also measure quantity of input, output, and food waste during the production in MBD. Principle the input amount to be equal to output amount. Quantity of input, output, and waste above are used for measure the productivity. The process which have low productivity assume that it produce many waste. And than, calculated the EPI to evaluate the level of sustainable development

effort. The end of this research suggest the alternatives to prevent environment impact due to grade of productivity.

2. Methods

2.1. Case Study

This study concern on efforts to prevent environment impacts for food production process, especially crispy fried chicken in Sidoarjo City. The reasons that the fried chicken is food favored by many people, so it has high of demand. High of demand will consume more water to wash meat of chicken and production equipment. It will also consume more energy like electrical, gases, and oil to fry the chicken meat. The water has used to wash chicken meat and cooking utensils has flowed through the food waste in the waterways. Water mixed with fats and oils often causes unpleasant odors. The use of large amounts of cooking oil to fry chicken meat coated with flour, will produce flour deposits. Usually the sediment is only separated with oil and then thrown away in the ground, watercourses, or trash cans. Obviously, the oil and grease thrown into the watercourse will harden and clog the drains, killing fish and other aquatic animals. While, oil and food residues that are dumped on the ground will seep into the soil and damage the quality of the soil.

The production process of crispy fried chicken includes the stages from the production process, waste identification is carried out directly from each process. Waste that appears includes : water waste, palstic, lumpy flour, slurry, and used cooking oil.

2.2. Concept of Green Productivity (GP)

To start the GP in this research, it will be carried out through 6 stages with 13 important activities [31]. The implementation steps to identify waste are as follows [32]–[34] and if described, they will look like figure 1 below :
1. Identification of the production process : starting from the preparation of the raw materials used, to the hands of consumers (Process flow diagram).
2. Identification of inputs, and outputs from the production process carried out
3. Create a Material Balance Diagram (MBD), to get information about the quantity : input used, output, and also the waste generated.
4. Calculating production productivity, and Environment Performance Indicator (EPI) index.
5. Propose solutions or alternatives to improve environmental productivity.

2.3. Waste Test and Environmental Impact Analyses

In this research, the waste that contributes the highest to environmental pollution is liquid waste from washing chicken and cooking utensils, as well as cooking oil waste. So that, to ensure the potential for environmental pollution as a result of liquid waste from the crispy fried chicken production process, a waste test will be carried out at the Department of the Environment (DLH) laboratory. The test result will then be compared with the water quality standards set by the government.

2.4. Material Balancing Diagram (MBD)

At this stage, it aims to measure the yield of the entire raw material used. MBD is a kind of Material Flow Analyses (MFA) which measures material flow comprehensively from input to output [35][36]. MBD and MFA ensure that the incoming material must be equal to the output plus the waste generated. The different is, the MBD will show in detail the quantity of raw materials and waste from the production process carried out.

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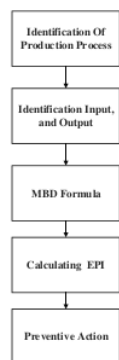
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Fig. 1. GP Configuration

2.5. Productivity and EPI calculation

Generally, the meaning of productivity is the ratio of output to input [37]. It can formulated with Y/X notation. Where Y is output from the activity, and X is input to used activity. And to improve the productivity values, should requires several factors which affect the process [38]. Why we need to calculate the productivity? Because the productivity has correlation with competition[39]. It means that every business will to compete and get the customer trust by providing the best services. When the bussines cannot increase it, they will be lose in the competition.

Calculation of Environmental Performance Index (EPI), aims to evaluate environmental, social, and economic conditions in a business or country. The higher the EPI value, the stronger a business or country is in carrying out sustainable development (sustainable development). And a healthy environment is certainly correlated with community prosperity and economic growth [40]. To measure the EPI index, can follow this formula [10] :

$$\text{EPI Indekx} = \sum_{i=1}^{k} W_i * P_i$$

where

$$Pi\ (\%) = \frac{\text{Quality standards (mg/l) – Result (mg/l)}}{\text{Quality standarts}} \times 100\%$$

For :
k   = the number of parameter research
Wi   = weight of each parameter
Pi   = deviation or slack between standart and result

In developed countries such as Colombia, to measure the environmental index in manufacturing companies, it is done by applying 10 parameters included in supply chain management (SCM), starting from resources, production processes, to product distribution [41]. While in the research conducted on this crispy fried chicken seller, the parameters

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There are 5 parts of the framework, namely, identification of waste, environmental impact analysis, MBD formula, calculating EPI, and preventive action. why doesn't the GP framework follow these 5 steps?

used to measure EPI are : Water quality, heavy metals contained in the waste water of the production process [40], the volume of water wasted, the amount of solid waste, and the handling of liquid and solid waste that has been carried out [42], as well as the oil and fat content in the water wasted.

