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Productivity Measurement of Urea Fertilizer Production at PT. X Using The Green Productivity Approach

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Abstract: Productivity is defined as a comparison between the output (Output) and input (Input) in the company which can also be said as the ratio between the amount of output produced and the number of inputs used. The purpose of this research is to measure the productivity and environmental performance of the urea fertilizer production process at PT. X by using the Green Productivity approach. Green Productivity is a method that can be used to increase the level of productivity as well as environmental performance. The first step is to identify the source of the waste from the field study, determine goals and targets, and choose alternative solutions for Green Productivity. Based on the Green Productivity methodology, the alternative solution is selected by calculating the EPI (Environment Performance Indicator) index, and the Green Productivity Index (GPI) for each alternative. From the results of the selection of these alternatives, the best solution that can be proposed for improvement is alternative 1, namely repairing and maintaining the hydrolyzer engine and making hydroelectric turbines. This result is obtained from the calculation of the material, labor, energy, and maintenance indexes which are above 1 which indicates a problem solving by selecting and implementing this alternative as a solution. The material GPI is 1.31, the human GPI is 1.05, the energy GPI is 1.11, the maintenance GPI is 1.01 and the waste GPI is 0.58. Meanwhile, the EPI index of human health is 16.67 and the EPI index of flora and fauna health is 15.23.

Keywords: Productivity, Green Productivity, Environmental Performance.

INTRODUCTION

The development of the industrial world is currently growing rapidly along with the development of the current of globalization that continues to run. Therefore, companies must be able to improve and improve their performance in order to survive and compete with other similar companies. Along with the increase in production, it turns out that there are many environmental problems around it. This problem is caused because the

production process often results in the waste of materials and energy which will burden the environment. even though a good production process not only pays attention to the safety and side effects of the residual waste from the process, but also reduces the waste generated. This problem is also often ignored by the company, even though currently environmental problems are a fairly hot issue to be discussed. Inputs are often limited to labor inputs while

outputs are measured in physical units, forms and values. L. Greenberg defines productivity as the ratio between the totality of expenditure at a certain time divided by the totality of inputs during a certain period. In line with the increase in production, it turns out that there are many environmental problems around it. Problems caused because the production process often results in the disposal of materials and energy that will burden the environment, even though a good production process not only pays attention to the safety and side effects of waste waste of the remaining production, but also seeks to reduce the waste waste produced. It is very important for companies to pay attention to environmental aspects in production operations that are carried out in order to create harmony with the surrounding environment. The right method to help companies improve their productivity and environmental performance is to apply the green productivity method. Starting with analyzing inputs, processes and outputs, green productivity is expected to be able to reduce waste from the production process and be able to reduce the use of material resources and energy which has an impact on reducing waste so that it will be more effective in the work process carried out. The purpose of this paper is to determine the level of productivity and environmental performance in the company. So that it can identify aspects of problems that affect productivity and environmental performance and provide solutions to problems to increase productivity and environmental performance.

Productivity Definition

Productivity is defined as a comparison between the output (Output) and input (Input) in the company which can also be said as the ratio between the amount of output produced and the number of inputs used. Productivity, which in English is called Productivity, basically consists of two words, namely "Product" and "Activity" which means an activity to produce something, be it a product or service. The philosophy and spirit of productivity has existed since the beginning of human civilization because the meaning of productivity is the desire (the will) and effort (effort) of humans to always improve the quality of life and livelihood in all fields (Marimin, 2004).

Green Productivity Concept

Green Productivity (GP) can be defined as environmentally friendly productivity which is part of an environmentally friendly productivity improvement program in order to answer global issues regarding sustainable development. Green productivity is a strategy to increase company productivity and environmental performance simultaneously in overall socio- economic development (Suhartini,2012).

The concept of green productivity is taken from the combination of two important things, namely environmental protection and increased productivity. Green Productivity is a comprehensive strategy that aims to improve the overall quality of life and simultaneously for sustainability. In detail, the benefits of implementing green

productivity are the ability to increase profitability, improve health and safety, make quality products, promote environmental protection, ensure compliance with regulations, improve corporate image, and generate enthusiasm for work. The concept of green productivity was developed by the Asian Productivity Organization (APO) in 1994 to raise public awareness of environmental problems. APO's main objective

is to demonstrate that environmental protection and productivity improvement can be harmonized, both for small and medium-sized companies, because the production process often results in the waste of raw materials and energy which can burden the environment. The following is a picture of the relationship between productivity and the environment shown in Figure 2.1 below.

