Prayer paper production facility layout redesign using systematic layout planning method and CRAFT

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Abstract.

Abstract. *The facility layout is a strategic design that is used for a long time. All manufacturing industries must pay attention to the right layout to increase the productivity of the industry. A prayer paper manufacturing industry located in the Tanjung Morawa area, Medan has an error in the placement of raw materials and the placement of production machines, so that the distance from the temporary warehouse to the printing and cutting work stations is far apart, causing high material handling costs. Seeing these problems, research was carried out to improve the layout of the facilities and redesign. The method used for this research is Systematic Layout Planning (SLP), which is one of the methods used to regulate a workplace in a factory by using two areas with high frequency and logical relationships with each other. And the Computerized Relative Allocation of Facilities Technique (CRAFT) Algorithm is a repair program, which is a program that looks for optimal design by making gradual improvements to the layout. CRAFT evaluates the layout by interchanging departmental locations. Inputs required for the CRAFT algorithm include initial layout, data flow or frequency of movement, cost data per unit distance, and the number of departments that do not change or remain. The CRAFT method is usually applied using Quantitative Systems (QS) software. By comparing the layout between SLP and CRAFT, the optimal result is obtained using the SLP method by reducing the distance between departments by 1.407 meters or a distance efficiency of 39.91%.*

Keywords: *ARC, ARD, Craft, Distance, Layout, Optimize, SLP.*

1. INTRODUCTION

The facility layout is a strategic design that is used for a long time. Layout planning is an integrated planning of the production flow of a product. It will be very detrimental if the layout owned by the company is not efficient and effective. By being inefficient and ineffective, there is a possibility of causing cost or over motion in production activities.

In planning a facility layout that must be a serious concern, namely how to place materials (raw materials, semi-finished materials, finished materials) as well as the placement of production equipment (production machines, boilers and others), if a

placement is not suitable for its location. it can result in obstruction of the existing production process in the company, with the appropriate placement of machines will make the production flow smooth.

The praying Paper Making Industry as one of the manufactures that produces paper is located in Tanjung Morawa Medan, North Sumatra. As a company that continues to make improvements, the company evaluates its production activities. One of the concerns is the layout of the company's facilities. The layout that is owned is not optimal and has an impact on company performance and productivity. The facility layout problem can be defined as an optimization problem that tries to make the layout more efficient by paying attention to the various interactions between the facility and the material handling system when designing the layout (Maral Zafar Allahyaria and Ahmed Azab, 2014) for example errors in the placement of materials to be transported to the machine production so as to cause moving distances that are far enough and increase the cost of production of these goods so that a re-planning of facilities is needed so that it can run effectively.

Systematic Layout Plant (SLP) is a method used to design the layout and as a method of solving problems caused by the non-optimal placement of the facility layout. To design the SLP layout, pay attention to the process and the close relationship between departments based on material flow. CRAFT is an example of a Heuristic technique type program based on the Quadratic Assignment interpretation of the layout process program, which has the basic criteria used to minimize the cost of material movement, where this cost is described as a linear function of the displacement distance. The objective functions of the CRAFT are:

$$F = \max/\min \Sigma_{ij} C_{ij} W_{ij} D_{ij} \quad (1)$$

Where:

Cij = Cost of flow between departments

Wij = Flow frequency between departments

Dij = Distance between departments

CRAFT requires input in the form of material transfer costs.

II. METHODS

This research was conducted through the stages that have been arranged. These stages, namely, problem identification activities, looking for references related to the problem being studied, determining the method as a problem solver, conducting field studies, namely the data collection stage. The next stage is processing the collected data, discussing it, and drawing conclusions. Meanwhile, to perform data processing / analysis, and design of the layout of this study using several methods, namely:

- Activity Relationship Chart (ARC), is used to convert quality into quantity. The compilation of the ARC itself is carried out based on the level of linkages and reasons between work stations. ARC is compiled by providing a code based on the value and reason for the relationship between work stations (Figure 1.1). In this research, ARC is compiled with 15 work stations, and each part / station is assigned a value of A, E, I, O, U, or X.

