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FACILITY LAYOUT REDESIGN USING SYSTEMATIC LAYOUT PLANNING METHOD IN PT. PILAR KEKAR PLASINDO

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ABSTRACT

Good equipment and product design are meaningless if there is no good layout planning. Problems owned by PT. Pilar Kekar Plasindo occurs in the production of small polyethylene. This is because small polyethylene production has large material total transfer distance. Small polyethylene problems include the distance between stations, cross-movement, backtracking, and the broken machine that is still placed in the production section. These conditions make the material handling costs and distance large. Therefore, this research aims to produce a layout design of production facilities that can minimize the distance and cost of material movement. The method used in this study is Systematic Layout Planning (SLP). Three alternative designs were compared, and the second proposed facility layout was chosen because it can reduce the total cost of material transfer by 68.3% and reduce the distance of material transfer by 59.6% from the initial facility layout.

Keywords: Material handling, cost, systematic layout planning, ARC, ARD

INTRODUCTION

Problems in the facility layout are often found in many industries, such as backtracking and cross-movement. Those problems occur because of an irregular factory layout. The facility layout design is important to increase company productivity (Pangestik, Handayani, & Kholil, 2016).The unplanned facility layout design and the large distance of material movement can cause many problems such as reduced production and increased costs incurred (Muslim & Ilmaniati, 2018). A good layout is a layout that can handle the material handling system as a whole (Wignjosoebroto, 2003). This is because the material transfer process affects operational flow time by 95% [4]. With a good plant layout design, problems like backtracking, the distance of material movement, and material handling costs can be minimized [5]. PT. Pilar Kekar Plasindo is a company that manufactures polyethylene types. Facility layout at PT. Pilar Kekar Plasindo is included in the process layout type. PT. Pilar Kekar Plasindo has several problems that occur in small polyethylene products, namely the distance between connected stations, cross-movement, and backtracking. Long distances between stations can cause material handling costs to be large and production times to be longer because workers need a longer time in moving goods between the stations. This follows the previous research that poorly planned inter-departmental layout designs and poor material transfer distances can cause problems such as reduced production and increased costs (Muslim & Ilmaniati, 2018). The existence of cross-movement and backtracking results in unfavorable material flow and increases the total material handling distance. Cross-movement is a problem because it causes material flow jams and safety risks (Stephens, 2010). While backtracking causes production costs to increase three times compared to the production flow carried out appropriately.

Based on the problems found in the small polyethylene production section, the improvement that can be done is to make a layout design for the production facility that can minimize the distance and cost of material movement. The method used in this research is Systematic Layout Planning (SLP). SLP can produce a layout design for production facilities that can minimize the total cost of material handling and minimize the distance between production spaces so that the flow patterns of production materials can run smoothly and well-organized (Pangestik et al., 2016). In addition, the use of the SLP method has a detailed procedure in designing factory layouts and can bring up more than one alternative (Muslim & Ilmaniati, 2018).

Previous research in this field used SLP and Blocplan methods (Kustriyanto et al., 2016). Although Blocplan can accept and use Relationship Charts and From To Charts like SLP but Blocplan cannot use both at the same time (Kustriyanto et al., 2016). Blocplan also has the possibility of not being able to describe the initial layout accurately. Another previous research uses a craft algorithm (Paillin & Kalimantan, 2013). Craft algorithm has a weakness that can lead to errors if the department being exchanged has a different size, so the estimated cost of material handling becomes inaccurate (Tompkins, White, Bozer, & Tanchoco, 2010). Another disadvantage of the craft algorithm is that it can only exchange the location of adjacent departments. Another study also used SLP but was applied to the garment industry with a straight type of production flow (Suhardi, Juwita, & Astuti, 2019). While this study uses the SLP method in a plastic factory with a circular production flow type. The existence of this research is expected to improve efficiency and productivity at PT. Pilar Kekindo Plasindo. This research is divided into several sections. Section 1 outlines the introduction. Section 2 describes the materials and methods. Section 3 outlines the Results and Discussion. Section 4 presents the conclusions.

