Waste Reduction with Green Productivity Approach for Increasing Productivity (Case Study : PT Indopherin Jaya)

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Abstract

PT Indopherin Jaya is a company producing automotive glue using phenol as the main raw material. The problem is too much liquid waste (which contain phenol) was generated in the production process. This occurrence drove the company to seek an alternative that can reduce waste disposal and also can increase company productivity. Evaluation of these alternatives aim to choose an alternative that has the level of Green Productivity (GP) is better than the previous condition and can do better on saving phenol PT Indopherin Jaya. Alternative evaluation is evaluated by using the concept of Green Productivity Indicator, and also performed the calculation of financial feasibility analysis of each alternative. Green Productivity Indicator as a measure the level of Green Productivity companies.

The best solution is to install the chiller (second alternative). The advantages of PT. Indopherin Jaya by installing a chiller is to increase the Green Productivity Index is shown with the Green Productivity Ratio of 1.0564, the rate of productivity increase by around 3%, and generate cost savings phenol purchases Rp 1,359,306,900 per year.

1. INTRODUCTION

The development of the industrial world is currently increasing rapidly in line with the rate of ongoing globalization. These developments require the industry to upgrade and improve performance in order to survive and win the competition with other industries, this can be done by increasing productivity.

These environmental problems to be warm enough issue that is discussed, but often ignored by the company. Therefore, to create harmony with the environment, needed more attention to environmental aspects in every process of production of the company.

The effort that can be done to overcome this problem is by using the concept of Green Productivity, that was popularized by the Asian Productivity Organization (APO). The concept of Green Productivity is a cut or re-products failed processing to preserve the environment, thus increasing productivity (APO, 2000). This concept begins by analyzing the input, process and output that is expected to provide substantial benefits to increase productivity.

2. LITERATURE REVIEW

This research is a modification of the research Ik Kim, et al (2003). Kim IK, et al (2003) conducted research on the company's production of polystyrene (PS) to measure the level of the Korean Petrochemical GP before and after improvements to the company by using the GP indicator. In addition to measuring the level of GP based on the environmental impact caused the PS production process, the study also assessed the costs to be incurred to do one of the proposed improvements by using the TCA, but the calculation is done is still not cost too much detail. Shortfall will be covered in this research. This research was conducted at PT. Indopherin Jaya which is a factory producing adhesives (glue) the automobile. GP level measurements were conducted on this research, but the calculation analysis of the cost incurred by the company. Calculation of operational costs is to know how big the company incurred costs each year if it implements an alternative is provided.

This research was also conducted by the calculation of estimated savings, estimated levels of productivity and GPR in each alternative. Feasibility analysis performed by calculating the NPV and IRR for each alternative, then searched the most positive NPV and IRR is the greatest. Payback period method is also performed to calculate how long it takes to be able to return capital investment. Use sensitivity analysis conducted at one of the alternatives is chosen, the goal is to find out how sensitive alternative to price changes that occurred. Measurements of environmental impact assessment (LCA) in this study using a database SIMAPRO 7.1 software so that the value produced more accurate

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and specific. Using software SIMAPRO 7.1 is expected to cover the shortage of trouble finding the data for Life Cycle Assessment (LCA) on research Burgess and Brennan (2000), because SIMAPRO 7.1 has enough database of raw materials, production processes, energy sources, recycling processes, as well as waste disposal process. EPI is also used in the measurement of chemical substances released at. Indopherin Jaya, only on research Kistanthy (2007), EPI is used to measure the level of liquid waste released in the company is being investigated. but EPI is used in this study are used to measure the level of pollution incurred by PT. Indopherin Jaya, whether in accordance with the Air Quality Standards or not, especially to measure the pollution level of phenol is burned when the incinerator. EPI serves as an indicator of chemical substances released by a company exceeds the standards set by the government or not.

2.1 Green Productivity

Green Productivity (GP) is a strategy to improve business productivity and environmental performance at the same time in the socio-economic development overall. This method of applying the techniques, technologies and systems of management to produce goods and services in accordance with environmental or environmentally friendly (APO, 2003).

The focus of Green Productivity is improved productivity and environmental protection. The main elements of the Green Productivity is a re-examination and evaluation (re-evaluation) of production processes and products to reduce environmental burden and represents the best path toward improved productivity and product quality. GP methodology is a procedure developed by the APO based on the principles of Kaizen and the PDCA cycle (Plan, Do, Check, Act).