- Systematic Layout Planning (SLP), which is a layout design method by paying attention to material flow or production sequences. To be able to do SLP design using the level of relationship or linkage of the ARC. In addition, SLP also uses ARD (Activity Relationship Diagram) which is arranged based on the value of ARC proximity and adjusted to the flow of the material.

- CRAFT, which is the method used to design layouts with minimum displacement distances.

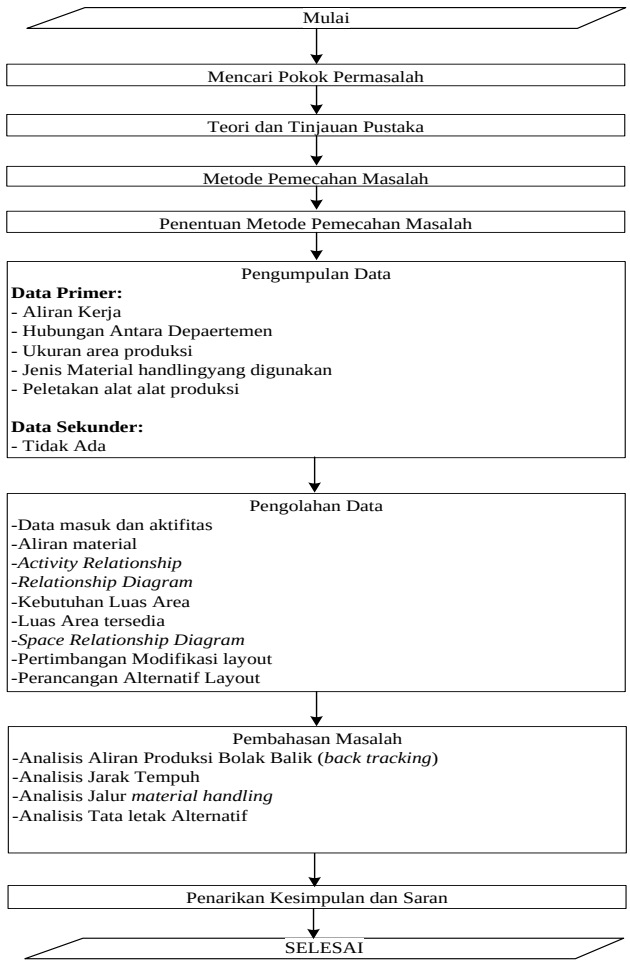

Fig. 1. Research Flowchart

III. RESULT AND DISCUSSION

In carrying out its operational activities, the company has 15 departments / work stations that are directly related to paper production activities. For the production area there are 3 buildings with a size of 18 x 12 m which are arranged lengthwise. The following is the initial layout of the company.

