The Implementation of Green Productivity for Plastic Manufacturer

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Abstract

This project presents the implementation of green productivity for plastic manufacturer. The main problem for plastic manufacturer is to increase company productivity and environment performance. One of the methods to increase the productivity with minimizing the waste of company has produced or convert the waste to gain value added. This project implements green productivity tools such as material balance, plant layout, and eco mapping. After the data analyzed using material balance, wastes the company produced were plastic pellets and remaining pieces of plastics that not used anymore. The proposed layout needs to consider workflow and to minimize material handling distance. Proposed layout has material handling distance of 44 m, which is more efficient 2% for every cycle time from original layout. In addition, the proposed layout also adds waste warehouse to convert the waste to gain value added. Finally, this research implements green productivity to increase productivity and minimize waste of the company.

Keywords: *Green Productivity, Material Balance, Plant layout, Eco mapping*

1. Introduction

Industrilization has growth rapidly nowadays, the high competition between companies requires each company to always innovate to improve their performance (Rajapathirana & Hui, 2018). One of main aspect to improve company performance with increase their productivity (Kaydos, 1999). Productivity can be improved by minimize resources (input) with the same result (output) or maximize the result(output) with the same resources (input) (Aprilyanti, 2017).

Improvement of productivity inseparable from environmental problem, as plastic manufacturer it will produce finished goods and waste. The company want to improve their productivity by minimizing waste. Asian Productivity Organization (APO) introduce green productivity to overcome these problems ("Eco-Products Directory 2011," 2011). Besides from improve productivity of the company, green productivity also increase environmental performance (Matondang, 2018).

Green productivity is a strategy to improve productivity and environmental performance, if it used effectively green productivity will bring positive change for socio-economic growth. Advantage of green productivity is its potential for integrating environmental protection into the business for improve the productivity (Christian & Sahroni, 2020). Green productivity ensures protection of environment (sustainable development), profitability (factor input) and quality (voice of customer). These three elements known as triple focus of green productivity(Asian Productivity Organization, 2006). There are many tools used in implementing green productivity, such as material balance, plant layout, eco-map, process flow diagram, brainstorming, Ishikawa diagram, pareto chart, cost benefit analysis (Asian Productivity Organization, 2008)

Waste can be defined as every activities that do not offer additional value for the company (Thürer et al., 2017). Waste can be classified into 7 categories known as 7 waste, the categories include overproduction, defects, unnecessary production, inappropriate processing, excessive transportation, waiting, unnecessary motion(Jaffar et al.,

2015). Waste reduction is one of the stages of green productivity, because it will ensure environmental performance by improve productivity through a multidisciplinary, systematic, and holistic approach (Muslimah et al., 2020)

The problems that have been found for plastics manufacturer are reducing waste as the result from production. This study implements green productivity method to solve waste problem for plastics manufacturer. Furthermore, activities in plastics manufacturer from warehouse and production analyzed using green productivity tools in aspects that include material balance, plant layout, and eco-mapping.

2. Literature Review

2.1 Productivity

Productivity is combination between effectivity and efficiency, effectivity related to performance and efficiency related to usage of resources (Rosyidah, et al., 2020). Productivity implies to improving quality of work continuously, productivity compare result(output) and resources(input) (Ashar & Saleh, 2015).

2.2 Green Productivity

Green Productivity is a strategy to improve productivity in business and environmental performance simultaneously, to bring growth in socio-economic. This Method applicate technique, technology, and management system to produce goods or service according to environmentally friendly system (Pradana, et al., 2017).

2.3 Process Flow Diagram

Process Flow Diagram (PFD) is a flowchart describing sequence of work activity with workflow or material flow. Process Flow Diagram used to identify production process from raw material until finished goods ready to sell (Riyanto, 2017).

2.4 Material Balance

Material Balance is a basic inventory tool that defined information of input, materials, output, and waste. Material balance used to evaluate qualitative process in material input and output, Principle of material balance for production system is inputs equals to output added by waste (Riyanto, 2017).

2.5 Plant Layout

Plant layout is a regulation procedure for facility placement to support flow of production process (Sukania, Ariyanti, & Nathaniel, 2016). Layout is a planning of placement of machine and tools, area, building, and room to optimize relation of workflow, material flow, information flow, and method to achieve company purpose efficiently, economical, and safely (Iskandar & Fahin, 2017).