2.2 Green Productivity Indicator

According to IK Kim, et al (2003) GP is a strategy, so we need an indicator that can be measured quantitatively to be able to see the success of the strategy. Measuring the level of GP can use the index and GP ratio as the indicator. GP productivity index is the ratio of company to the impact on the environment, in other words, if described by the equation, output from the company divided by the inputs used and then divided by the environmental impacts caused. GP ratio was used as a decision-making tools to evaluate alternative proposed improvements, GP GP index ratio is the ratio of the current system used by the alternatives proposed improvements. GP index calculation can be seen in equation (1).

$$\text{GP } index = \frac{Productivity}{Impact\ Assessment} \quad (1)$$

GP can be calculated by comparing the ratio between the GP index improvement alternative GP system with the initial conditions. When the results of the calculation are more than one then it can be concluded that the alternative repair has better performance. The calculation can be seen in equation (2).

$$GP\ ratio = \frac{(\frac{SP_{alt}}{PC_{alt}})/EI_{alt}}{(\frac{SP_{cur}}{PC_{cur}})/EI_{cur}} = \frac{GP\ index_{alt}}{GP\ index_{cur}} \quad (2)$$

3. CASE STUDY

PT Indopherin Jaya is a phenolic resin-producing company in Indonesia. Phenolic resin is a special adhesive (glue) that is required by heavy industries like automobile tire industry, electronics industry, steel industry and residential uses phenol, formalin, cashew oil (nut oils) and some catalyst as the main raw material. The use of phenolic resins produces waste as solid waste, liquid and gas. Phenolic resin product is divided into three types, namely Flake (a piece), powder and liquid. Given the phenol is the most important raw materials and has hygroscopic properties and toxic, then the phenol is classified as Toxic and Hazardous Materials (B3) either in a state of liquid, solid, or gas. Most of the waste is liquid waste (liquid waste) and contain phenols that can be reused. Figure (1) is a graph of the amount of liquid waste than solid waste produced by PT. Indopherin Jaya in 2009.

3.1 Measurement of Productivity Rate

The productivity level of firms can be calculated using equation (5).

$$\text{Productivity Rate} = \frac{Total\ Output}{Total\ Input} \quad (5)$$

Raw materials used to measure the rate of productivity PT. Indopherin Jaya is the phenol content of 95% in the liquid state and 100% in the solid state or a pure phenol, formaldehyde content of 43% and cashew oil within a period of one year. The use of electricity and gas in one year is quite large due to the production process at PT. Jaya Indopherin continuous process every day in the 24 hours a day and the amount of electricity and gas consumption in a single production process alone has already reached 17 000 Kwh and 500 m^3, it causes the cost for electricity and gas are quite large. Workforce numbering 97 people per month with a total cost of Rp 323,360,000.00.

3.2 Preparation of Alternative Solutions

With the root causes and objectives to be achieved in the Green Productivity, phenol recycle that it can save the purchase of raw materials and also minimize the amount of fluid that comes into the

phenol evaporate and incinerators. As for some alternative solutions are as follows:

1. Do nothing, that allow the tank to accommodate the remaining liquid dehidralyzation separated from each reactor (R1, R2, R3) having a temperature of about 30-40°C and wait until cold, then later retrieved from under the tank and the liquid will be used returned as recycle phenol.
2. Install the pipe connecting the tank separated so that the water used as the circulation in the reactor, is also separated into the tank through the coils are already installed on the inside of the tank. Water used for circulation in the reactor is a cold water temperature range is at 27°C and is expected to increase the amount of phenol produced in the recycle do nothing alternative.
3. Installation of an empty tank with a volume of 5 m^3 for container used for the circulation of water in tanks separated by using a pump with a capacity of 1 m^3 per hour through a coil that is placed inside the tank separated. It also made the installation of the chiller to cool the engine water used on new tanks at the tank separated by the circulation temperature range used in <27°C.