Figure 2. 1 The relationship between productivity and the environment

Green Productivity Method

At the beginning of the implementation of the Green Productivity Demonstration Program (GPDP) demonstration program by the Asian Productivity Organization (APO) in 1996 to 1998, the project focused on Small and Medium Enterprises (SMEs) such as electroplating, textiles, food processing and paper making. However, the Green Productivity method has been modified to be more general so that it can be applied to other areas related to productivity and the environment. The Green Productivity method is a procedure developed by the Asian Productivity Organization (APO) based on Kaizen principles and the PDCA (Plan, Do, Check, Act) cycle.

Green Productivity Tools

In applying the Green Productivity method, appropriate tools are needed and support the implementation of the method. These Green Productivity tools can be used to describe solutions both quantitatively and qualitatively. Some of these tools are adapted from various management theories and process improvement practices.

1. Flowchart

Flowchart is a diagram that describes business processes, information processes (input, data processing, data storage, and output) related to operating processes (humans, equipment, organization, and work activities).

2. Brainstorming

The main purpose of brainstorming is to generate several possible ideas or ideas to tackle a problem. This tool can be used by the repair team as easily as identifying the root of the problem or finding a solution to the problem.

3. Ishikawa Diagram

Ishikawa Diagram is one of the tools in Quality Control (QC) which is also known as Cause Effect Diagram or Fishbone Diagram. A cause-and-effect diagram is a diagram that shows the relationship between cause and effect. In relation to statistical process control, cause-and-effect diagrams are used to show the factors causal factors (cause) and quality characteristics (effect) caused by causal factors.

4. Green Productivity Index (GPI)

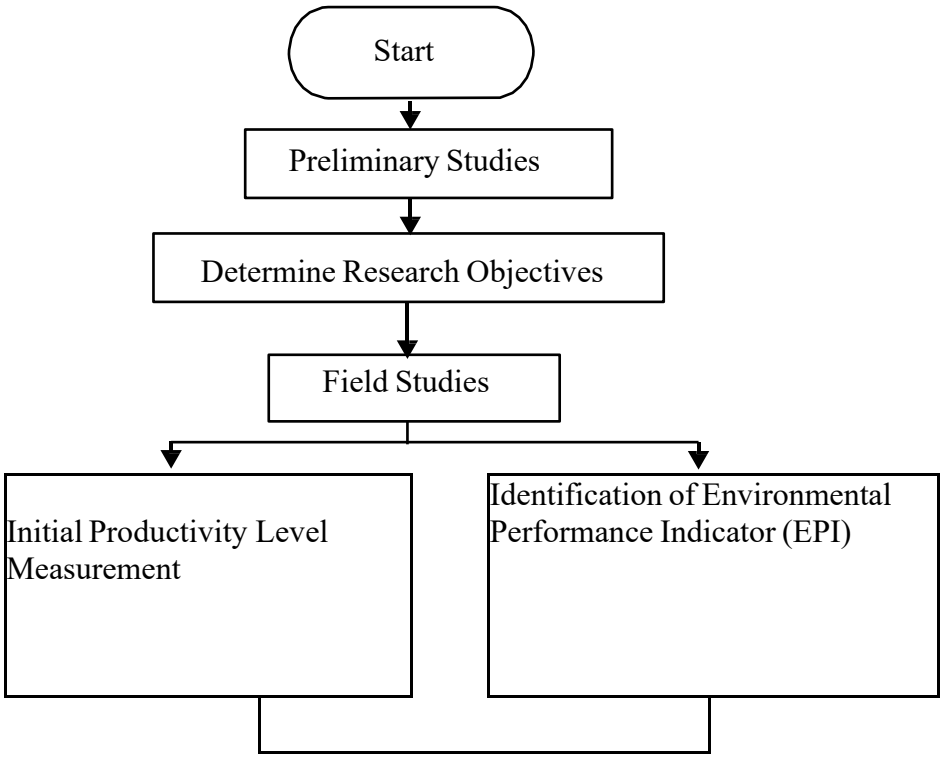
Green Productivity Index (GPI) is a measure of two different dimensions, namely the dimensions of environmental protection and productivity improvement. The GPI index combines the value drivers into one measure to describe a company's performance. Green Productity Index (GPI) as the ratio between the productivity of a system and its impact on the environment. GPI is a calculation of environmental impact, the results of the analysis, the seventh generation of waste that has been obtained from the green material flow map (current state) processing this activity is classified into four GPI environmental variables.

5. Environment Performance Index (EPI)

is an environmental indicator which is one thing that is expected to show the various impacts of an activity on the environment and efforts to reduce it. EPI describes the environmental efficiency of the production process by involving the number of inputs and outputs. Indicators can be evaluated physically, by linking performance to the amount of input raw materials used, waste flow, energy consumption, air and water quality.