2.6 Eco Mapping

Eco mapping is a method to analyze and manage environment problems, this method already applied in many companies and industries (Purwanti & Suwono, 2018). Eco mapping is easy to apply because it require minimum technology and cost, with eco mapping company will know which section have problems and improvement can be done (Handbook on Green Productivity, 2006).

2.7 Activity Relationship Chart

Activity Relationship Chart shown score of connection between production activity. Activity relationship Chart between production activity symbolized as A, E, I, O, U, and X sequentially means Absolute necessary, especially important, important, ordinary, unimportant, avoid closeness (Martha & Ardiansah, 2020).

3. Materials and Methods

Generally, plastics industries have similar process of production as each other. In this study, the data was collected using reference and interview with plastics manufacturer owner. The plastics manufacturer located in Surakarta; Indonesia is selected as study case for improvement using green productivity. The plastics manufacturer had many wastes as result of production. Layout of plastic manufacturer shown in Figure 1, current layout is analyzed to reduce waste.

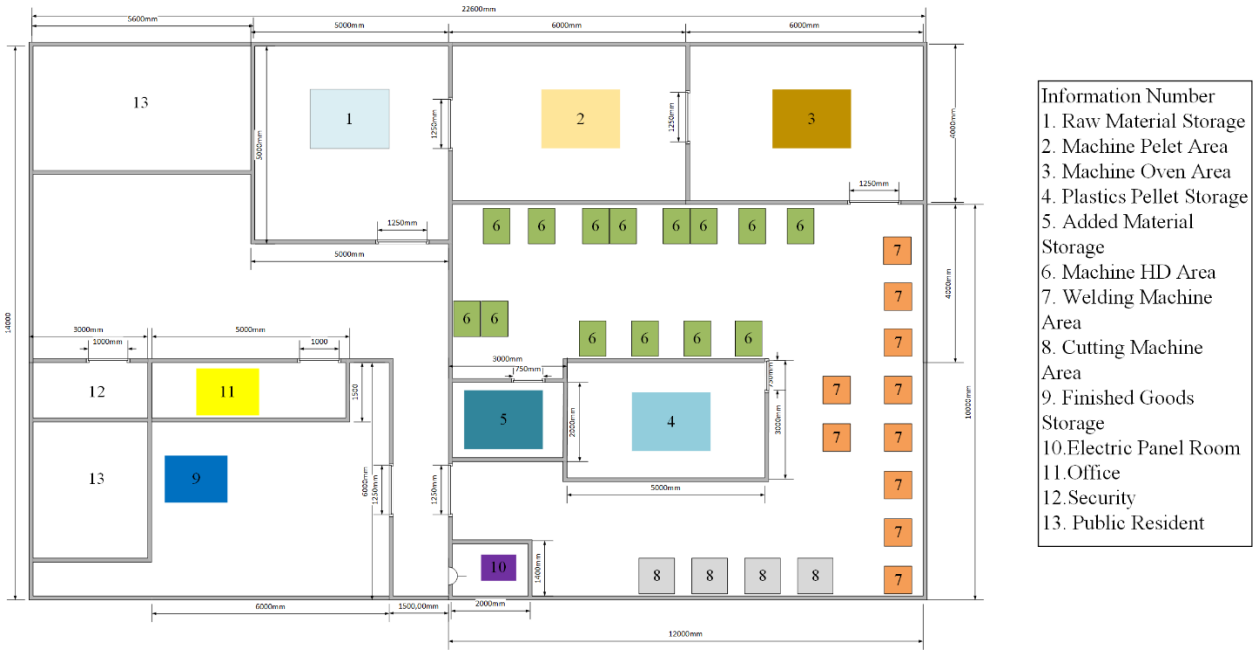


Figure 1. Current Layout

Current layout is identified using space relationship diagram (Figure 2) in order to show production and material flow in the area. Current layout also identified using activity relationship chart (Figure 3) in order to show relation between area in production process. In addition, process of production at plastics manufacturer produce waste such as leftover pieces of plastics and defective plastics pellets, leading to environmental pollution. In this study green productivity was implemented to improve productivity and reduce waste of production, by utilizing several tools such as material balance, plant layout, and eco-map.