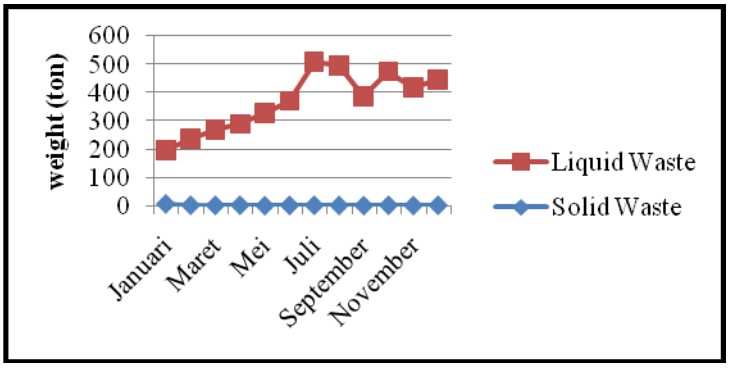

Figure 1: Graph of Liquid Waste and Solid Waste Produced

Table 1: Productivity Rate

Month	Output (hundred billion) (A)	Input (hundred billion) (B)			Productivity Rate (A/B)
	Flake	Raw Material	Labor	Energy	
January	Rp 139.39	Rp 55.00	Rp 3.23	Rp 10.78	2.019
February	Rp 139.56	Rp 55.69	Rp 3.23	Rp 10.29	2.016
March	Rp 139.16	Rp 55.09	Rp 3.23	Rp 10.42	2.024
April	Rp 139.50	Rp 53.53	Rp 3.23	Rp 11.07	2.029
May	Rp 139.67	Rp 55.33	Rp 3.23	Rp 10.26	2.029
June	Rp 139.74	Rp 54.69	Rp 3.23	Rp 9.72	2.065
July	Rp 139.31	Rp 55.45	Rp 3.23	Rp 10.86	2.003
Augustus	Rp 138.96	Rp 54.95	Rp 3.23	Rp 9.88	2.041
September	Rp 139.06	Rp 54.57	Rp 3.23	Rp 9.88	2.054
October	Rp 139.36	Rp 55.08	Rp 3.23	Rp 10.40	2.028
November	Rp 139.20	Rp 55.10	Rp 3.23	Rp 9.58	2.049
December	Rp 139.67	Rp 54.96	Rp 3.23	Rp 10.77	2.025

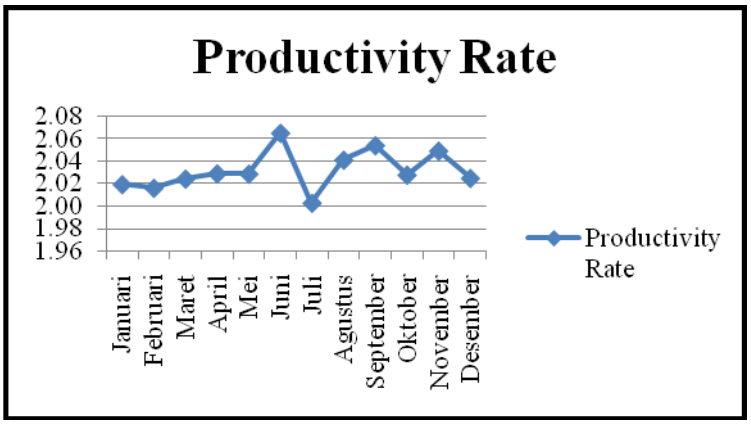

Figure2: Productivity Rate

3.3 Measurement of GP Level

The first step to measure the level of GP is to calculate the index value of each condition, whether the initial conditions or circumstances after the repairs. The function of GPI is to measure the level of Green Productivity (GP) in the production process of phenolic resins in the form of Flake (chips) at PT. Indopherin Jaya. GPI is obtained by comparing the level of productivity of firms with environmental impact (environmental impact) on the production of PT. Indopherin Jaya. Obtained from the calculation of the environmental impact from SIMAPRO 7.1 software using EDIP 2003 method.

Here is the result of each alternative GPI calculations in Table (2). GPI every alternative has been established, then the GPR each alternative can be found by comparing the alternative GPI and GPI initial conditions, for alternative 1 has the GPR at 1.0203 and for the second alternative has the GPR at 1.0564. GPR is worth more than one alternative then we can call that good enough to replace the existing condition.

- GPR 1 = GPI alternative 1 / GPI *do nothing*
  GPR 1 = 0.0886024 / 0.0868385
  GPR 1 = 1,0203
- GPR 2 = GPI alternative 2 / GPI *do nothing*
  GPR 2 = 0.0917416 / 0.0868385
  GPR 2 = 1,0564

Both of these alternatives have a GPR value of more than one, so both of these alternatives are better than the initial conditions.