METHOD

This research was conducted at PT. X Production Department IIA. This research took place in May 2021 for approximately one month. The purpose of this descriptive study is to describe and interpret the data on the results of the environmental impact assessment using the Green Productivity approach and explain how the results of the assessment given during the study.



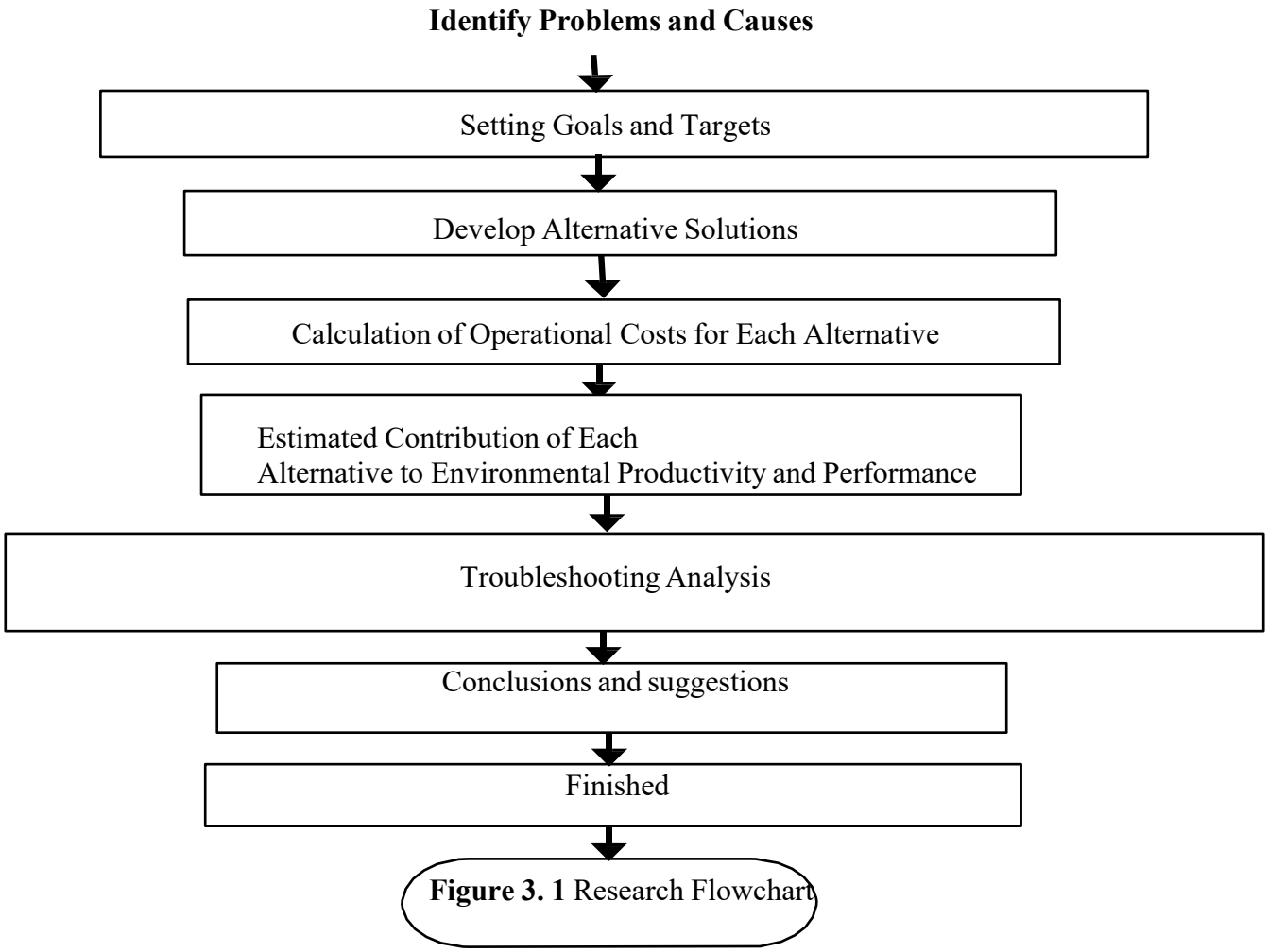


Figure 3. 1 Research Flowchart

DATA PROCESSING

Data collection

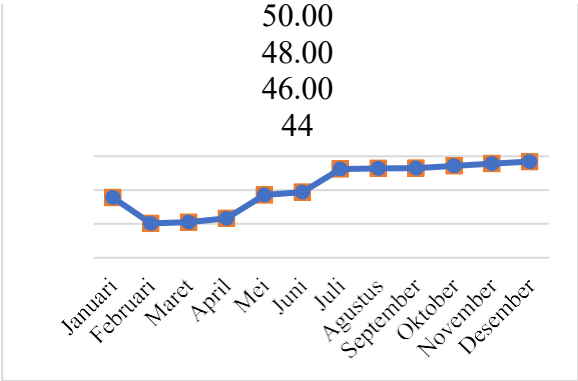
namely by observing the company by reviewing the production process, testing the quality and by-products of the production process and conducting interviews with the authorities regarding the needs of the research and summarizing the data on the company.

Productivity Measurement

The productivity level measured in this study is for the period January – December 2020. After calculating each input cost incurred, the next step is to calculate the amount of input costs for the urea fertilizer production process during the period January – December 2020.

Table 4. 1 Overall Productivity Level

Periode 2020	Productivity Index
January	47.57
February	46.03
March	46.11
April	46.33
May	47.71
June	47.87
July	49.25
August	49.28
September	49.30
October	49.42
November	49.57
December	49.68



Graph of Urea Fertilizer Production Productivity Level 2020 period
Figure 4. 1 Productivity Level Chart

From the graph above, it can be seen that the total productivity fluctuated in the index value with an upward trend. Productivity that experienced the lowest decline occurred in the February 2020 period. This was due to reduced market demand.

EPI Index Identification

The Environmental Performance Indicator (EPI) index is an indicator used to determine the environmental performance that has been achieved by the company in relation to the amount of waste produced during the production process that will have an impact on the surrounding environment.