MATERIAL AND METHODS

This study uses the Systematic Layout Planning (SLP) method. SLP method consists of three stages. Those stages are the analysis stage, the adjustment stage, and the evaluation stage (Naganingrum, Jauhari, & Herdiman, 2013). The SLP method starts by analysing the material flow, analysing the needs of the available area, planning the spatial relationship diagram, and designing the alternative facility layout. The last step is to choose the alternative facility layout that has been designed. This research was conducted in several stages. The first stage is direct observation and interviews with several production workers and non-production workers in PT. Pilar Kekar Plasindo. From the observation and interview stage, the conditions and the problems that exist in this company can be identified. Based on direct observations and interviews, it is known that the layout design for small polyethylene production needs to be done. The next stage is data collection consist of primary data and secondary data. Primary data obtained from direct observations in the field such as the initial facility layout of the company, the available production process area, the number and size of machines, and the flow of material. While secondary data obtained from the company in the form of general corporate data, organizational structure, production processes, and employee data. The next step is processing the initial facility layout data and designing the proposed facility layout.

Initial Facility Layout Data Processing

Data processing is carried out in the initial facility layout using SLP, namely material flow analysis that consists of determining the frequency of material transfer and determining the distance of material transfer by the rectilinear method using equation (1). Then the calculation of material handling costs (OMH) uses equation (2), determination From To Chart Inflow uses equation (3), and priority scale table. The following are the equations in the initial facility layout data processing.

$$d_{ij} = |x_i - x_j| + |y_i - y_j| \tag{1}$$

$$\text{OMH Total} = (\text{OMH per meter}) \times (\text{transportation distance}) \times (\text{frequency}) \tag{2}$$

$$\text{Inflow} = \frac{\text{The Cost on Machine A}}{\text{The Cost that goes to machine A}} \tag{3}$$

Proposed Facility Layout Design

Data processing with SLP produces a draft of facility layout design consists of adjustments and evaluations. The adjustment stage has several steps, namely creating an Activity Relationship Chart (ARC), creating Activity Relationship Diagram (ARD), determining the required area, and making three alternative improvements to the layout of existing production facilities. Activity Relationship Chart (ARC) is symbolized by the letters A, E, I, O, U, and X. The letters indicate the level of importance ranging from activities that are absolutely essential to undesirable activities. Activity Relationship Diagram (ARD) is a material flow analysis after ARC that makes the visualization of material flow and activity relationships between workstations clearer. While determining the required area is done by considering the area of the machine and equipment, as well as the space for the operator. The allowance space for operators is 15%. The allowance given to each machine is 0.75 meters until 1 meter based on the industrial facilities method (Purmono, 2004). Then the proposed layout design is based on the previous data processing. While the evaluation stage is to choose from three alternatives facility layouts that have been designed.

RESULTS AND DISCUSSION

Frequency of Material Handling Between Work Areas

The determination of the material transfer frequency is obtained based on direct observation in the process of producing small polyethylene plastics at PT. Pilar Kekar Plasindo. The initial facility layout with a scale of 1: 100 is shown in Figure 1 and the frequency of material transfer in small polyethylene production is shown in Table 1.