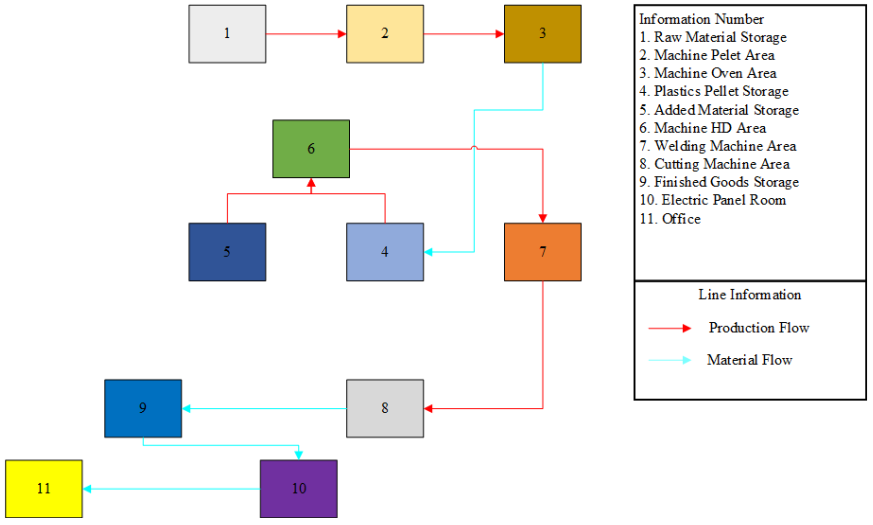
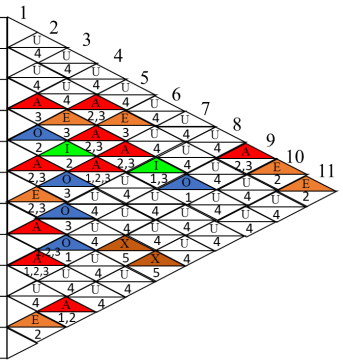


Figure 2. Space Relationship Diagram

Storage	1	Finished Goods Storage
	2	Raw Material Storage
	3	Plastics Pellet Storage
	4	Added Material Storage
Production	5	Machine Pelet Area
	6	Machine Oven Area
	7	Machine HD Area
	8	Welding Machine Area
	9	Cutting Machine Area
Office	10	Office
Panel	11	Electric Panel Room



Code	Description	Colour
A	Absolute Necessary	Red
E	Especially Important	Orange
I	Important	Green
O	Ordinary	Blue
U	Unimportant	White
X	Avoid Closeness	Brown

No.	Reason
1	At the Same Room
2	According to Production Flow
3	Simplify Flow of Material
4	Not Related
5	Produce Waste and Heat

Figure 3. Activity Relationship Chart

4. Results and Discussions

Base on space relationship diagram and activity relationship chart on current layout, new layout proposal was generated. As shown in Figure 4 for layout proposal, the layout proposed was made by following production flow process and consider relation between areas of production. There was no major change for the proposed layout, at machine pellet area, waste storage is added at corner section, with the wide of 1.2m x 1.2m. This waste storage useful for reduce waste of production by reused defective plastics as added mixed material for pellet machine. All of HD machine, welding machine, and cutting machine distance are adjusted according to principle of room design. The distance between added material storage to HD machine adjusted from 6m to 5m, the distance between HD machine to welding machine adjusted from 3m to 4m. These adjustments made the material flow easier in the layout. The distance between cutting machine to finished goods storage are adjusted from 10 m to 5m. Then a door with a width of 1m is made to get into office from finished goods storage area to help the workers. Finally, the gate with a width of 2.25m area build to increase security of manufacturer. The material handling for this proposal is more efficient compared to the current layout.