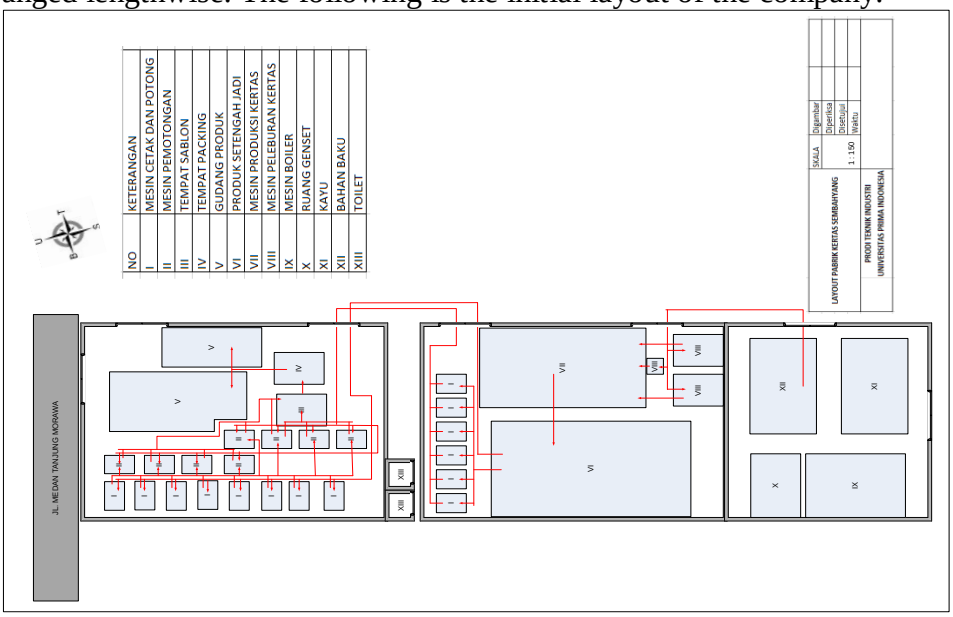

Fig. 2. Initial Layout

To allocate work stations, the first step is ARC analysis of paper production.

NO.	AKTIVITAS
1	BAGIAN PRODUKSI KERTAS
2	BAGIAN PELEBURAN KERTAS
3	GUDANG BAHAN BAKU
4	BAGIAN PENERIMAAN BAHAN
5	BAGIAN PENGIRIMAN PRODUK
6	GUDANG PRODUK
7	GUDANG SETENGAH JADI
8	GUDANG KAYU
9	BAGIAN CETAK DAN PEMOTONGAN
10	BAGIAN PEMOTONGAN
11	BAGIAN SABLON
12	BAGIAN PACKING
13	MESIN BOILER
14	TOILET
15	RUANG GENSET

DERAJAT KEDEKATAN

Fig. 3. Activity Relationship Chart

After obtaining the ARC analysis, then the station allocation is carried out based on the SLP method and Corelap Algorithm with the ARC relationship and the Total Closeness Rate (TRC).

SLP is a layout design method, combining logistic relationship analysis with non-logistical relationship analysis to solve layout problems and considers minimal logistics costs as its goal.

Collection of input and activity data.

Material analysis and operational activities.

Creating an Activity Relationship Diagram (ARD)

Relationship diagram.

Area requirement.

Layout design (Wignjosoebroto, 2009)

After making ARC, the next step is making ARD which can be seen in Figure 4.

A 13	E 15	I 2				A 6	E 12	I 1,4,9,10,11
14. TOILET						5. BAGIAN PENGIRIMAN PRODUK		
O 1,8,9,10,11,12	U 3,4,5,7,14	X -				O 2,3,7,8	U 14	X 13,15
A -	E 14	I -	A 1,2,3	E 7,9	I 5,6,10,11,12	A 5,12	E 11	I 1,3,4,7,9,10
15. RUANG GENSET			4. BAGIAN PENERIMAAN BAHAN			6. GUDANG PRODUK		
O 2,3,4,13,15	U 1,9,10,12	X 5,6,7,8,11	O 8,15	U 13,14	X -	O 2,8	U 14	X 13,15
A 14	E 8	I -	A 1,2,4	E 7,9	I 10,11,14	A 6,11	E 5	I 1,3,4,7,9,10
13. MESIN BOILER			3. GUDANG BAHAN BAKU			12. BAGIAN PACKING		
O 3,15	U 1,4,9,10,12	X 2,5,6,7,11	O 5,6,8,12,15	U -	X 13	O 2,8,14	U 13,15	X -
A -	E 13	I 3	A 1,3,4	E 7,9	I 10,11,14	A 10,12	E 1,6	I 2,3,4,5,7,9
8. GUDANG KAYU			2. BAGIAN PELEBURAN KERTAS			11. BAGIAN SABLON		
O 1,2,4,6,8,9 10,11,14	U -	X 7,15	O 5,6,8,12,15	U -	X 13	O 8,14	U -	X 13,15
			A 2,3,4,7,9	E 10,11	I 5,6,7	A 11	E 1	I 2,3,4,5,6,7,9, 12
			1. BAGIAN PRODUKSI KERTAS			10. BAGIAN PEMOTONGAN		
			O 8,14	U 13,15	X	O 8,14	U 13,15	X -
			A 1,9	E 2,4	I 3,6,10,11,12	A 1,7,10	E 2,4	I 3,5,6,11,12
			7. GUDANG SETENGAH JADI			9. BAGIAN CETAK DAN PEMOTONGAN		
			O 5	U 14	X 8,12,15	O 8,14	U 13,15	X -