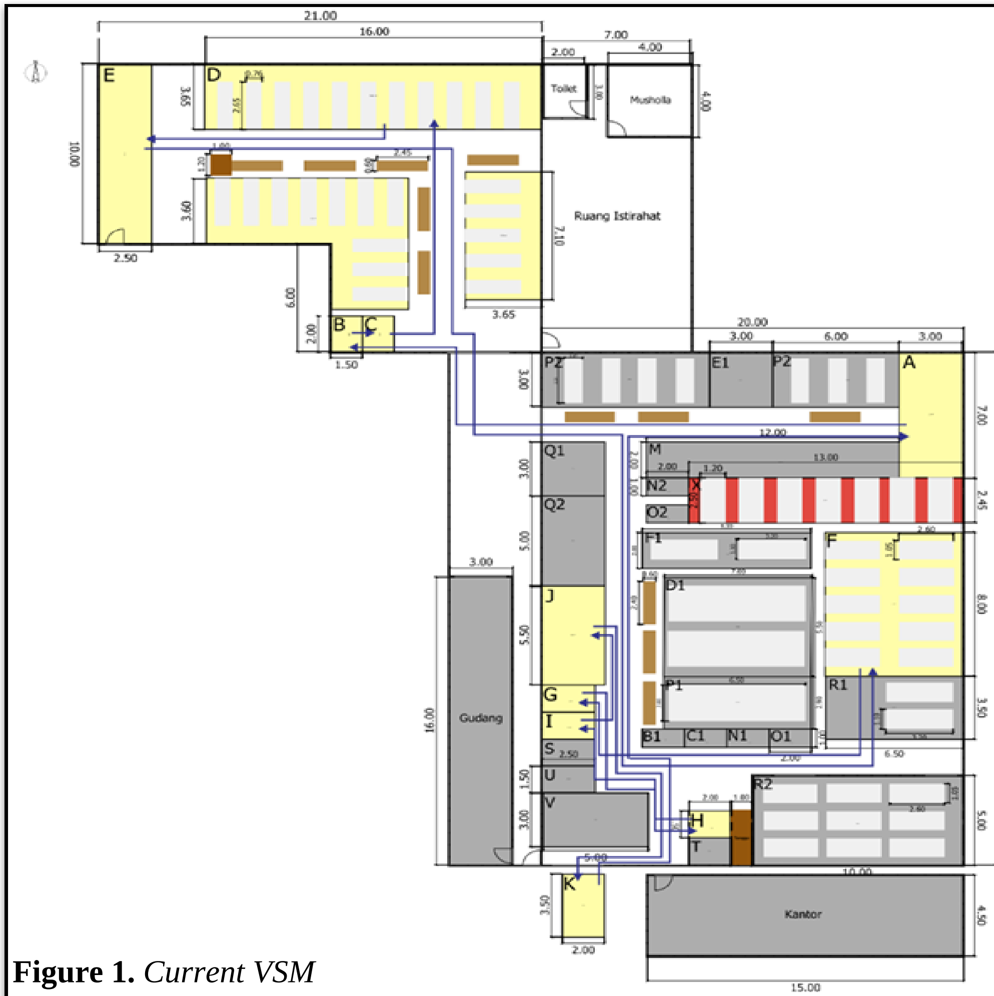

Figure 1. *Current VSM*

Table 1.

Frequency of Material Handling Between Work Areas

No	Type of activity	Conveyance	Total Activities per Day (Unit) (d)	Material Handling Capacity (Unit) (e)	Material Handling Total per Day (f) = (d) / (e)	Frequency (g) = (f) x 24 days	Process Sequence
1	Retrieval of raw materials	Trolley	96	6	16	384	K,A
2	Mixing of raw materials	Trolley	192	6	32	768	A, B

3	Heating of raw materials	Man	192	1	192	4608	B, C
4	Manufacture of plastic rollers	Trolley	192	6	32	768	C, D
5	Storage of semi-finished products	Trolley	192	6	32	768	D, E
6	Plastic cutting	Trolley	192	6	32	768	E, F
7	Inspection	Trolley	192	6	32	768	F, G
8	Stitching	Man	192	1	192	4608	G, H
9	Packaging	Man	192	1	192	4608	H, I
10	Finished product storage	Trolley	192	6	32	768	I, J
11	Shipment of finished products	Trolley	96	6	16	384	J, K

Determination of Material Transfer Distance Using the Rectilinear Distance

The determination of material transfer distance between workstations can be calculated using Rectilinear distance. Rectilinear distance is the distance measured following the perpendicular path. The total displacement distance in small polyethylene production is 229 meters.

Initial Material Handling Cost

Material handling cost in the production of small polyethylene plastics is divided into two, namely human labor cost and trolley-help cost. The total material handling cost for the production of small polyethylene plastics is shown in Table 2.

Table 2.