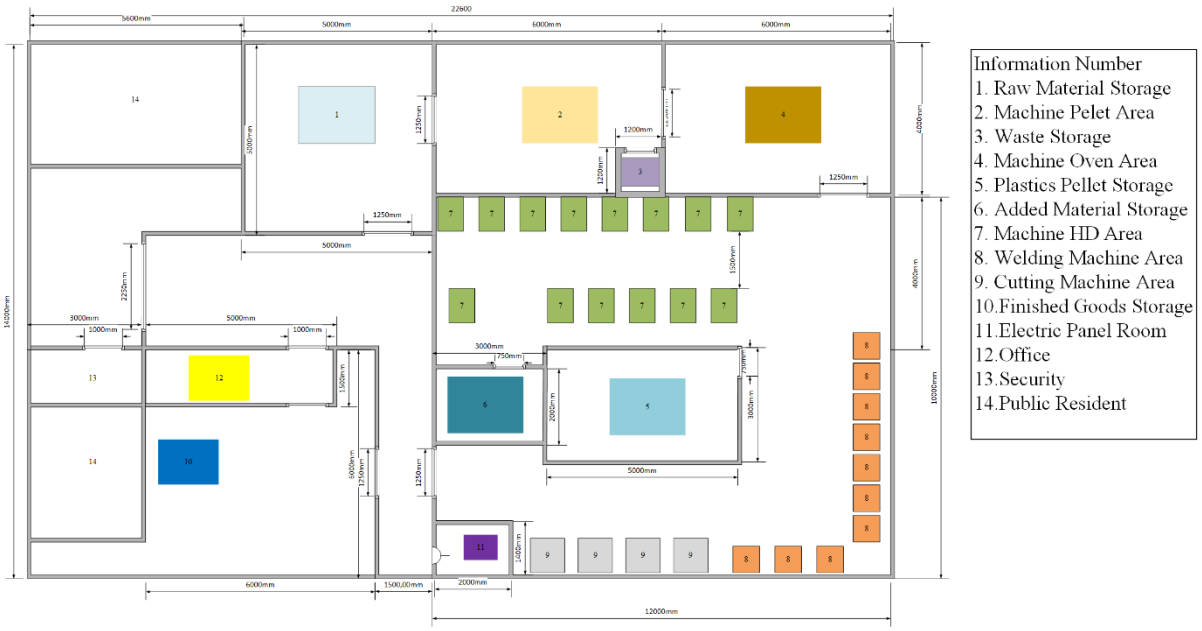


Figure 4. Proposed Layout

After the proposed layout for plastics manufacturer were made, the best layout chosen by compare strengths and weakness of each layouts. In the initial layout, the layout already made according to production flow process and consider relation between areas of production. Weakness in the initial layout was the waste of production are not processed and the location of machine that disturb the production process, resulting in waste such as reduce the productivity, environmental performance and transportation distance. The best layout is chosen by considering total distance of material handling as shown in Figure 5.

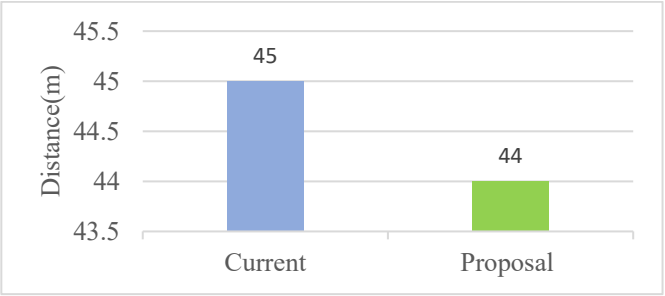


Figure 5. Layout Material Handling Comparison

Figure 5 shown, total material handling in initial layout is 45m, and the first proposal layout is 44m. Therefore, the redesign layout in plastics manufacturer used the proposed layout, with material handling distance of 44 m. This material handling result is 2% more efficient compared initial layout.

In order to understand wastes produced form production process in plastic manufacturer, the green productivity that material balance is utilized (Figure 6). The result is demonstrated one of the Green Productivity tools and technique that initiated by Asian Productivity Organization (Asian Productivity Organization, 2008).

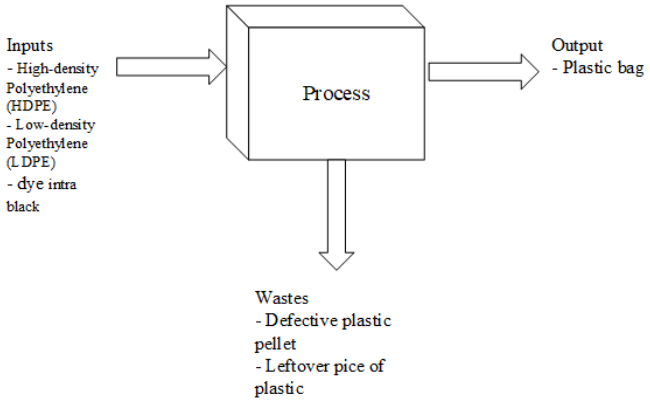


Figure 6. General Material Balance for plastic manufacturer

Process production in plastic manufacturer will through series of input and output, the process will produce waste such as defective plastic pellets and leftover pieces of plastic. These wastes will become the main discussion in this study. In production process, the input includes High-density Polyethylene (HDPE), Low-density Polyethylene (LDPE) that used as raw material for pellet machine to produce plastic pellets, dye intra black used as additional material for HD machine. The output of this production process are plastic bags that can be used. To describe which areas that potentially produce waste, the eco-map is selected and created according to Figure 7. This eco-mapping made according to expected outcome of using Green Productivity from APO (Asian Productivity Organization, 2008).