The first step in measuring the EPI index is distributing questionnaires to workers with the aim of obtaining the hazard level weight value of the environmental indicators used as measurements in this EPI index. The scale used ranges from 1 to 5, the greater the value given. the greater the level of danger. The distributed questionnaire is divided into two parts, namely based on parameters human health and animal health. Questionnaires were distributed to seven workers. Below are the results of weighting the hazard level of human health parameters.

Table 4. 2 Hazard Level of Human Health Parameter

Parameter	Hazard Level 1	2	3	4	5	Total	Weight
COD	0	1	3	2	1	7	4,8
TSS	0	1	3	3	0	7	4,6
Oil and	0	2	3	2	0	7	4,2
Ammoni a Total	0	2	3	1	0	7	3,8
pH	1	2	3	1	0	7	3,6

For the calculation of weights with other parameters, it is done the same way with the same formula, but the results are different. The following is a summary of the hazard rating questionnaire based on flora and fauna parameters.

Table 4. 3 Danger Level of Flora and Fauna Health Parameters

Parameter	Hazard Level 1	2	3	4	5	Total	Weight
COD	0	2	1	3	1	7	4,8
TSS	0	2	2	3	0	7	4,4
Oil and	1	3	2	1	0	7	3,4
Ammonia Total	1	2	2	0	0	7	3,2
pH	0	4	2	1	0	7	3,6

EPI Index

After weighting. recapitulation results that Chemical Oxygen Demand (COD) has the greatest weight compared to other indicators, which means that COD has the highest level of danger compared to other indicators. Examples of calculations for COD parameters based on human health are as follows:

Table 4. 4 Human Health Parameter EPI Index

Parameter	Weight	Liquid Waste Raw Standa	Analysis Results	Deviation	EPI Index
COD	4,8	3,75	0,0175	0,99%	4,75
TSS	4,6	1,5	0,036	0,97%	4,46
Oil and	4,2	0,4	0,0003	0,99%	4,15
Ammonia Total	3,8	0,75	0,19	0,74%	2,81
pH	3,6	9	7,7	0,14%	0,50
TOTAL					**16,67**

Table 4. 5 EPI Index of Flora and Fauna Health Parameters

Parameter	Weight	Liquid Waste Raw Standa	Analysis Results	Deviation	EPI Index
COD	4.8	3.75	0.0175	0.99%	4.75
TSS	4.4	1.5	0.036	0.97%	4.26
Oil and	3.4	0.4	0.0003	0.99%	3.36
Ammonia Total	3.2	0.75	0.19	0.74%	2.36
pH	3.6	9	7.7	0.14%	0.50
TOTAL					**15.23**

Based on the resulting data collection and data processing that has been carried out, it can be seen that there are problems regarding the waste generated during the urea fertilizer production process. The amount of waste generated during this production process can affect the decline in the level of production productivity during the period January – December 2020.