Initial Material Handling Cost

From	To	Component	Conveyance	Frequency (g)	Distance (m) (h)	Total Distance (m) (i)=(g)x(h)	Material Handling Time (s) (j)	Material Handling Time (s) (k)=(j) x (g)	OMH/ meter (Rp) (l)	Tot OMH / Month (Rp) (m)=(i)x(l)
K	A	Plastic seed	Trolley	384	40,75	15.648	82	31.488	170	2.654.481
A	B	Plastic seed	Trolley	768	32,25	24.768	71	54.528	170	4.201.571
B	C	Plastic seed	Man	4.608	1,50	6.912	5	23.040	123	849.563

C	D	Plastic seed	Trolley	768	13,50	10.368	32	24.576	170	1.758.797
D	E	Plastic rollers	Trolley	768	15	11.520	36	27.648	170	1.954.219
E	F	Plastic rollers	Trolley	768	61,50	47.232	110	84.480	170	8.012.297
F	G	Plastic pieces	Trolley	768	20,75	15.936	48	36.864	170	2.703.336
G	H	Plastic pieces	Man	4.608	13,75	63.360	26	119.808	132	7.787.664
H	I	Finished product	Man	4.608	12,25	56.448	23	105.984	123	6.938.101
I	J	Finished product	Trolley	768	5,25	4.032	21	16.128	170	683.977
J	K	Finished product	Trolley	384	12,50	4.800	25	9.600	170	814.258
				19.200	229	261.024	479	534.144	1.726	38.358.263

Inflow

Inflow calculation is made based on From To Chart. Inflow shows the coefficient of costs on From To Chart that seen from the costs that go into a machine. The inflow coefficient is shown in Table 3.

Table 3.

Inflow

To From	K	A	B	C	D	E	F	G	H	I	J	Total OMH
K		1										1
A			1									1
B				1								1
C					1							1
D						1						1
E							1					1
F								1				1
G									1			1
H										1		1
I											1	1
J	1											1
Total OMH	1	1	1	1	1	1	1	1	1	1	1	11

Priority Scale Table

The priority scale table is obtained from the calculation of inflow. Priorities are sorted by the inflow coefficient where the largest coefficient is placed on the first. TSP in small polyethylene production is shown in Table 4.

Table 4.

Priority Scale Tables

No	Work Areas	Code	Priority	
			I	II
1	The raw material warehouse area	A	B	
2	Material mixing area	B	C	
3	Material heating area	C	D	
4	The plastic roller manufacturing area	D	E	
5	Semi-finished material area	E	F	
6	Cutting area	F	G	
7	Inspection area	G	H	
8	Stitching area	H	I	
9	Packaging area	I	J	
10	Finished good area	J	K	
11	Loading and unloading area	K	A	

Activity Relationship Chart (ARC)

The next step is creating an Activity Relationship Chart (ARC). ARC is arranged based on the level of relationship importance between activities and each has a reason for the closeness. In the making of ARC, it is necessary to consider the priority scale table. ARC in the production of small polyethylene is shown in Figure 2.