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2.6. Alternative Proposal and Determination

Controlling the disposal of both solid and liquid waste into the environment resulting from the production of crispy fried chicken, is carried out by identifying the types of waste that arise from each process. Alternative proposals were obtained by involving experts from the Environmental Service (DLH). The decision making process is carried out by determining the priority or urgency of the waste released into the environment, and also based on the quantity of the waste.

3. Results and Discussion

Before identify the waste production, this study conducted with process production. This figure show the process production of chicken crispy.
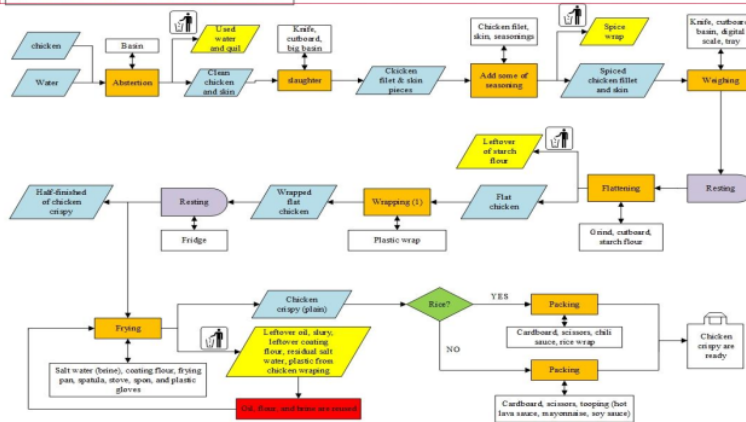
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Fig. 2. Proses flow of chicken crispy

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3.1 Identification of Process and Waste

Several processes that produce waste in the crispy chicken production process consist of solid waste, as well as liquid waste. In addition to these two types of waste, the production process also produces emissions in the form of odors that are carried by the wind. Solid waste appears, in the form of plastic packaging, but the amount is minimal. Plastic that appears from the chicken washing process, comes from 2 pieces of chicken packaging. This small amount is because the seller buys raw material in large quantities so that it can minimize the amount of plastic waste. The use of plastic gloves and chicken meat coatings, will usually be reused by the seller and will be replaced when the plastic is damaged.

This washing process also produces waste water which contains oil/fat, soap, and also chicken feathers. The process of washing chicken meat is carried out in the same place as washing cooking utensils so that the waste water also contains soap and oil/fat. Sometimes the seller also throws the slurry in the drain if there is a small amount, or throws is together with other garbage in the trash. You can imagine, that the slurry that settles in the waterways and accumulates will inhibit the flow of water, causing flooding and unpleasant odors. Meanwhile, the slurry that is thrown into the trash is mixed with other garbage and is exposed to rainwater, and then flows into the ground and rivers. Obviously, it will damage the quality of the soil, and river water, and cause unpleasant odors as well.

3.2 environmental impact analysis

Liquid waste in the form of wastewater is more in number than other wastes and has not been treated before being released into the water stream. So that a sample of 3 liters was taken to be tested in the DLH laboratory. The results of the waste test are summarized in table 1 below.

Table 1. The results of the waste water test for the seller of crispy fried chicken

No.	Parameter	Unit	Results	Quality standards
1.	BOD	mg/l	769	30
2.	COD	mg/l	1699	100
3.	TSS	mg/l	2536	30
4.	Oil/fat	mg/l	2661	5

Source : processed data

From the results of these laboratory tests, when compared with the quality standards determined by the DLH, it appears that the waste that comes out of the production house does not go through the filtering process first. The composition of the discharged waste will be cumulative and mixed with other domestic waste resulting in decreased river water quality.

3.3 Formulation MBD

This MBD shows the composition of input, output, and waste generated at each stage of the crispy fried chicken (fillet) production process. At this MBD stage, the number of inputs in the form of resources used is calculated in detail, as well as the resulting output. It can be said that this MBD is an analysis of the yield of the resource, with a total of 5 kg of chicken meat, and only 15 pieces of chicken fillet weighing @7 grams were produced, at the time of observation.

The output that dominates the production of this crispy fried chicken is waste water with a quantity of 50 liters per day. Other wastes, such as plastic in very small quantities, can be minimized by washing and reusing. Liquid waste in the form of slurry is disposed of together with domestic waste or by washing other cooking utensils. Liquid waste that is just wasted has the potential to damage water and soil quality.