Fig. 4. *Activity Relationship Diagram* (ARD)

The next step, designing a Relationship Diagram. Like the following picture:

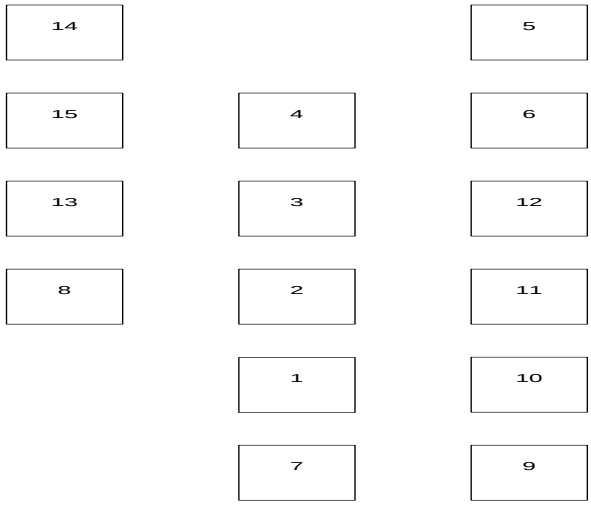

Fig. 5. Relationship Diagram

After designing the relationship diagram, it is followed by designing the area requirements, namely:

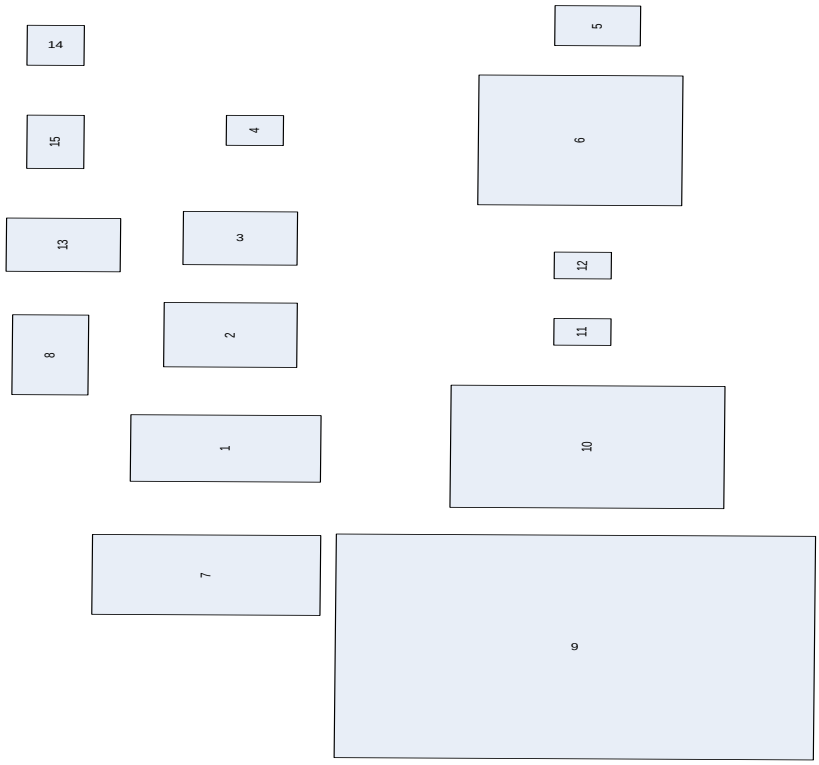

Fig. 6. Required Space

From the steps above, a final layout design using the SLP method is formed, namely:

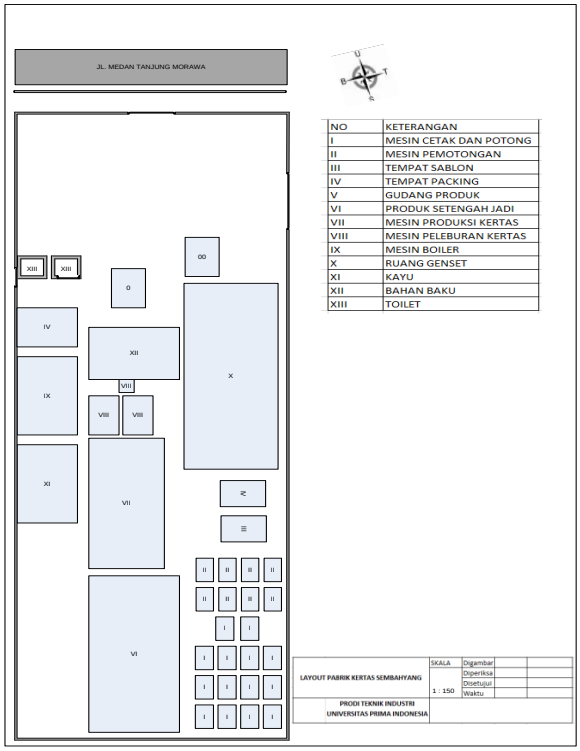

Fig. 7. Final Layout Using SLP Method

CRAFT Method

As for the things that are related in this activity, namely the displacement distance and the coordinate points of each department. The iteration of activities can be seen in the appendix. The following are the results of using the CRAFT method for 12 departments or work stations of the Company.

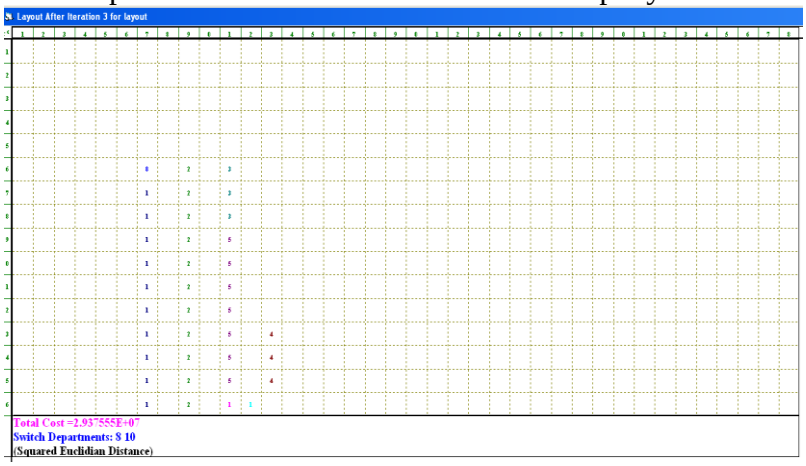

Fig. 8. CRAFT Layout

Table 1. Layout Analysis

10-11-2020 13:52:37	Department Name	Center Row	Center Column	Flow to All Departments
1	1	11.50	7	15850
2	2	11	9	15525
3	3	7	11	19425
4	4	14	13	18525
5	5	12	11	20505
6	6	0	0	12855
7	7	0	0	11830
8	8	6	7	13425
9	9	0	0	19875
10	10	16	12	15105
11	11	0	0	20235
12	12	16	11	15825
Total				**198980**

The final results obtained can be seen in the table 2.

Table 2. Displacement Distance Results

Displacement	Displacement Distance (cm)			
	Initial Layout	SLP	Corelap	Craft
XII - VIII	150	30	165	377
VIII – IX	615	60	900	85
IX – VII	990	33	1500	0
VII – VI	90	60	120	0
VI – II	900	120	1356	202
II – I	525	60	1470	4,25
I - III	45	570	1810,5	36,25

Based on the table above, a layout with the smallest total displacement distance of each layout is obtained. The layout with the smallest displacement distance is the layout using SLP with a total displacement distance of 2118 cm.

$$\frac{3525-2118}{3525}\times 100\%=39{,}91\%$$

thus, the displacement distance on the production floor at the company is optimized.

IV. CONCLUSION

This study proposes to improve the facility layout of the company using the Sytematic Layout Planning (SLP) method and Corelap Algorithm. The layout chosen was the layout with the smallest displacement distance, namely the SLP method where there was a reduction in the distance of 1,407 meters or by 39.91%.

V. ACKNOWLEDGMENTS

Thank God for the glory ang His mercy, for my lecture, team and all my support sistem that this study have done.

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