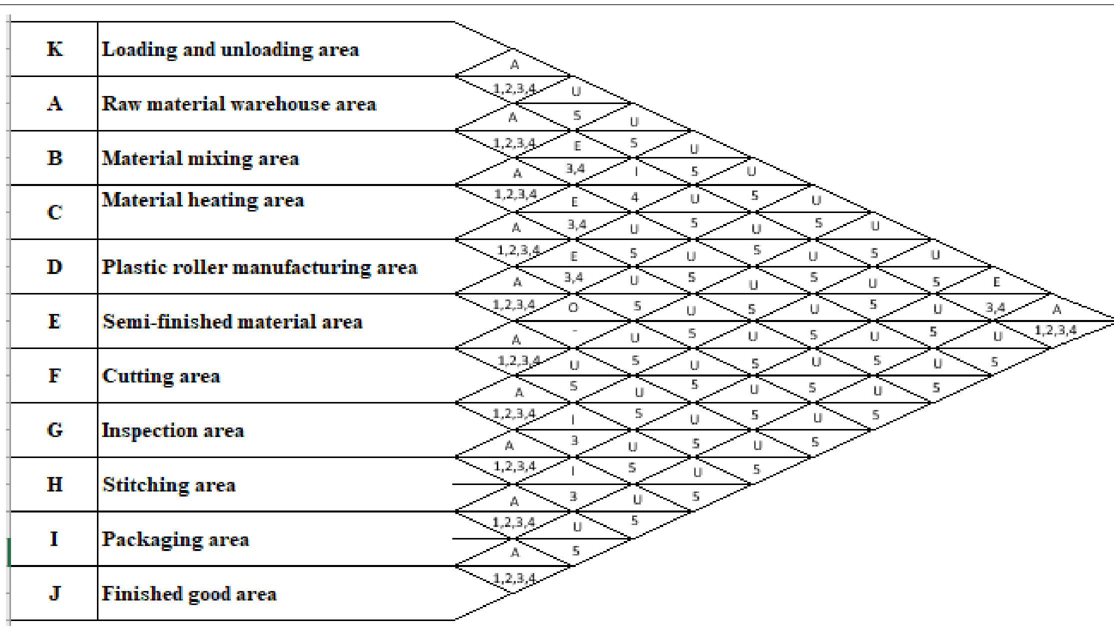

Figure 2. *Activity Relationship Chart*

Determination of Area Required

Determination of the area required is aimed at designing the layout of the proposed facilities that are adjusted to the needs of production activities. Three things that can be used as a basis for determining the area are the level of production, equipment needed, and employees who work in the area. The area required for small polyethylene production is shown in Table 5.

Table 5.

Area Required in Small Polyethylene Plastic Production Areas

No	Activity Area	Machine or Material	Total (m)	Machine + Tolerance		Area (L) = (m)x(a)x(b)	Allowance (15%)	Room Needs (N) = (L)+(c)
				Length + Tolerance = (a)	Width + Tolerance = (b)			
1	The raw material warehouse area	Plastic seeds	24			7,02	1,053	8,073
2	Material mixing area	Mixing machine	1	2,75	2,25	6,1875	0,928125	7,115625
3	Material heating area	Heating machine	1	2,75	2,25	6,1875	0,928125	7,115625
4	The plastic roller manufacturing area	Rolling machine	26	3,4	1,5	132,6	23,778	182,298
		Table	6	3,2	1,35	25,92		
5	Semi-finished material area	Plastic roll	32	0	0	9,36	1,404	10,764
6	Cutting area	Cutting Machine	10	3,05	1,8	54,9	9,9675	76,4175
	Inspection area	Mini digital scales	10	1,1	1,05	11,55		
7	Stitching area	Big digital scales	2	1,55	1,4	4,34	0,651	4,991
8		Stitching machine	2	1,65	1,15	3,795	0,56925	4,36425
9	Packaging area	Packing machine	2	1,65	1,35	4,455	0,66825	5,12325
10	Finished good area	Finished Products	24	0	0	7,02	1,053	8,073
11	Loading and unloading area	Truck	1	4,25	2,75	11,6875	1,753125	13,440625
								327,775875

Proposed Facility Layout Design

The proposed facility layout design has a circular material flow patterns. The improvements carried out are moving the damaged machine to the warehouse and arranging the machines, tools, and workstations following the results of the finished product and the order of the process. Distance of material transfer and material handling costs in the three alternative improvements are obtained. The total result of material transfer distance from the first proposal is 98 meters. The total distance of material transfer from the first proposal is 131 meters shorter or 57% shorter than the initial facility layout. Total OMH per month from the first proposal is Rp 13,498,656.00, which is reduced by Rp 24,859,607.00 or by 64%.

The total result of material transfer distance from the second proposal is 92.5 meters. The total distance of material transfer from the second proposal is 136.5 meters shorter or 59.6% shorter than the initial facility layout. The total monthly OMH from the second proposal is Rp 12,163,273.00, which is reduced by Rp 26,194,990.00 or 68.3%. While the total result of material transfer distance from the third proposal is 92.5 meters. The total distance of material transfer from the third proposal is 136.5 meters shorter or 59.6% shorter than the initial facility layout. Total OMH per month from the third proposal is Rp 12,716,968.00, which is reduced by Rp 25,641,295.00 or by 66.8%. The facility layouts of the first proposal until the third proposal are shown in Figure 3 until Figure 5 respectively.