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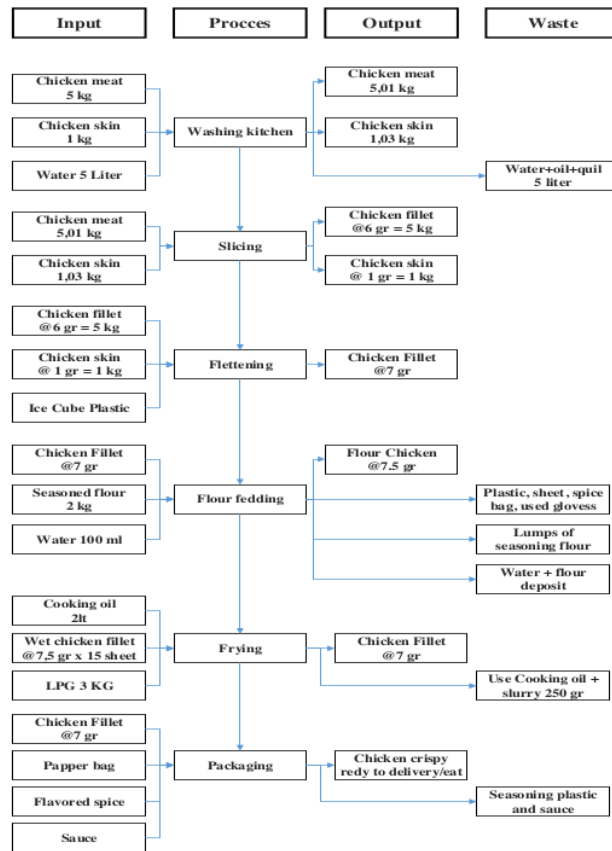
Fig. 3. MBD crispy fried chicken

3.4 Calculating Productivity and EPI

From the MBD, we can calculated the productivity of water and energy which used in each production.

Tabel . 2 Calculating the productivity of MBD

Input	Component	Process	Output	Waste	Productivity
5 kg	Chicken meat	Washing kitchen	5,01	Water + oil + quil	
1 kg	Chicken skin		1,03		1
5 liter	Water		5	5 liter	
5,01 kg	Chicken meat	Slicing	5		1
1,03 kg	Chicken skin		1		

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Input	Component	Process	Output	Waste	Productivity
6 gr	Chicken fillet	Flattening	7 gr	Ice cube plastic	1
1 gr	Chicken skin				
1 lembar	Ice cube plastic				
7 gr	Chicken fillet	Flour fedding	Flour chicken 7,5gr	Plastic sheet, spice bag, used gloves	1
2 kg	Seasones flour			Lumps of seasoing flour	
100 ml	Water			Water + flour deposit	
2 liter	Cooking oil	Frying	Chicken filet 5gr x 15	Used cooking oil + Slurry 250 gr	0,6
7,5 gr x 15 sheet	Wet chicken fillet				
3 kg	LPG				
7,5 gr x 15 sheet	Wet chicken fillet	Packaging	Chicken crispy	Seasoning plastic and sauce	1
1	Paper bag				
1	Flavored spice				
1	Sauce				

And than results of the EPI calculation, can be concluded that the environmental performance that has been sought by producers in protecting the environment. EPI calculation is generally done by multiplying the weight of each environmental performance criterion by the amount of deviation from the waste test results with the quality standards set by the government [43].

Table 3. EPI calculation

No.	Parameter	Wi	Results (mg/l)	Quality standards (mg/l)	Pi	EPI
1.	BOD	3,17	769	30	-24,63%	-0,78
2.	COD	3,35	1699	100	-15,99%	-0,54
3.	TSS	3,56	2536	30	-85%	-3,02
4.	Oil dan Fat	5,03	2661	5	-531,2%	-26,71
	Total					-31,05

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From the results of the EPI calculation, it shows the efforts of crispy fried chicken to protect the environment is very low [44], [45]. But, if the EPI value is positive indicates that the environmental performance of the crispy fried chicken production house is environmentally friendly.

3.5 Preventive Action Proposal

Based on the results of the EPI calculation obtained from the waste test sent to DLH, as well as achieving the goal of preventing environmental damage, several alternatives that can be proposed are as follows:
1. Buying chicken directly from the slaughterhouse to reduce the oil and fat content in the washing water
2. Filtering used cooking oil to separate the oil and flour content. Do not reuse used cooking oil, and collect it for recycling.

3. Flour mixed with oil is filtered and dried by making a flour filter and dryer. So that the dried flour can be used as animal feed or plant fertilizer.

4. Conclusion and Recomendation

The use of GP in crispy fried chicken production houses produces information on the magnitude of the EPI value. The results of EPI Index calculating which using 4 parameters showing a negative values of -31,05. This show that improvement steps in the production process need to be carried out, in order to be more environmentally friendly. But, limitation of this study is necessary to determine the environmental impact measurement parameters accurately, and predict the consistency of the parameters for long term. This study have not made a comparison of productivity for each period, so it cannot display the progress of preventive measures against environmental impacts.

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Acknowledgements

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