3.4 Feasibility Study

Once known estimates for each alternative, both the level of productivity, saving raw materials phenol and GPR, to design the implementation of each alternative by using NPV and IRR as a feasibility analysis. NPV is the difference between revenue and expenditure which has been drawn into the present, while the IRR shows the ability of a project to produce a profit rate of return achieved. The interest rate used in calculating NPV is WACC (Weighted Average Cost of Capital), whose value represents the total amount of loan rates and deposit interest rate loans and own capital. WACC interest 11.38%, inflation rate 5.05% and income tax is used by 30%. Table (3) shows the cash flow calculation has been done. Alternative 1 has a payback time when projects have reached the age of 1 year 3 months, whereas the second alternative has a payback time at the time the project reaches the age of one month a year. Incremental cost analysis results in Table (3) shows that the calculation of incremental IRR is greater than the MARR used, i.e ., 99.46%. Can be concluded that the second alternative is more profitable than the alternative one, because the second alternative has the great advantage if the level of cost calculation is pulled into the present and the rate of return on capital is also relatively large, so that it can be concluded that the alternative two feasible and profitable to be built at PT. Indopherin Jaya.

Table 2: *Green Productivity Index* Each Alternative

	do nothing	**alternative 1**	**alternative 2**
Tingkat Produktivitas	2.0320	2.0467	2.0642
Impact Assessment	23.4	23.1	22.5
GPI	0.0868385	0.0886024	0.0917416

Table 3: Alternative Feasibility Analysis Result

Years	Cashflows		Incremental Cost (B-A)
	Alternative 1 (A)	Alternative 2 (B)	
0	Rp (305,000,000.00)	Rp (688,100,000.00)	Rp (383,100,000.00)
1	Rp 259,454,100.00	Rp 618,386,620.00	Rp 358,932,520.00
2	Rp 275,045,236.05	Rp 655,577,664.31	Rp 380,532,428.26
3	Rp 291,346,520.07	Rp 694,461,887.48	Rp 403,115,367.41
4	Rp 308,393,814.53	Rp 735,124,795.05	Rp 426,730,980.52
5	Rp 326,224,792.97	Rp 777,656,210.58	Rp 451,431,417.61
6	Rp 344,879,031.41	Rp 822,150,493.71	Rp 477,271,462.30
7	Rp 364,398,104.50	Rp 868,706,769.27	Rp 504,308,664.77
8	Rp 384,825,686.38	Rp 917,429,167.86	Rp 532,603,481.49
9	Rp 406,207,656.74	Rp 968,427,078.72	Rp 562,219,421.98
10	Rp 428,592,212.20	Rp 1,021,815,415.19	Rp 593,223,202.99
NPV	**Rp 1,566,000,723.83**	**Rp 3,771,952,950.15**	
IRR	**90.75%**	**95.60%**	**99.46%**

Table 4. Sensitivity Analysis Result

Capital Cost Increase at (%)	NPV	Saving Cost Decrease at (%)	NPV
0%	Rp 3,771,952,950.15	0%	Rp 3,771,952,950.15
100%	Rp 3,296,964,358.77	10%	Rp 3,134,913,238.79
200%	Rp 2,821,975,767.38	20%	Rp 2,497,873,527.42
300%	Rp 2,346,987,175.99	30%	Rp 1,860,833,816.06
400%	Rp 1,871,998,584.61	40%	Rp 1,223,794,104.69
500%	Rp 1,397,009,993.22	50%	Rp 586,754,393.32
600%	Rp 922,021,401.83	60%	Rp (50,285,318.04)
700%	Rp 447,032,810.45		
800%	Rp (27,955,780.94)		

3.5 Sensitivity Analysis

Having obtained the technology is financially feasible alternative, it is necessary for the calculation of sensitivity analysis, a feasibility study of uncertainty and inaccuracy. The variable that contains the uncertainty is the large investment costs, savings and improvements which may affect the feasibility of the selected technology. Through sensitivity analysis, it was found that the sensitivity and feasibility of two alternative technologies to the investment costs amounted to 794.1144% with NPV = 0, meaning that the second alternative has been deemed unfit or harmful to be built if the increase in investment reached 794.1144% or more. Cost savings generated second alternative has the possibility to go down, so the cost can be conducted sensitivity analysis. See at Table (4)

Alternative 2 is considered feasible or profitable to be built if the cost savings decreased with a maximum of up to 59.2106%, NPV = 0.

4. CONCLUSION

On the basis of all the research process, results can be summarized some of the following:

1. Based on the calculation of productivity levels for the condition before improvement of PT. Jaya Indopherin average 2.032 per month.
2. Estimated savings that can be done by each alternative are as follows:
   - Alternative1 = Rp 49.250.250,- per month
   - Alternative2= Rp 108.350.550,- per month
3. The solution taken in this study is the second alternative. Alternative 2 provides increased productivity an average of 2.9% and also has a GPR value of 1.0548572, which means second alternative is better than the state level prior to the Green Productivity improvement.
4. Alternative 2 has a NPV of Rp 3,771,952,950, - and an IRR of 95.60% with a payback period of one month during the first year.

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