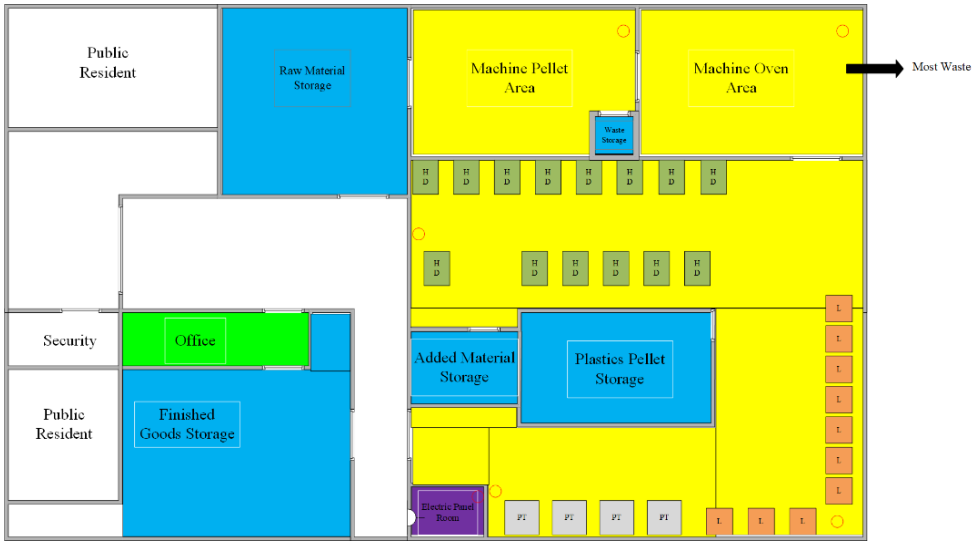


Figure 7. Eco-Mapping of Plastic Manufacturer

In this study, eco mapping is a mapping of company layout to figure area that potentially produce waste to find out what improvement can be made. The mapping is divided into 4 main areas, namely storage area, production area, panel area, and office area. The storage area marked in blue, the production area marked in yellow, while the panel area marked in purple and office area is marked with green. The storage area has 5 parts, which are for raw material, waste, plastic pellets, additional material, and finished goods. The production area has 5 parts, which are machine pellet area, machine oven area, machine HD area, welding machine area, and cutting machine area.

The area that potentially produce waste is symbolized by red circle line in the area. This study will start from storage area, In the storage area, raw material storage, plastic pellets storage, added material storage, and finished goods storage have no potential to cause waste, because of its utility to only store goods. The waste storage was made in order to store the waste to reuse it as additional mixed material and minimize the distance in production flow. In the panel area has minimum potential to cause waste in some circumstances. This is because if the operation in the

manufacturer already finishes and the workers forgot to turn the electricity off. The waste of electricity will occur. In the office area has no potential to cause waste, because of there are always workers in the room.

In the production area is categorized as area that potentially produce waste. Mainly the waste that produced in production area are from electricity, for every machine need electricity to run, the problem will arise if the machine that not used for production still running. Machine oven area used for processing the plastic pellets to fulfil the quality standards material of company. The defective plastic pellets produced in this area was wastes. The cutting machine area used for cutting the plastic rolls into plastic bags, leftover pieces of plastics will appear as a result of the cutting process.

In the initial production process, the defective plastic pellets and leftover pieces of plastic are not processed. According to interview with owner of similar plastic industries, these production waste can be reused as additional mixed material at machine pellet. These waste that previously has no value can be reused again. This process will reduce the environment problem and productivity, by turn these wastes into value added activities.

5. Conclusion

This study for selected plastics manufacturer implements green productivity tools, namely material balance and eco-mapping to find out and decrease wastes of production process, that were defective plastic pellets and leftover pieces of plastic, while plant layout to analyze and increase productivity. Activity relationship chart also used to know relation between area in production process. Based on the distance of material handling, the layout proposed improve the efficiency from material flow by 2% per cycle time calculated. The proposed layout also solves the production waste problem, these wastes are reused as additional mixed materials to gain value added activities. As the result of green productivity implementation, the productivity of company and environmental performance were improved significantly.

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