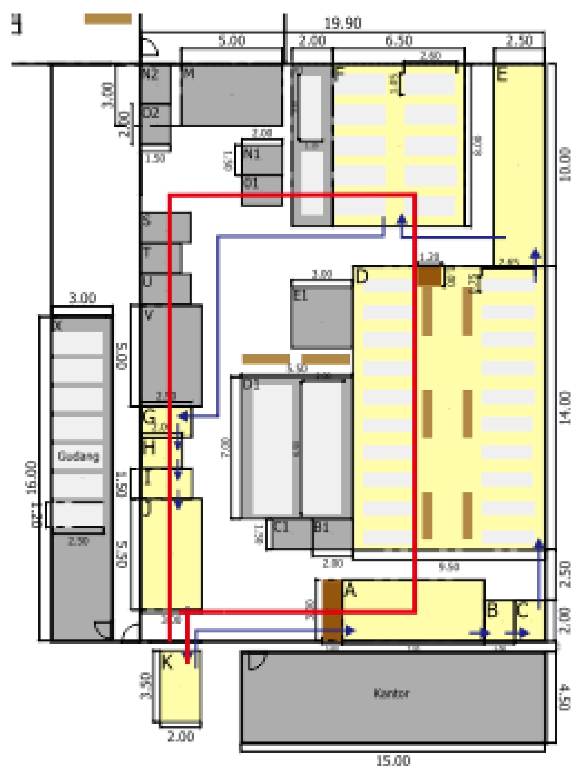

Figure 3. *The First Proposed Facility Layout*

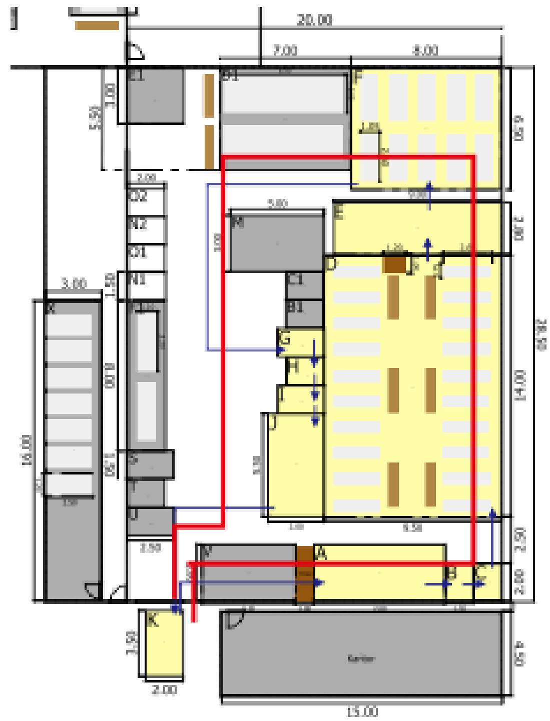

Figure 4. *The Second Proposed Facility Layout*

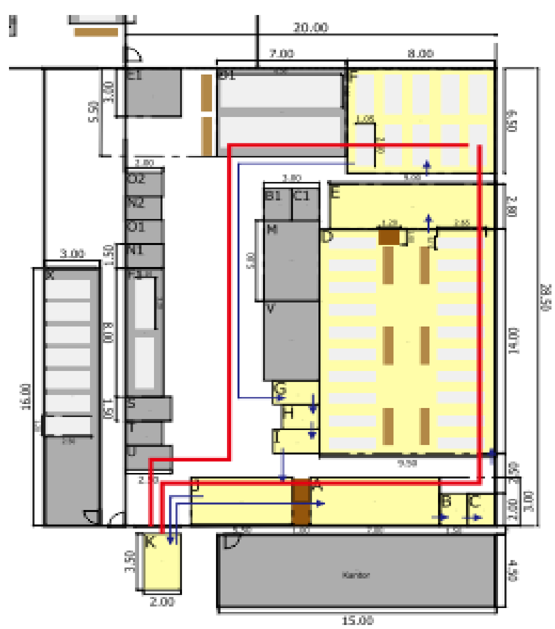

Figure 5. *The Third Proposed Facility Layout*

Based on the results of the calculation, the chosen facility layout is the second because it can reduce the total material transfer costs by 68.3% and reduce the material transfer distance by 59.6% from the initial facility layout. This percentage is the largest compared to the two other alternative proposals.

CONCLUSION

This study improved the facility layout for small polyethylene production at PT. Pilar Kekar Plasindo using the SLP method. Three alternatives layout design proposals are made in this study and it is found that the second alternative facility layout has a better performance compared to the first and the third proposals. The layout of the second proposed facility was chosen because it has the smallest distance and the smallest cost of material handling compared to the other proposed facility layouts. The layout of the second proposal also eliminates backtracking and reduces cross-movement.

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