In finding the root of the problem, the Ishikawa diagram can be used. Ishikawa diagrams were obtained based on observations and interviews conducted. Some of these factors are described as follows:

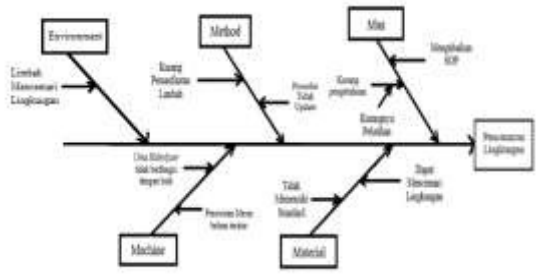


Figure 4. 2 Ishikawa Diagram

Based on the root of the problem in the urea fertilizer production process, namely the presence of waste that can affect the decline in productivity and environmental performance, especially liquid waste generated during the production process. then the main objectives can be determined in making improvements to be made and the targets to be achieved.

Referring to the problems that have been identified and the setting of goals to be achieved

in the previous stage, it is necessary to make improvements to reduce or even eliminate hazardous waste generated during the production process. The alternatives offered must consider environmental, economic, and social aspects.

Table 4. 6 AlternativeProposal

Company	Alternative 1	Alternative 2
Haven't made any repairs (Current condition)	• Perform regular repairs, rejuvenation and maintenance on hydrolyzed machines. • Making a hydroelectric turbine that functions to	Adding an absorber tube to absorb ammonia and carbon dioxide gases that occur in the purification process and then recycle them again. Because the existing absorber tube is

RESULT AND DISCUSSION

The current condition is used as a comparison that becomes a benchmark in calculating productivity for alternative problem solving in accordance with the green productivity approach. The current condition does not change and the data used is the average value of each input and output data for January – December 2020.

After calculating each alternative, then the next step is to calculate the estimate to find the Green Productivity Index (GPI), then calculate the GPI obtained according to the equation:

$$\text{GPI} = \frac{GPR \ \square l\square\square \ \square \ n\square\square i\square}{GPR\square\square\square\square}$$

The results of the calculation of the Green Productivity Ratio (GPR) and Green Productivity Index (GPI) for each indicator can be seen below.

Table 5. 1 GPR Calculation Results

Green Productivity	***Base Scenario***	***Alt 1 Scenario***	***Alt 2 Scenario***
GP Material Ratio	601.23	796.78	668.04
GP Human Ratio	98.10	103.75	98.04
GP Energy Ratio	326.58	362.90	326.58
GP Maintenance	171.26	172.92	166.27
GP Waste Ratio	0.896	0.524	0.717

Furthermore, if we have obtained the calculation results from the Green Productivity Ratio (GPR), we can calculate the Green Productivity Index (GPI) by dividing the figure from the calculation of the Alternative GPR with the initial GPR. The results of the GPI calculation can be seen in the table below.

Table 5. 2 GPI Calculation Result

Green Productivity	***Base Scenario***	***Alt 1 Scenario***	***Alt 2 Scenario***
GP Material Index	1.00	1.32	1.11
GP Human Index	1.00	1.05	0.98
GP Energy Index	1.00	1.11	1.00
GP Maintenance	1.00	1.01	0.96
GP Waste Index	1.00	0.58	0.80

If the value of the Green Productivity Index (GPI) is more than one, it means that the alternative used is better than the previous condition. From the calculation results, the chosen alternative is alternative 1, it can be seen from the average GPI value above one.

CONCLUSION

Based on the results of measurement of productivity and processing using the Green Productivity approach, the following conclusions are obtained:

1. The lowest productivity index value in the 2020 period occurred in February, which was 46.03 and the highest occurred in December, which was 49.68. This shows that in general the company has a tendency to increase productivity.

2. From the results of data processing that I did, the Environment Performance Indicator index value of 16.67 for human health parameters and 15.23 for flora and fauna health parameters showed a positive number, which means that the environmental performance achieved by the company is quite good and not harmful. for the surrounding environment.

3. There are two alternative solutions to the problems that exist in the company. From the analysis I did, I can propose two alternative solutions, namely the first alternative is to repair and maintain the hydrolyzer engine and build a hydroelectric turbine. And the second alternative is to add an absorber tube to absorb ammonia and carbon dioxide gas.

SUGGESTIONS

1. It can be trialed or tested on the proposed improvements or alternative solutions that I propose, namely repairing, and maintaining the hydrolyzer engine and making hydroelectric turbines.
2. In measuring productivity using the Green Productivity method, it should be more thorough so that there is no confusion in the calculation of research results.

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